United States Patent

Kellner et al.

[15] **3,688,965**

[45] **Sept. 5, 1972**

[54] MACHINE FOR FABRICATING WALLS

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[22] Filed: **Oct. 13, 1969**

[21] Appl. No.: **865,742**

[52] **U.S. Cl.** **227/45,** 227/50, 227/100, 227/103, 227/152

[51] **Int. Cl.** **B27f 7/02**

[58] **Field of Search**.....227/3, 20, 21, 39, 40, 44, 227/45, 48, 50, 76, 99, 100, 101, 103, 152

[56] **References Cited**

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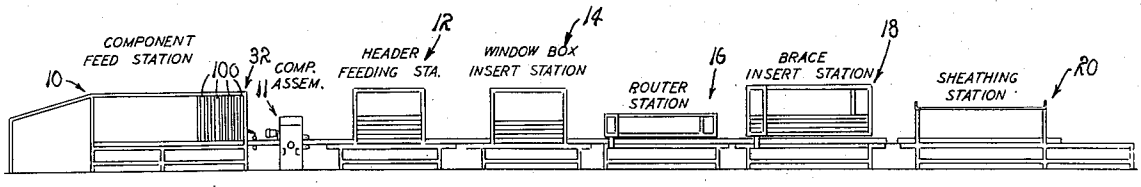
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Primary Examiner—Granville Y. Custer, Jr.
Attorney—Huebner & Worrel

[57] **ABSTRACT**

A machine for fabricating walls from wood framing materials, particularly suited for use in fabricating walls of a type normally employed in constructing frame structures and the like, characterized by an employment of a series of sequentially actuated machine systems electrically interconnected for selecting and feeding components and for selectively assembling the components into walls having adjustably regulated dimensions and selectively controlled spaced and dimensioned openings defining doors, windows and the like, a particular feature of the invention being a combination of an electrical control system interconnected with a series of operative systems for driving the machine through a predetermined sequence of machine events, in redundant or non-redundant modes, for fabricating a series of walls to be erected into frame structures.

13 Claims, 31 Drawing Figures



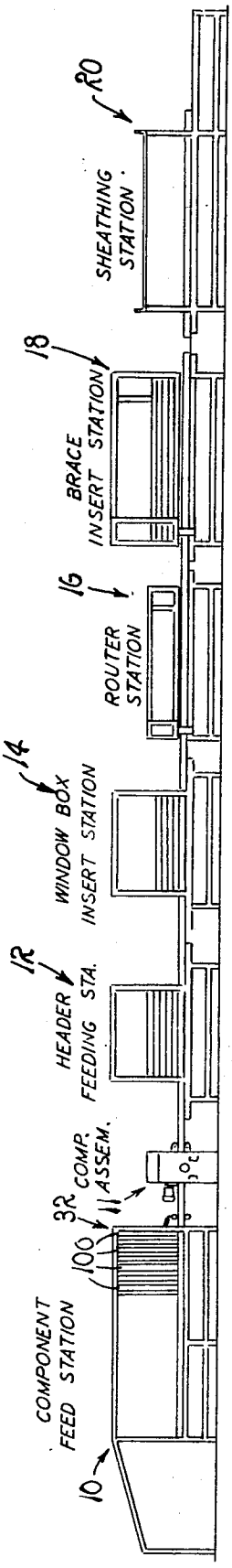


FIG. 1.

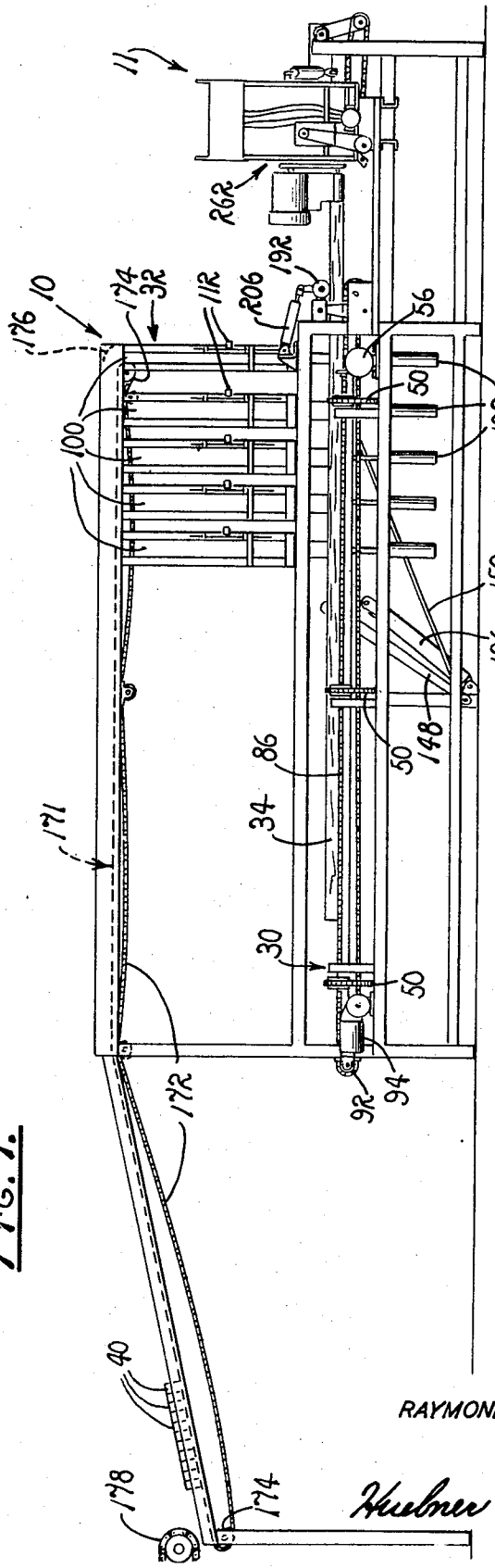


FIG. 2.

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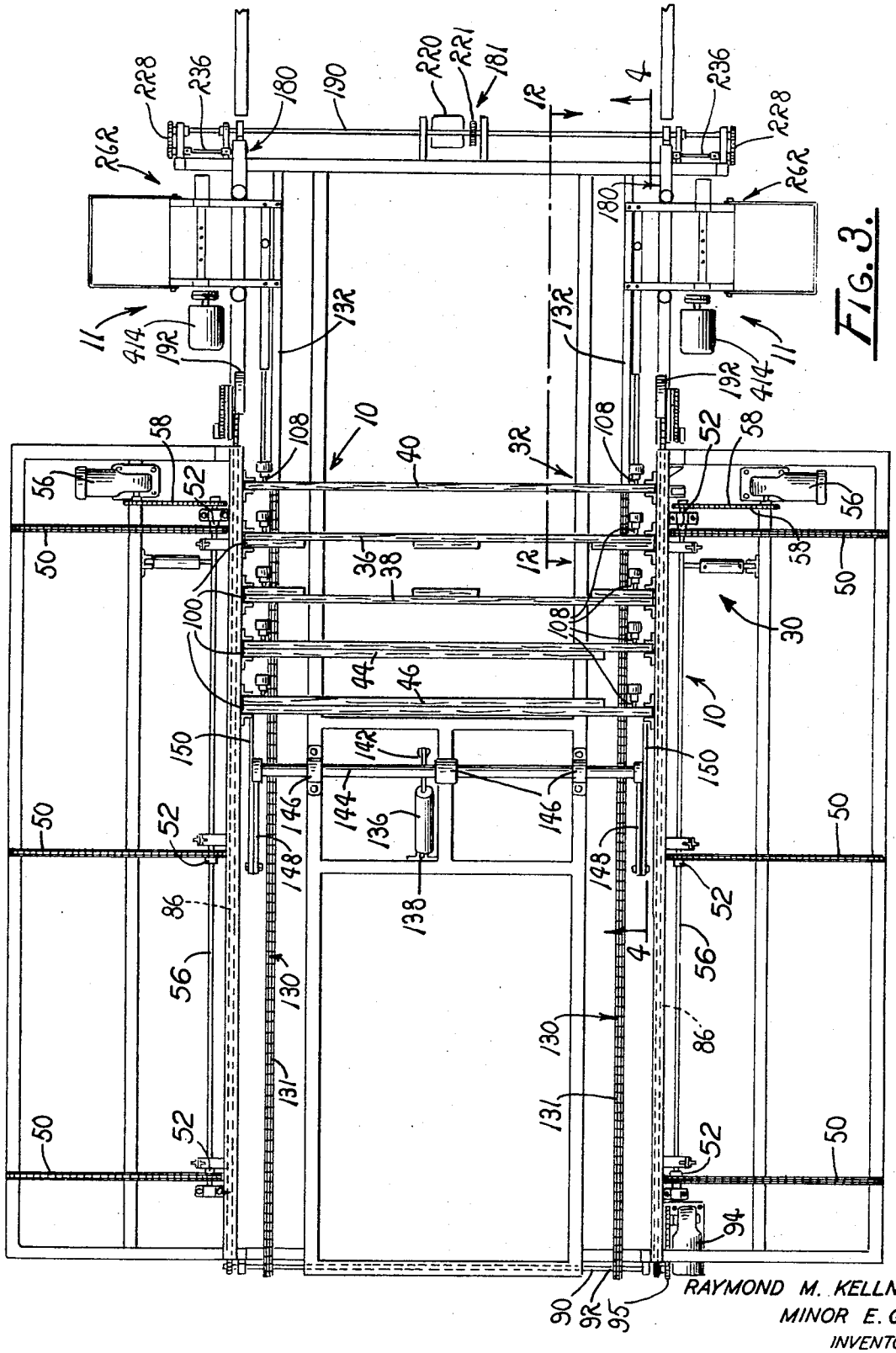


FIG. 3.

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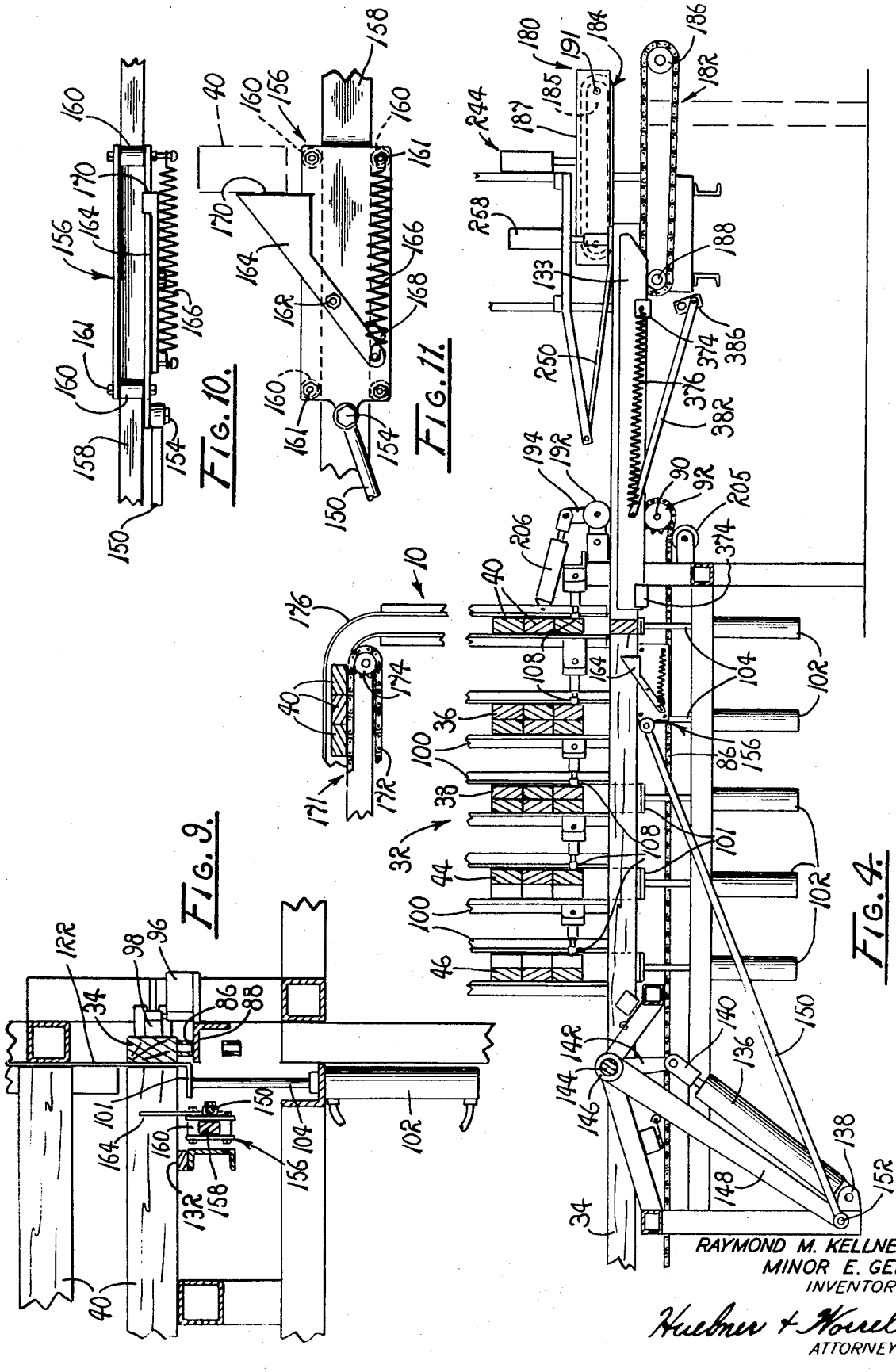


FIG. 10.

FIG. 11.

FIG. 9.

FIG. 4.

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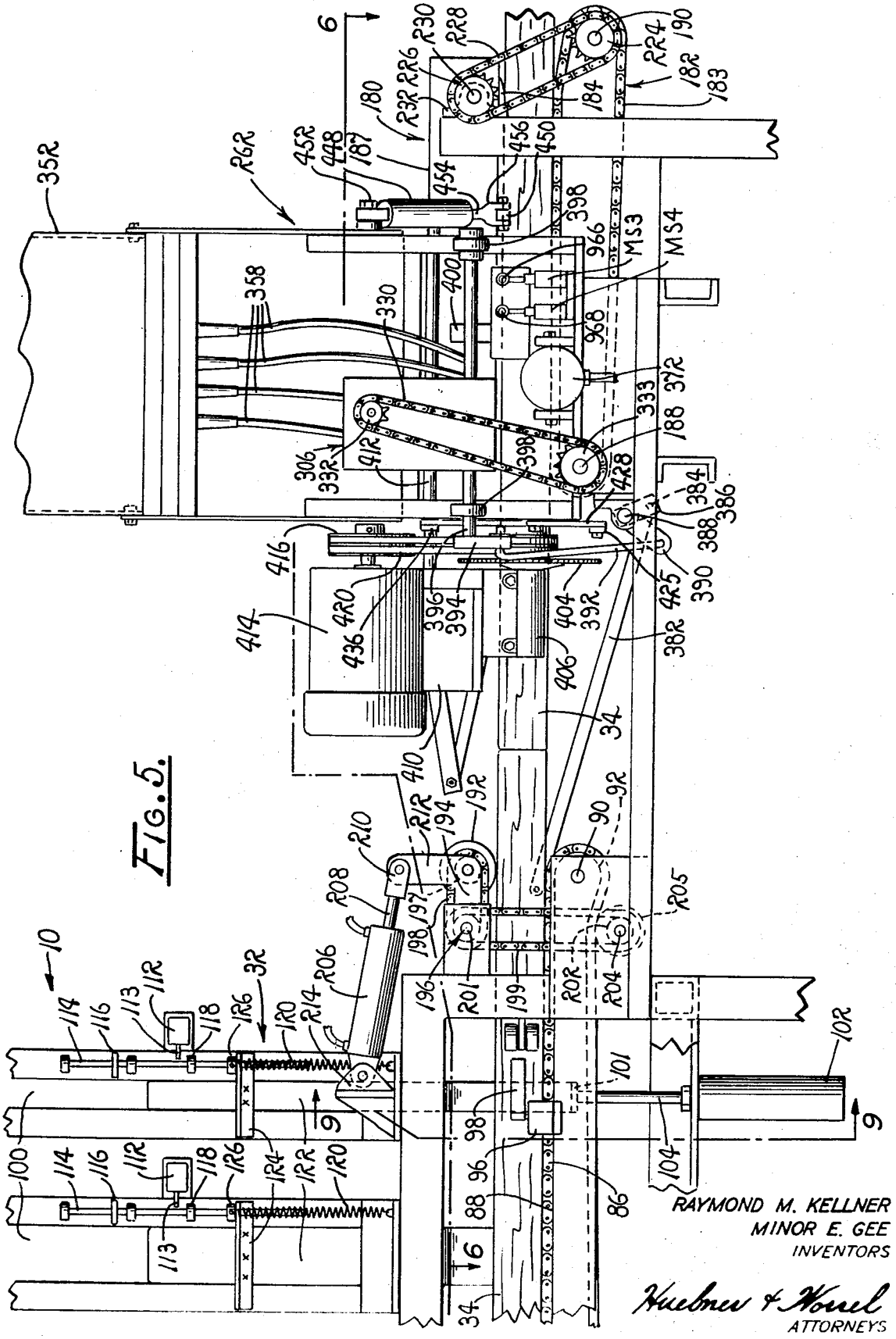


FIG. 5.

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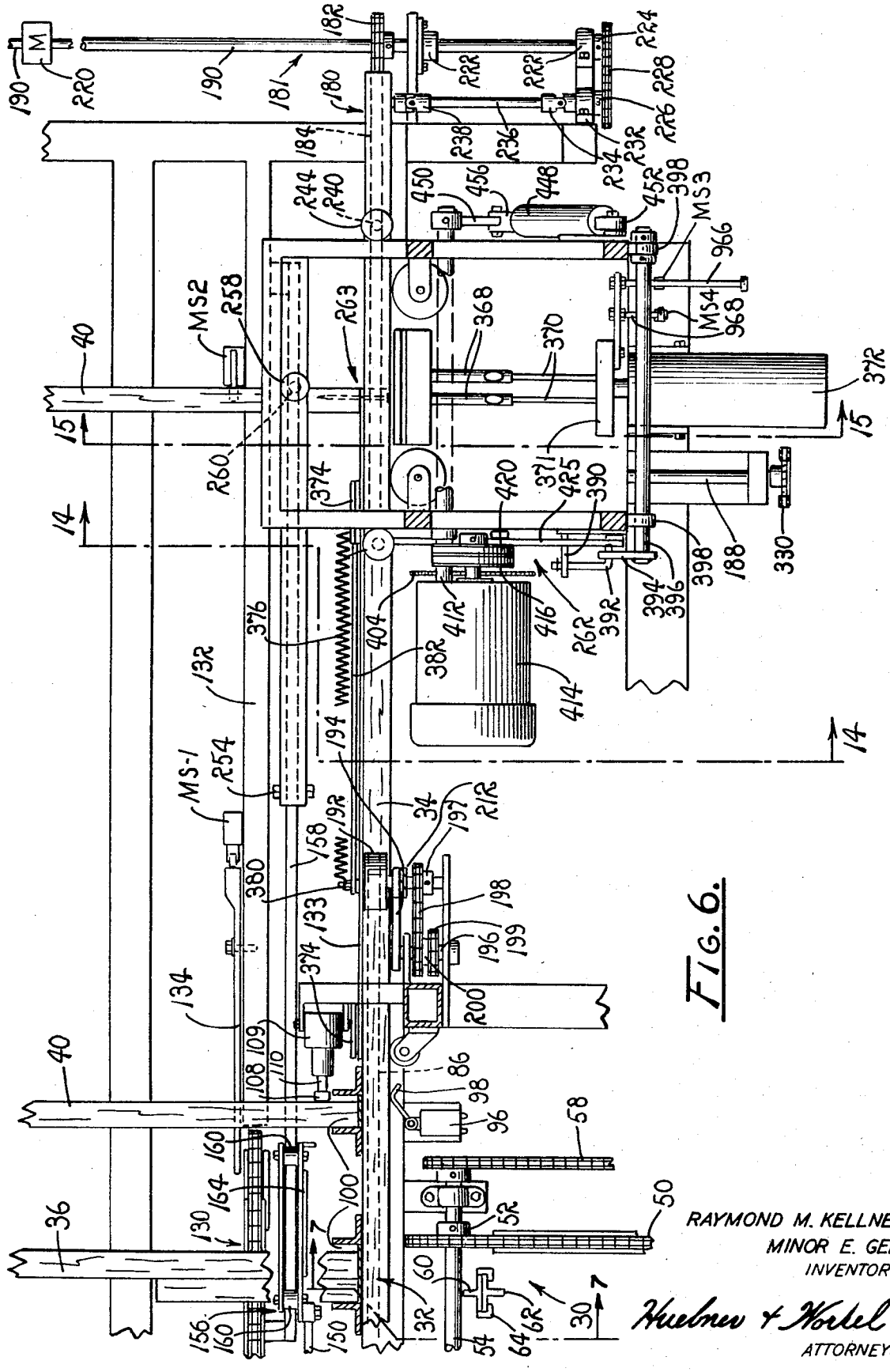


FIG. 6.

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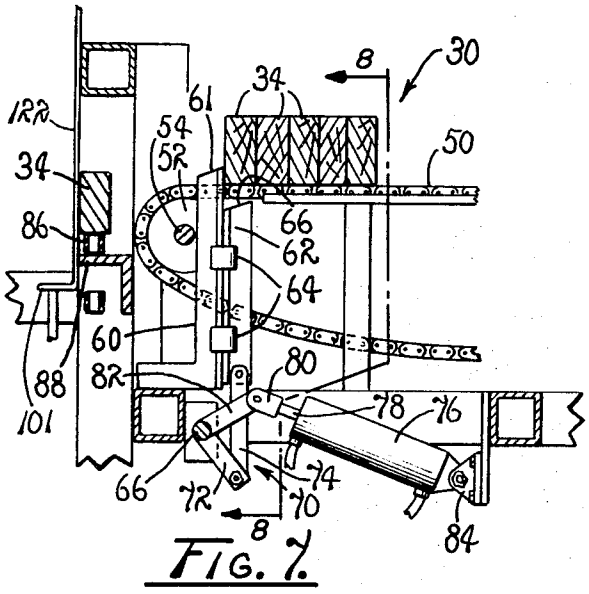


FIG. 7.

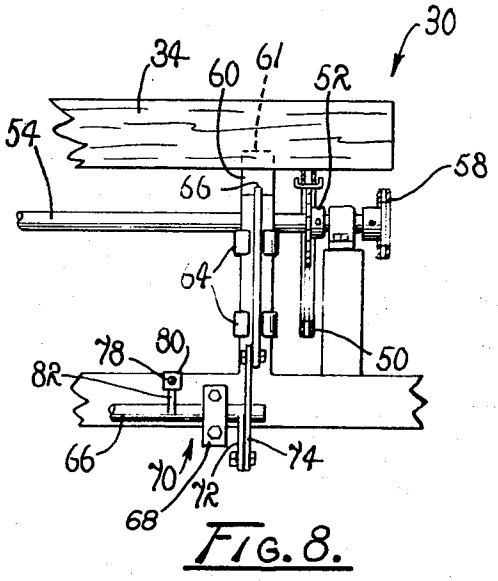


FIG. 8.

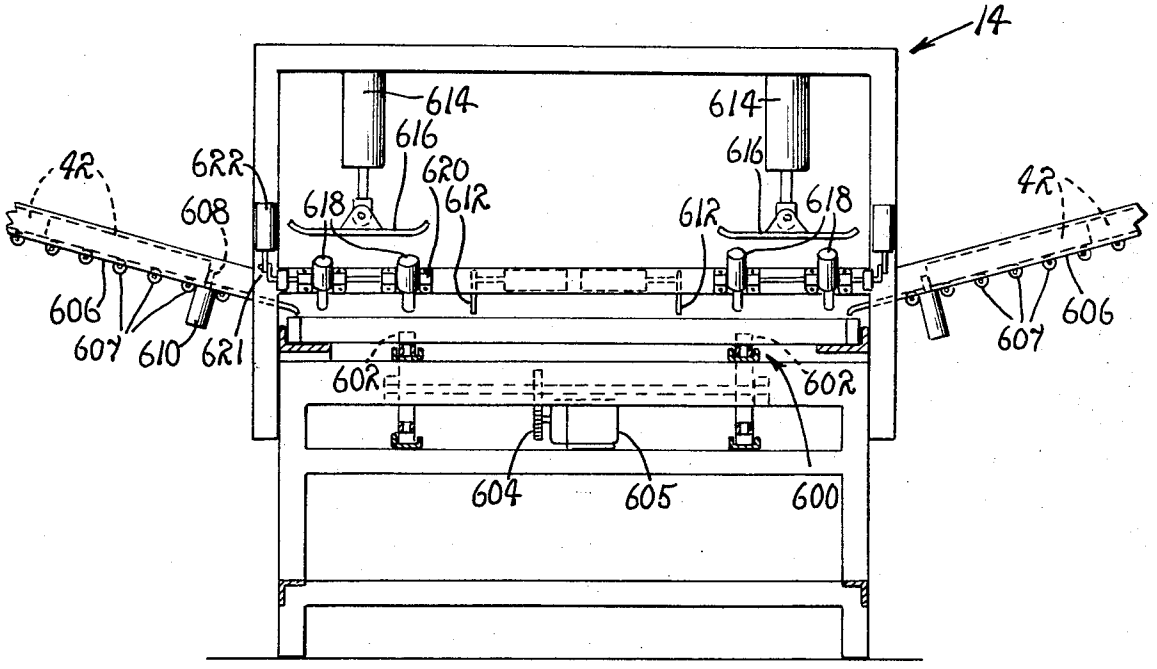


FIG. 22.

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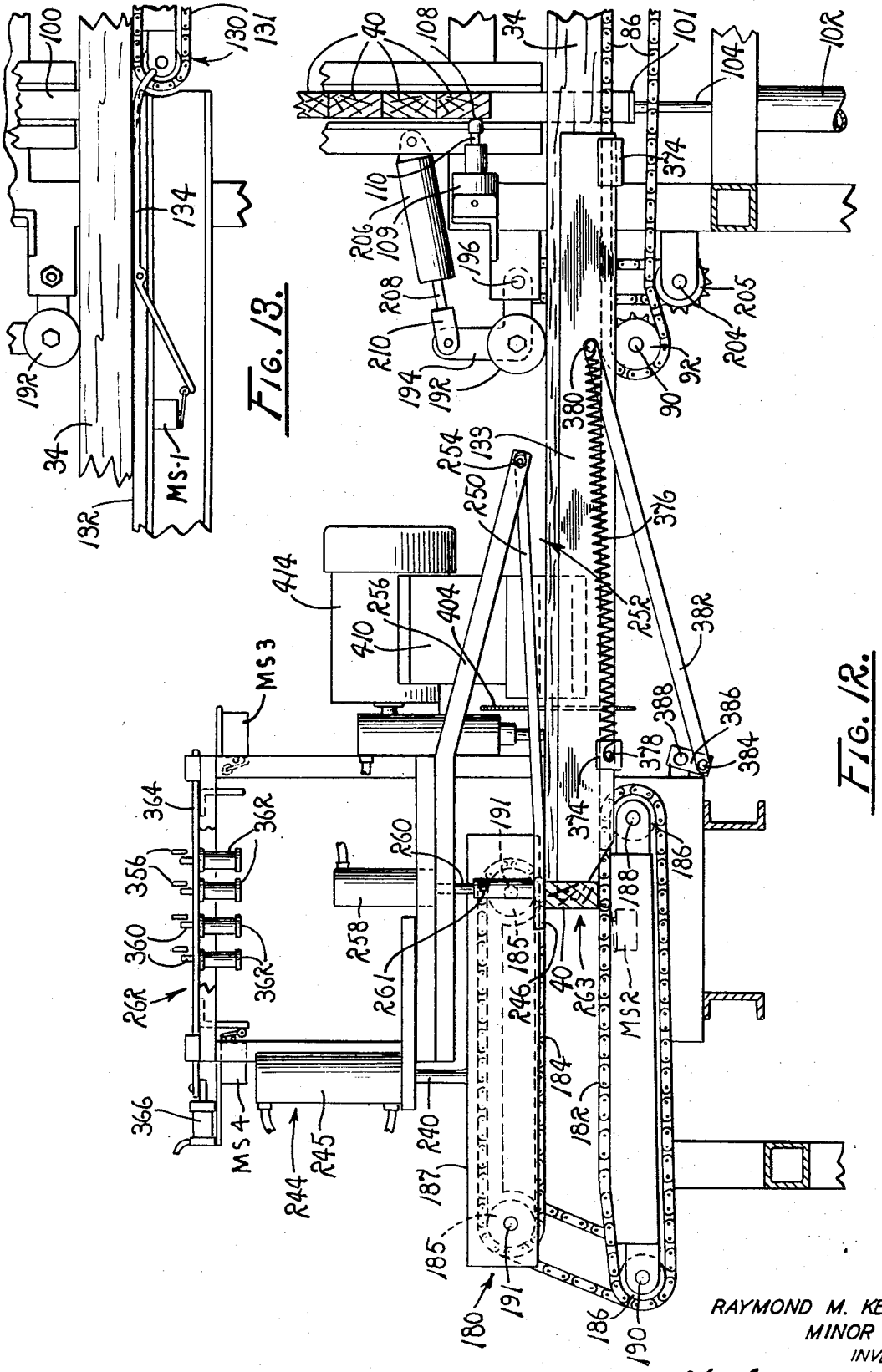


FIG. 13.

FIG. 12.

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FIG. 14.

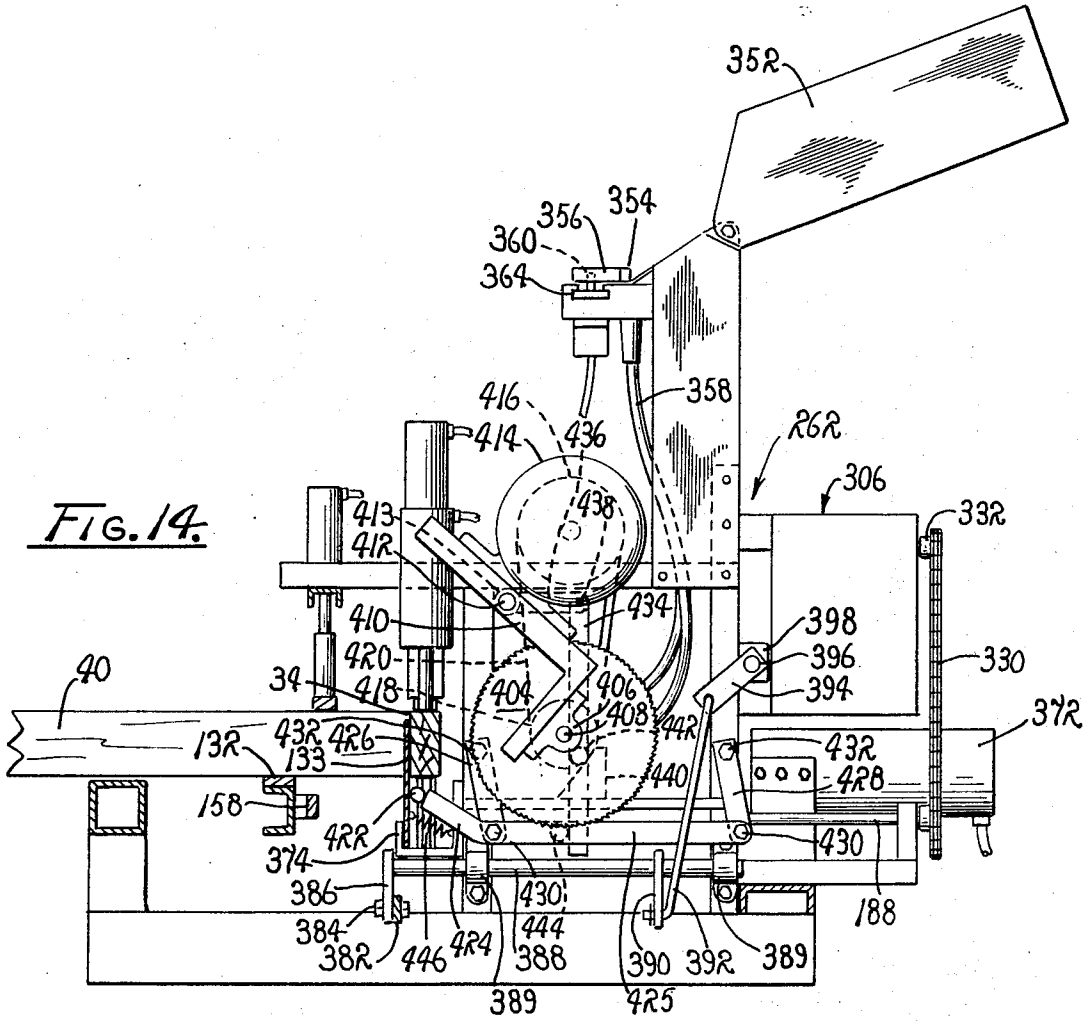
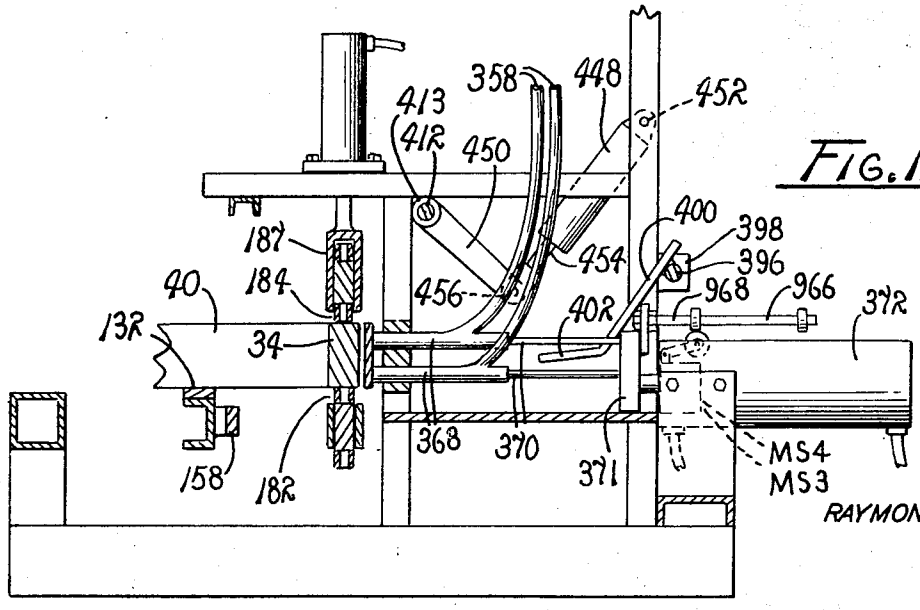


FIG. 15.



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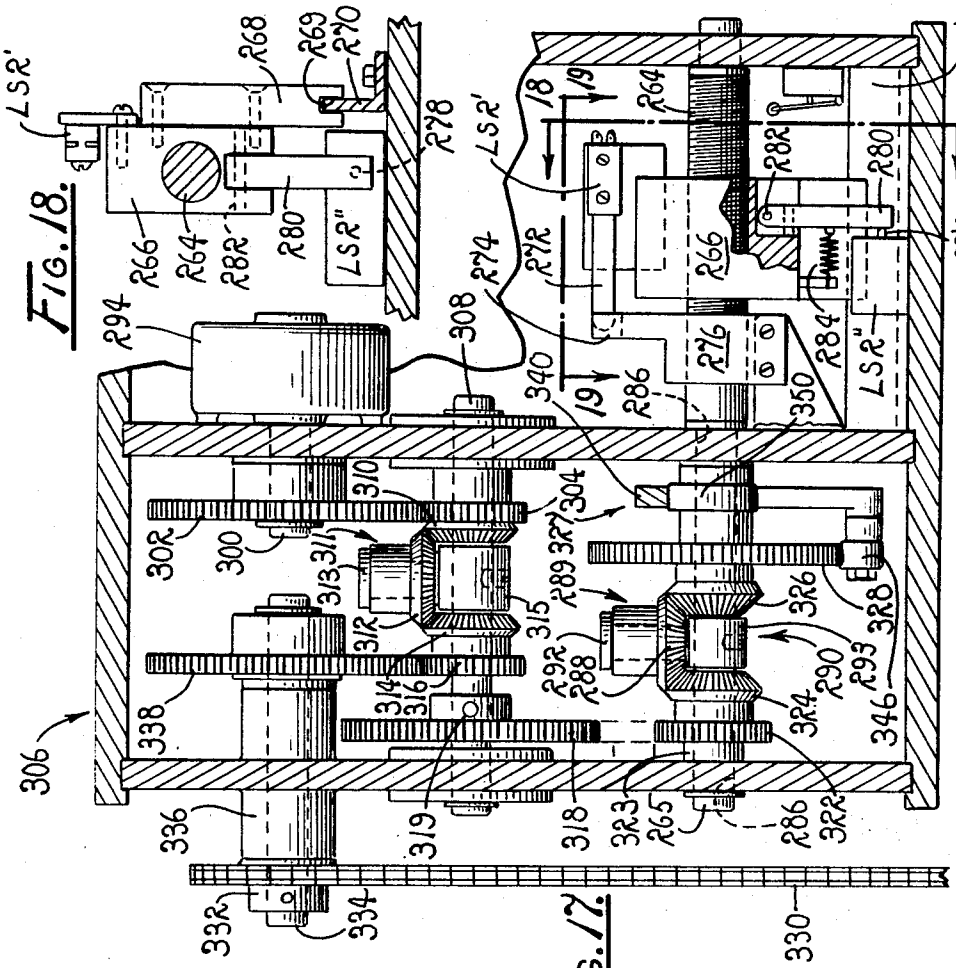


FIG. 18.

FIG. 19.

FIG. 17.

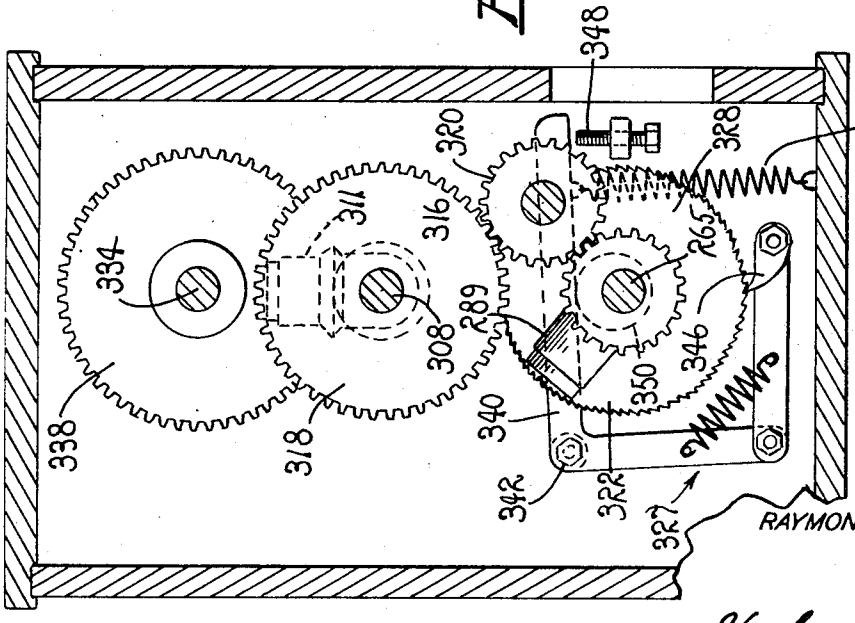


FIG. 16.

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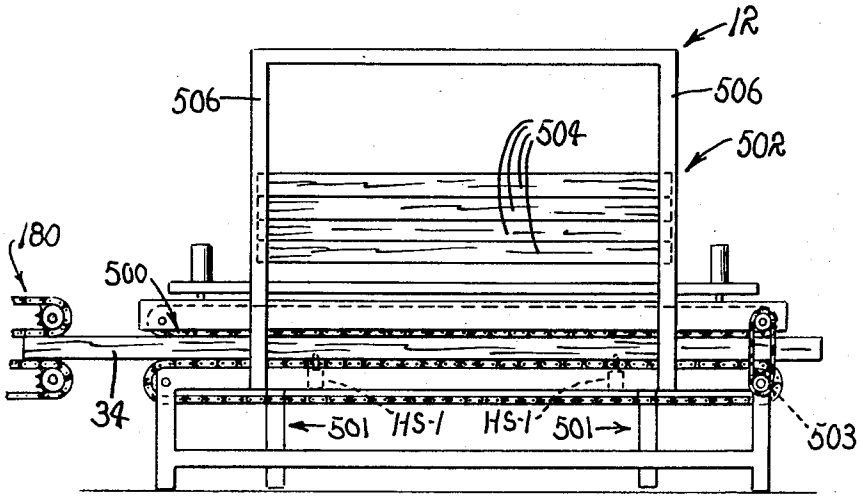


FIG. 20.

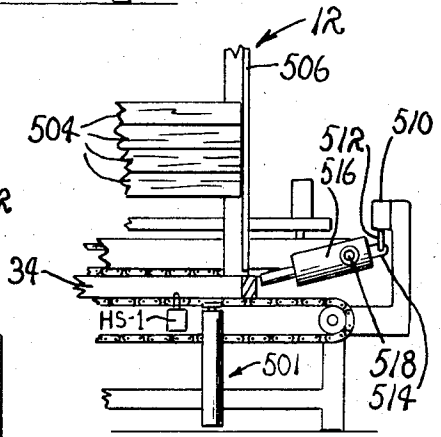


FIG. 21.

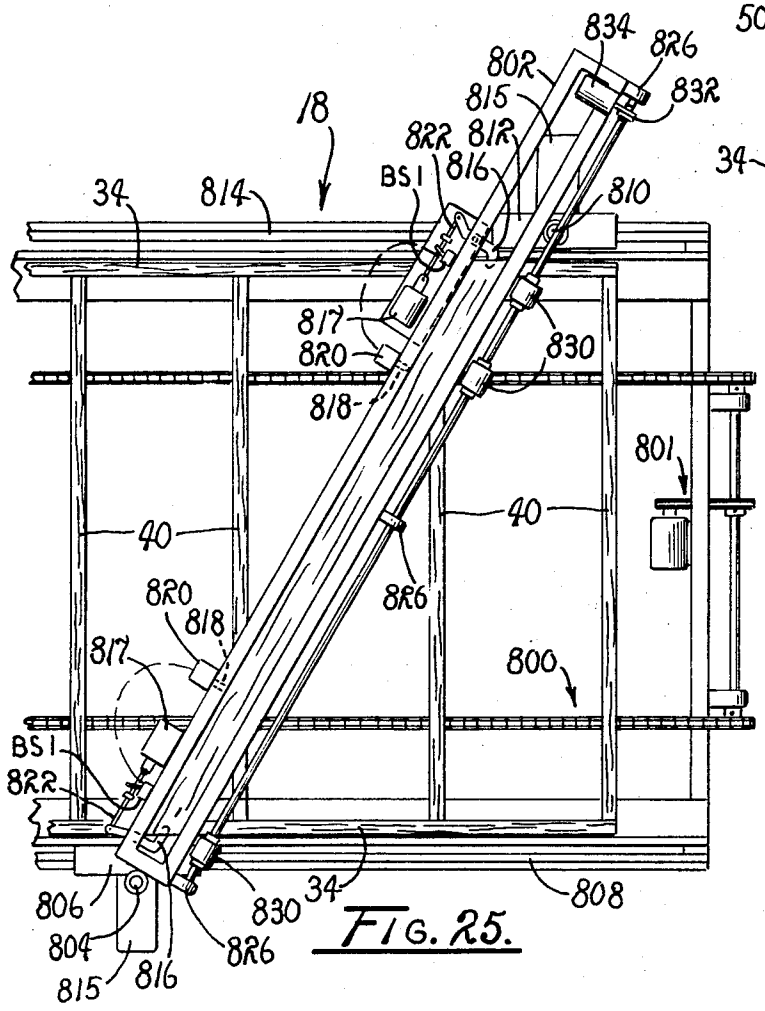


FIG. 25.

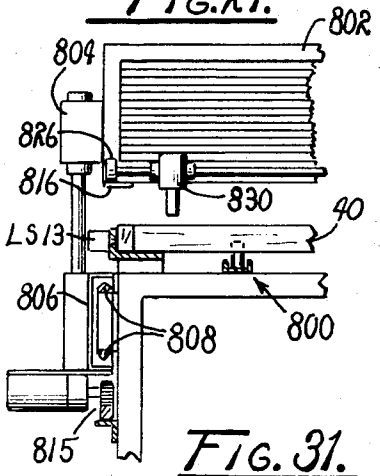
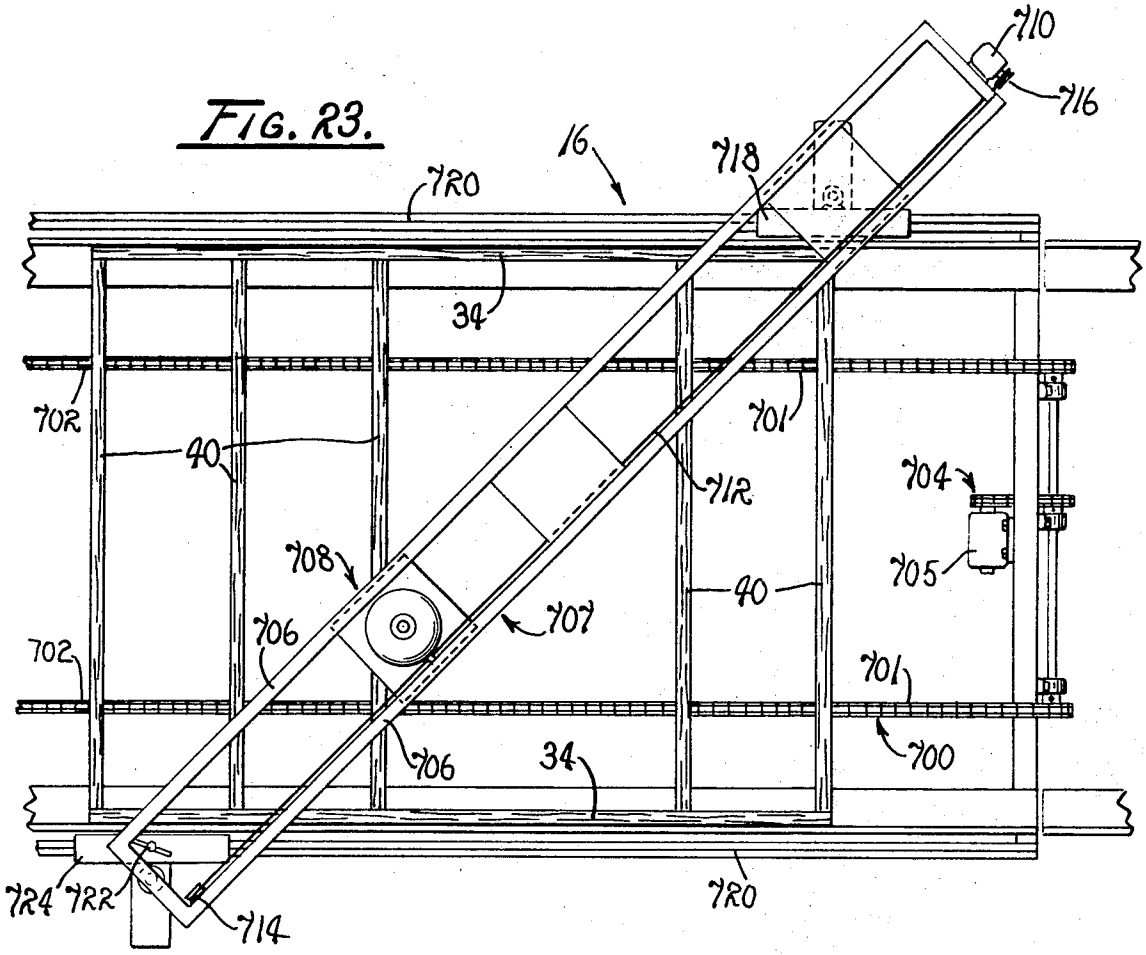


FIG. 31.

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FIG. 23.



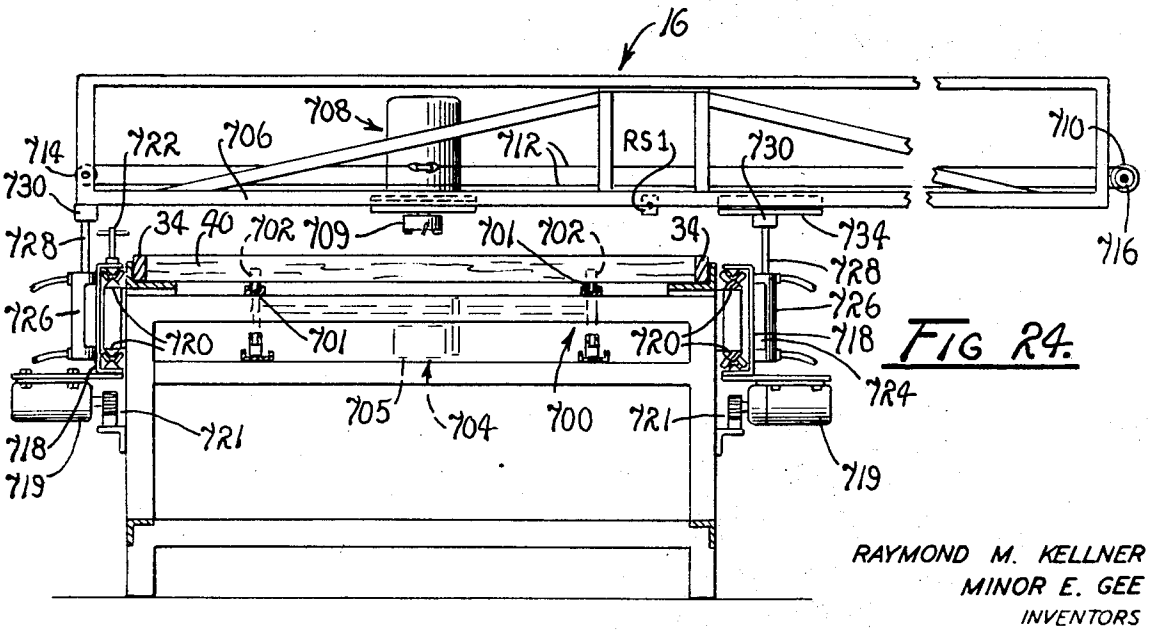


FIG 24.

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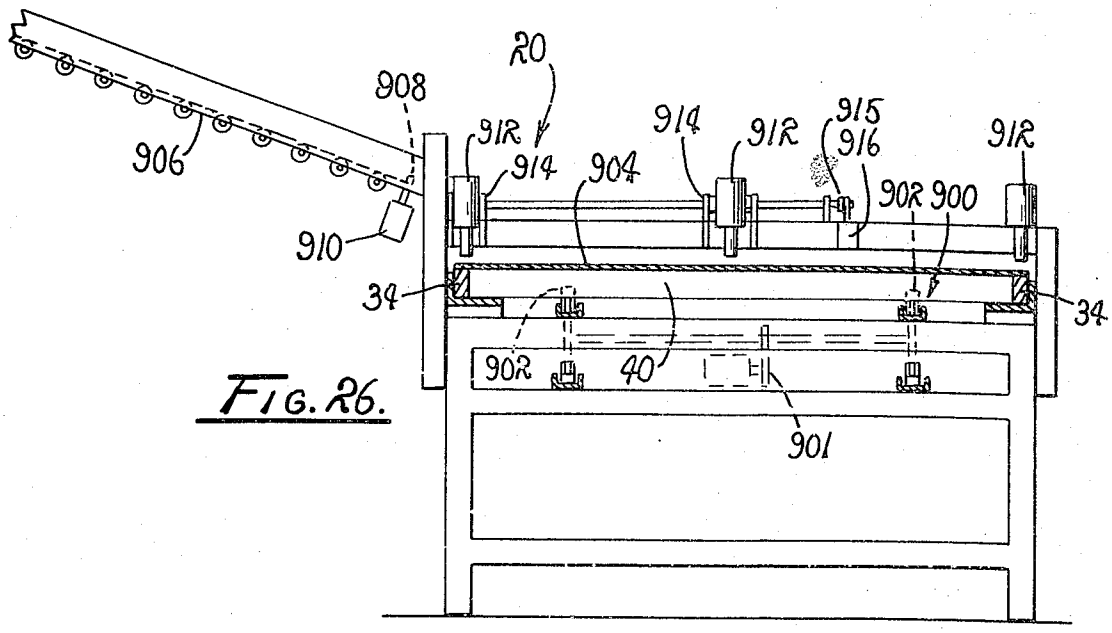


FIG. 26.

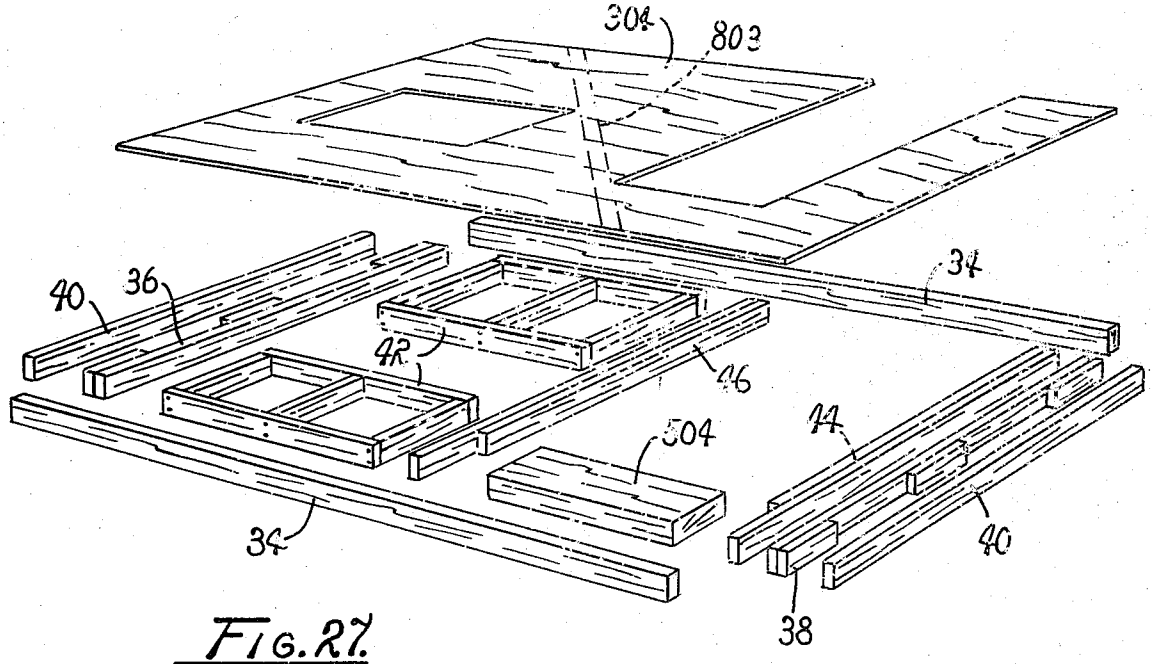


FIG. 27.

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FIG. 30.

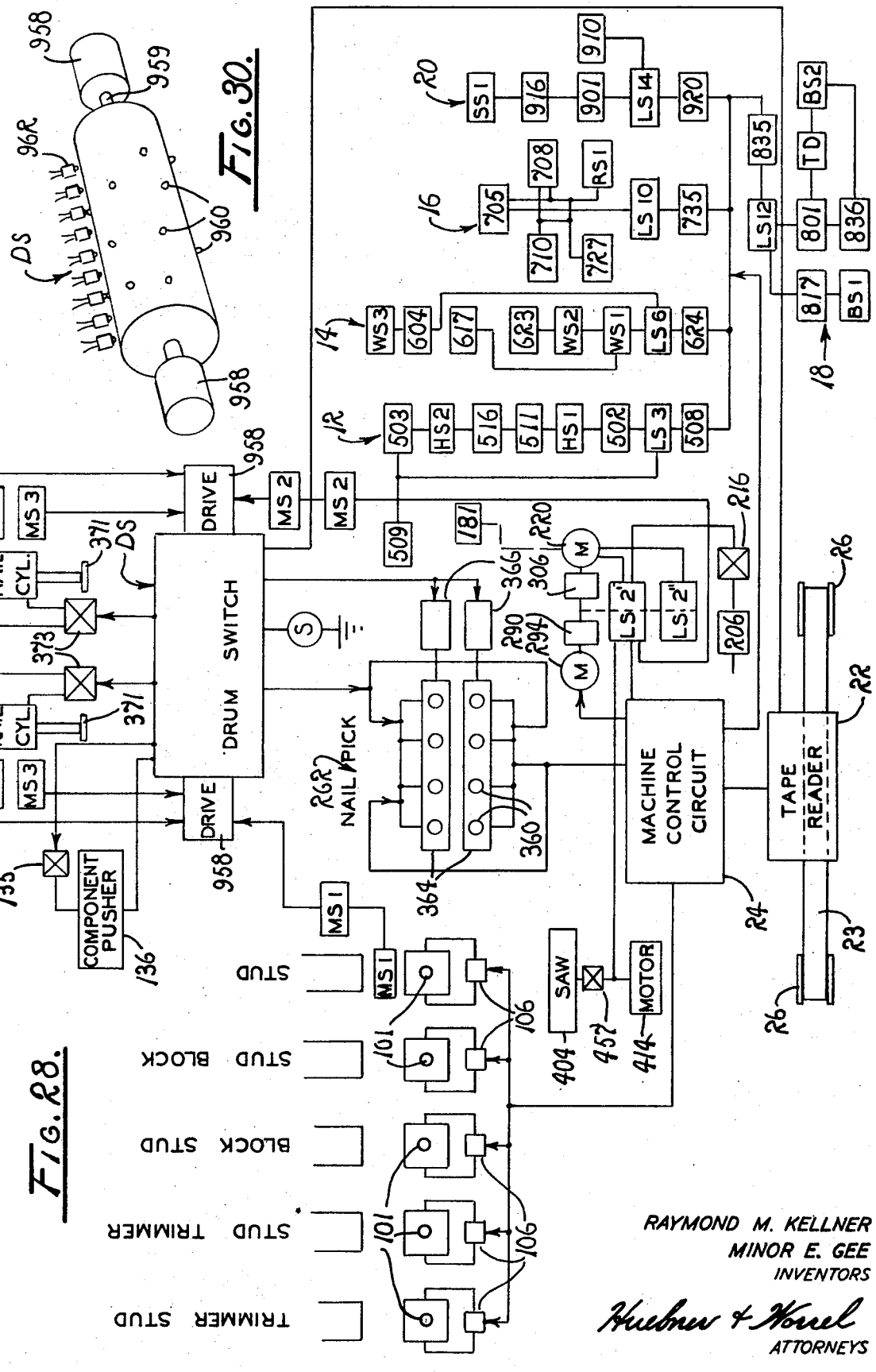


FIG. 28.

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STEP NO.	CONTOL SWITCH FUNCTION	COMP PUSHER ADV	COMP PUSHER RET	NAILER PICK BAR ADV	DRIVE NAILS	NAIL DRIVE RETURN	READ TAPE	CANCEL NAIL PATTERN	FEED WALL	SET NAIL PATTERN	ADVANCE COMPONENT
1	MS 1 & MS 1-1	X									
2	AUTO. STEP									X	SET NAIL PATTERN
3	AUTO. STEP			X							ADVANCE PICK BAR
4	MS2, LS2, MS2			X							COMPONENT IN NAIL POSITION
5	AUTO. STEP			X				X			NAIL & CANCEL PATTERN
6	AUTO. STEP										READ TAPE FOR NEW CYCLE
7	MS 3 & MS 3				X						NAIL DRIVE AT END OF NAILING STROKE
8	AUTO. STEP		X								
9	MS 4 & MS4					X					NAILING STROKE RETURN COMPLETE
10	AUTO. STEP								X		ADVANCE WALL
11	AUTO. STEP										
12	AUTO. STEP										

1 2 3 4 5 6 7 8 9

FIG. 29.

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MACHINE FOR FABRICATING WALLS

BACKGROUND OF THE INVENTION

The invention relates to the fabrication of frame structures and more particularly to machine fabrication of walls of predetermined and adjustably regulated size and configuration to be employed in erecting buildings of frame construction.

Frame structures normally are erected by age-old custom framing techniques which necessitate an on-site cutting of selected timbers to required dimensions and then joining the selected members according to given building plans. Techniques presently employed in framing buildings, including dwellings, inherently involve numerous redundant efforts. However, due to the individuality of each wall incorporated within frame buildings, a large force of skilled workmen is normally required at on-site building locations. The result necessarily flowing from this combination of conditions is that skilled workmen expend large quantities of time performing time-consuming redundant functions. Furthermore, since conventional framing techniques usually require operations performed on-site, efficiency is severely inhibited due to an existing lack of convenient equipment suitable for automating construction and assembly of wall structures. This is particularly true where the buildings being erected are widely variable in their wall requirements. Consequently, a waste in building materials, as well as a loss of time inherently attends the use of the techniques presently employed in framing buildings. This inadequacy becomes particularly acute where given buildings must be constructed with a minimum supply of skilled labor supported by a minimum budget.

The prior art is replete with prefabrication techniques for fabricating selected subassemblies ultimately to be utilized as a building is erected. These techniques employ numerous jigs and various types of control systems for positioning and rigidly supporting manually selected structural members in a given orientation while a joining of the members is effected through processes including nailing, bolting, clamping and the like. Normally, the structural members, once properly oriented, are nailed in place through nailing operations, frequently employing hand operated hammers, nailing guns, and the like. Unfortunately, only certain simple building structures of repetitive structural form are subject to being efficiently fabricated utilizing known techniques, due to the fact that, in fabricating complex structures, each subassembly normally requires a separate and a unique jig of a fixed dimension. Consequently, it has been found economically prohibitive to provide the required number of jigs and combinations of jigs for supplying subassemblies for most practical construction purposes. This is particularly true where the selected configuration for the subassembly must be custom-built for providing a unique complex building subassembly.

SUMMARY OF THE INVENTION

This invention overcomes many of the aforementioned difficulties through the use of a novel machine for fabricating redundant or non-redundant walls employing a multiplicity of interrelated slaved systems located at a series of stations through which various framing components, and related materials, selectively

are indexed in response to a series of machine control signals derived from a convenient source of intelligence, such as a coded tape, and supplied to a machine control circuit which operatively dictates control of the slaved systems in accordance with the coded intelligence.

Accordingly, an object of the instant invention is to provide a machine for serially fabricating walls having individually controlled dimensions and configurations for use in framing buildings and the like.

Another object is to provide a machine for automating the fabrication of walls employed in the framing of buildings.

Another object is to provide a machine for completing the fabrication of a wall from a plurality of building components for reducing on-site time requirements, and overall construction costs.

Another object is to provide an improved machine wherein studs, plates, headers, trimmers and the like are selected, assembled and nailed into a series of walls of individually controlled dimensions and configurations for delivery as construction subassemblies and erected on-site with minimal labor requirements.

Another object is to provide an improved machine for fabricating a series of walls to be transported and subsequently employed in framing buildings while employing a minimum of on-site fabrication operations.

Another object is to provide a machine for fabricating a series of walls of individually controlled dimensions and configurations.

Another object is to provide a machine adapted to respond to stored intelligence for fabricating a series of walls into preselected configurations.

Another object is to provide a machine having a multiplicity of sequentially oriented stations adapted selectively to assemble framing components, including studs, plates, headers, trimmers and the like, into a series of subassemblies, the control of which is dictated by stored intelligence derived from an examination of building requirements for selected buildings.

Another object is to provide a fully automated machine adapted to respond to a delivery of electronically stored intelligence for selecting various combinations of studs, plates, headers, trimmers and the like, and assemble the selected components into a series of individually controlled unitary structures including headers, window boxes, sheathing and the like, defining walls for building constructing purposes.

Another object is to provide a machine adapted to respond to stored intelligence for sequentially selecting and delivering building components including studs, plates, trimmers and other components.

Another object is to provide a wall advancing means capable of advancing a wall having plates in preselected and variable increments to orient the plates of the wall at appropriate locations for receiving therebetween studs and other components.

Another object is to provide a positive wall advancing device capable of advancing a wall without experiencing slippage between the wall and the advancing means.

These together with other objects and advantages which will subsequently become apparent are directed to the broad purposes of substantially reducing the costs of building construction, improving its quality, and speeding up its production time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of the machine embodying the principles of the present invention.

FIG. 2 is an elevation of the component feed station mechanism employed in delivering certain wall components including vertical support members, wall plates and the like.

FIG. 3 is a plan view, on somewhat an enlarged scale, of the component feed station mechanism illustrated in FIG. 2.

FIG. 4 is a sectional view taken on line 4-4 of FIG. 3.

FIG. 5 is a partial side elevation, on an enlarged scale, of the component feed station and the component assembly station illustrated in FIG. 4.

FIG. 6 is a sectional plan view taken generally along line 6—6 of FIG. 5.

FIG. 7 is a fragmentary elevation of the plate delivery conveyor, taken generally along line 7—7 of FIG. 6.

FIG. 8 is a fragmentary elevation taken generally along line 8—8 of FIG. 7.

FIG. 9 is a sectional elevation taken generally along line 9—9 of FIG. 5.

FIG. 10 is a detailed plan view, on an enlarged scale, of the component pusher head employed in advancing various wall components.

FIG. 11 is a detailed side view of the pusher head illustrated in FIG. 10.

FIG. 12 is a side elevation, on somewhat of an enlarged scale, taken along line 12—12 of FIG. 3.

FIG. 13 is an enlarged detail view of a microswitch actuating mechanism employed in initiating a component advance operation for the machine embodying the principles of the instant invention.

FIG. 14 is a side elevation, on an enlarged scale, taken generally along line 14—14 of FIG. 6.

FIG. 15 is an enlarged view taken generally along line 15—15 of FIG. 6.

FIG. 16 is an end view of a timing mechanism employed by the machine.

FIG. 17 is a plan view of the timing mechanism illustrated in FIG. 16.

FIG. 18 is a sectioned, fragmentary end view taken along line 18—18 of FIG. 17.

FIG. 19 is a fragmentary sectional view taken on line 19—19 of FIG. 18.

FIG. 20 is a side elevation of the header feeder shown in FIG. 1.

FIG. 21 is an enlarged fragmentary view of a portion of the header feeder shown in FIG. 20.

FIG. 22 is an end elevation illustrating the mechanism employed in feeding window boxes.

FIG. 23 is a top plan view of router employed in routing the studs and stud-trimmers for receiving a let-in brace therein.

FIG. 24 is an end elevation of the router shown in FIG. 23.

FIG. 25 is a top plan view of the brace feeder at the brace assembly station.

FIG. 26 is an end elevation of a sheathing feeder employed in feeding the sheathing at the sheathing applicator station illustrated in FIG. 1.

FIG. 27 is an exploded perspective view of an assembled wall fabricated employing the machine of the instant invention.

FIG. 28 is a block diagram of the control circuit for the machine embodying the principles of the instant invention, illustrating the circuits employed at the various stations depicted in FIG. 1 and through which each wall ultimately is conveyed.

FIG. 29 is a timing chart illustrating the sequential operation of the machine.

FIG. 30 is a perspective view of a drum-switch which may be employed for achieving a sequential operation of the machine.

FIG. 31 is a fragmentary side view taken at one end of the brace assembly station, as shown in FIG. 25.

DESCRIPTION OF THE PREFERRED EMBODIMENT

GENERAL DESCRIPTION

In fabricating walls which are to be employed in framing buildings and the like, the various wall components, including the wall plates and the vertical structural support components necessarily must be accurately dimensioned, as well as precisely spaced within the assembled wall for meeting building code requirements, as well as for satisfying construction needs of building integrity and accuracy in construction.

Through the employment of the process and machine embodying the principles of the instant invention, it has been found that it is entirely possible and practical to reduce construction data to coded intelligence and then drive slaved, special-purpose machine systems in a manner consistent with the intelligence for fabricating wall structures which are both accurately dimensioned and structurally sound.

In practicing the instant invention, a set of engineering and architectural drawings are acquired for a given building, or group of buildings, to be constructed. This material includes specific data as to the dimensions of the walls to be constructed, the location and types of openings to be provided as well as the types of material to be employed. This data then is reduced to readily comprehensive intelligence, including the required vertical components, their relative spacing and dimensions. Thereafter, the thus provided listing is converted to electronically stored intelligence which ultimately is electronically extracted and employed in driving slaved sub-systems of the machine of the instant invention for causing the machine to carry out a series of mechanical functions for assembling selected components in a manner consistent with the stored intelligence. The resulting structure is a series of completed walls, each wall being of individually determined dimensions and configurations and satisfying the requirements of acquired drawings and engineering data.

Turning now to FIG. 1, therein is illustrated a machine embodying the principles of the present invention. The machine is provided with a plurality of stations, including a component feed station **10**, a component assembly station **11**, a header feeding station **12**, a window box inserting station **14**, a router station **16**, a brace inserting station **18**, and a sheathing station **20**.

The various stations are arranged in a serial alignment and in a manner such that various wall components sequentially are fed, partially assembled into a wall and then conveyed to a series of next-in-line stations for sequentially receiving successive operations,

whereby upon an application of sheathing, applied in the sheathing station **20**, there is provided a completed wall.

Of course, it is to be understood that the wall being fabricated selectively can be delivered through any of the various stations without receiving an operation, depending upon the desired status of completion required for the wall, and the ultimate configuration of the wall being fabricated.

For the purposes of storing and retrieving intelligence, numerous information storage and retrieval devices currently are commercially available. These devices include card and tape encoders, readers and data processing machines. As a matter of convenience, the instant invention utilizes intelligence storage and retrieval systems of a type which employ reelable tapes.

As best illustrated in FIG. **28**, the machine of the instant invention employs a suitable tape reader **22** through which is threaded an electronically coded intelligence bearing tape **23**. Since the tape reader forms no specific part of the instant invention it is illustrated in block form. However, in practice, an optical reader has successfully been employed. These devices normally include a light-responsive head and serve to extract and decode coded intelligence by delivering light through openings provided in a punched tape whereupon a supply of electrical output signals, which represents the stored intelligence, is provided. The output is then delivered to various slaved circuits through control circuits for performing selected functions. As presently employed, the reader **22** electrically is coupled with a machine control circuit **24** which utilizes the output signals derived from the reader **22** for closing a series of electrical circuits to the actuators for tape selected machine systems. In practice, the tape **23**, as illustrated, is punched by a key punch operator, or a suitable machine, in a prescribed manner for coding the tape with intelligence indicative of the sequence of machine events which must occur to fabricate a series of selected walls.

Since the tape reader **22**, tape **23**, and the machine control circuit **24** may be of any suitable design, and be varied as desired, a detailed description thereof is omitted in the interest of brevity. However, it should be understood that the tape **23** is coded through an intelligence storage system to provide signal generating indicia thereon for thus establishing the required intelligence on the face of the tape, while the tape reader **22** complements the intelligence storage system and serves to review the intelligence and deliver electrical signals to the control circuit **24** consistent with the intelligence provided on the tape. Any convenient tape advancing mechanism may be employed in feeding the tape, however, as illustrated, the tape **23** is fed between a pair of selectively driven spools **26**.

The control circuit **24**, in effect, includes a plurality of normally open, solenoid-operated switches which respond, or are closed to a source of electrical potential, in response to the input signals delivered by the reader **22**. The output of the control circuit **24** is made up of electrical signals delivered to various circuits located throughout the machine and serve to close appropriately arranged switches for achieving desired functions at appropriate intervals.

Consequently, it should be appreciated that as the tape **23** is fed through the tape reader **22**, the reader responds to coded intelligence and provides a series of electrical signals or pulses which are delivered to the circuit **24** which, in turn, completes various electrical circuits within the operative circuits of the machine for thus achieving a predetermined sequence of machine functions for thereby completing a wall in a desired or preselected configuration.

For purposes of description of the machine, unless otherwise designated, the machine elements at opposite sides of the longitudinal axis of the machine are deemed to constitute mirror images. Therefore, it is to be understood that, except where indicated, machine components are duplicates and are arranged at opposite sides of the machine to perform complementary functions.

COMPONENT FEED STATION

Turning now to FIGS. **2** through **9**, **12**, **13** and **27**, it will be seen that at the component feed station **10** there is provided a plate feed system **30**, and a vertical component feed system **32** which are united into a unitary wall structure. The wall ultimately includes a pair of parallel plates **34** having extended therebetween a multiplicity of vertical support members, including a stud-block **36**, a block-stud **38**, a plurality of studs **40**, a plurality of window boxes **42**, a plurality of stud-trimmers **44**, and a plurality of trimmer-studs **46**. The stud-blocks and block-studs are of similar design except that they are reversely oriented. The same convention is employed in designating the stud-trimmers and trimmer-studs.

(Plate Feed)

The plates **34** are delivered to the machine by a plurality of parallel conveyor chains **50** arranged at opposite sides of the machine and driven in a manner such that the upper surfaces of the upper reaches thereof continuously are advanced toward the longitudinal axis of the machine, whereby plates may be deposited on the upper surfaces of the chains and indiscriminately fed to the machine to there be received.

In practice, the plates **34** are manually deposited on the chains **50**, however, the plates could be delivered thereto by any suitable device including continuously actuated feed conveyors. The chains **50** are driven through a mechanism including a plurality of sprockets **52** pinned or otherwise secured to a journaled drive shaft **54**. The shaft **54** is powered by a suitable electrical motor **56** coupled to the shaft through a chain and sprocket coupling **58**. Of course, it is to be understood that the conveyor chains could, through suitable gearing, be driven from a common power source such as the motor **56**, however, in practice, a pair of electrical motors **56** are employed in a manner such that the chains **50** at opposite sides of the machine separately are driven for randomly delivering the plates **34** to the station **10**.

As best illustrated in FIGS. **7** and **8**, the advancing plates **34** are intercepted and engaged at longitudinally spaced points by a plurality of stops **60**. Each of the stops **60** includes a vertically supported, rigidly mounted stop finger **61** extended above the plane of the upper surface of the conveyor chain adjacent the station **10**. Therefore, as the chains **50** are driven, the

plates **34** are brought into a contiguous side-by-side relationship and are restrained from further advancing displacement by the fingers **61**.

In order to achieve a selected feeding of the plates **34**, a plurality of vertically reciprocating discharge fingers **62** are reciprocally mounted by a plurality of suitably arranged bearing clamps **64** mounted adjacent the fingers **61**, at a position directly beneath the plates **34** as they are engaged by the fingers **61**.

As best illustrated in FIG. **7**, each of the discharge fingers **62** includes a kicker surface **66** so inclined that as the surface is brought into engagement with the lowermost surface of a plate **34**, the plate is elevated and subsequently tilted toward the machine so that, in effect, the plate is permitted to roll over the upper surface of the finger **61**. As a practical matter, the upper surfaces of each of the fingers **61** also are inclined toward the machine for enhancing the delivery of the plates **34**.

The discharge fingers **62** simultaneously are extended and retracted relative to the surface of the conveyor chain **50** by means including a drive shaft **66** supported for rotation by a plurality of journal bearings **68**. The shaft **66** is coupled through a plurality of similar drive linkages **70** to the lowermost end of the various discharge fingers. Each of the drive linkages **70** includes a radial arm-like link **72** having a first end securely fixed to the shaft **67** and adapted to be oscillated thereby. The second end of each of the links **72** pivotally is coupled to the lowermost end of one of the fingers **62** through a pivoted push rod **74**. The rods **74** include suitable pivot connections at each of their opposite ends for effecting a coupling thereof between the finger **62** and the radial links **72** so that as the shaft **67** is oscillated, reciprocation is imparted through the links to the fingers **62** for elevating and retracting the kicker surfaces relative to the plane of the upper surface of the chains **50**.

Oscillation is, in turn, imparted to the shafts **67** through a pneumatic, piston-type actuator **76** having a reciprocating drive shaft **78** adapted to be extended and retracted in response to alternate pneumatic pressurizations of the actuator. The distal end of the shaft **78** includes a clevis **80** pivotally coupled with the shaft **67** through a rigid crank arm **82** having one end pivotally connected at the clevis **80** and the opposite end rigidly fixed to the shaft **67**. The actuator **76** is pivotally supported by a coupling **84** located at the heel thereof so that the actuator is permitted to pivot at the clevis **80** for accommodating an arcuate oscillation of the clevis **80** so that oscillation of the shaft **67** and, consequently, oscillation of the link **72** is achieved for imparting desired reciprocation to the fingers **62**.

As best illustrated in FIG. **7**, each of the plates **34** is delivered from the stop fingers **61** to the upper surface of an endless conveyor chain **86**. Each of the chains **86** includes an upper reach extending transversely to the discharge ends of the upper reaches of the chains **50**. The plane of the chains **86** is beneath the plane of the chain **50** so that as the plates are delivered by the discharge fingers **62** they are received by the upper surfaces of the chain **86**. As illustrated in FIG. **9**, each of the chains **86** is supported for continuous displacement by the upper surface of a laterally extended supporting track **88**. The track **88** extends between a pair of support shaft **90**, FIG. **3**, having suitable sprockets **92** mounted thereon with the chains **86** being trained thereover. As a practical matter, various devices may be employed in driving the shafts **90**. However, in practice, a continuously operable motor **94** operatively is coupled to a selected one of the shafts **90** through a convenient chain-and-sprocket coupling **95**.

Therefore, it should be apparent that as the plates **34** are fed at the component feed station **10**, initially they are directed along a first path, transverse to their longitudinal axes, as they are delivered by the chains **50**, and then are delivered along a path extending parallel to the longitudinal axes, as they are received at the upper reaches of the chains **86** upon being discharged by the discharge fingers **62**. Since the motor **94** is a continuously driven motor, the plates **34** continuously are urged to advance through a frictional engagement with the upper surfaces of the chains **86**. However, in the event an obstruction is encountered, slippage or relative displacement between the lower surfaces of the plates and the upper surfaces of the chains **86** is readily accommodated.

In order to effect delivery of the plates **34**, through a reciprocation of the fingers **62**, there is provided a microswitch **96** having a spring-biased pivoted arm **98** disposed in the path of the plates **34** as they are advanced by the chains **86**. In the absence of a plate **34** on the upper surfaces of the chains **86**, the arm **98** is biased across the chain causing the microswitch **96** to close a circuit to a suitable valve, not shown, for initiating actuation of the actuator **76**, whereupon the actuator **76** is caused to extend for rocking the shaft **67** causing the discharge surface **66** of the fingers **62** to be elevated for thereby delivering a plate **34** to the chain **86**. Once the plate **34** is supported by the chain **86**, it will be advanced past the microswitch **96** causing the circuit to open, whereupon the actuator **76** is returned to a retracted position for returning the discharge surface of the fingers below the surface of the conveyor chains **50**.

Vertical Component Feed)

The vertical component feed **32** includes a sequentially aligned multiplicity of transversely arranged, vertically disposed hoppers **100**. Each of the hoppers **100** is of a vertical chute configuration adapted to receive therein a stack of super-imposed, horizontally oriented vertical support members of a specific type. For example, the first-in-line hopper, as illustrated in FIG. **3**, is adapted to receive elongated studs **40** in a superimposed relationship, while the next-in-line hopper serves to receive and retain a stack of superimposed stud-blocks **36**, the next hopper receives and retains therein block-studs **38**, the next hopper receives and retains stud-trimmers **44** while the last-in-line hopper serves to receive and retain trimmer-studs **46**.

In order to deliver a vertical component from a selected one of the hoppers **100**, each hopper is provided with a pair of vertically disposed reciprocating elevators **101** arranged therebeneath and adapted to engage the opposite ends of the components for lifting the components as they are retained within the hoppers. The elevators **101** are driven through an energization of a pair of actuators **102**, of a design quite similar to the actuators **76**. Each of the actuators **102** includes an output shaft **104** and a pair of parts, not designated,

through which pressurized fluid operatively is delivered to one end of the actuator's cylinder, while an exhaust of pressurized fluid is accommodated at the opposite end of the cylinder for thus extending and retracting the output shaft **104**.

Hence, by controlling the direction of delivery of pressurized fluid to the actuators **102**, each of the shafts **104** selectively is upwardly extended or downwardly retracted for causing the elevators **101** to engage the end portions of the lowermost component for selectively lifting the stack of vertical components in the associated hopper **100**. In practice, a suitable selector valve **106**, FIG. **28**, is provided and coupled with each actuator **102** for determining the direction of fluid flow thereto.

Control for the selector valves **106** is achieved in response to a signal delivered from the machine control circuit **24**. Therefore, as a signal is delivered from the control circuit **24** to the component feed station **10**, a selected actuator **102** is actuated. Of course, it is to be understood that each of the hoppers **100** is provided with a pair of simultaneously energized elevators **101** so that the component's ends are elevated simultaneously to preclude a "jam" of the feed mechanism.

As shown in FIG. **3**, each of the hoppers **100** also is provided with a pair of spaced clamping feet **108**, FIG. **6**. Each of the clamping feet **108** includes a pneumatic actuator **109** and a reciprocating shaft **110** coupled therebetween. The feet, when extended, engage the lowermost component within the associated hopper **100**. These feet are located adjacent to the ends of the hoppers and serve as pressure applicators to clamp the engaged components so that downward displacement thereof is inhibited. In practice, the actuators **109** are driven from a pneumatic pressure source, not shown, however, as presently employed, operation of each of the clamping feet **108** operatively is controlled by a microswitch **112**, FIG. **5**, having an actuator arm **113**. Each microswitch is mounted near one end of the associated hopper **100** and is adapted to be actuated by a reciprocable actuating rod **114**. The rods **114** are supported for vertical reciprocation adjacent to the ends of the hoppers **100** by suitable bearing brackets **116** having vertically aligned bores extending therethrough. Each of the rods includes a camming collar **118** fixedly secured thereto and adapted to actuate the actuator **113** of the adjacent microswitch **112**. The rod **114** is biased in a downward direction by a tension spring **120** connected therewith. The spring **120** assures a seating of the rod **114** in a position to be driven into engagement with the actuator of the microswitch **112**.

In order to impart upward displacement to the rods **114**, each of the elevators **101** further includes a vertically extended plate **122**, FIGS. **5** and **9**, mounted in suitable vertically aligned tracks, not designated. Each of the plates has secured thereto an elevator link **124**, FIG. **5**. The link **124** extends laterally from the plate **122** and is provided with a vertically aligned opening, not designated, which receives therein the rod **114**. As each elevator **101** is displaced, the plate **122** and the associated link **124** are displaced upwardly. A collar **126** is fixed to the rod **114** in a position to be engaged by the link **124** as it is displaced upwardly.

Therefore, as the elevator actuator **102** drives the shaft **104** upwardly, beneath a hopper **100**, the clamping feet **108** are caused to be released, whereupon the stack of components is free to descend. However, due to the extension of the shaft **104**, the components cannot descend except at such time as the shaft **104** is retracted. As the elevator **101** is retracted into a plane below the clamping feet **108**, the actuator **113** of the microswitch **112** again is actuated by a release of the collar **118** fixed to the rod **114** so that the clamping feet again are actuated for engaging the adjacent component arranged in a coplanar relationship therewith. In practice, the collar **118** is so adjusted that one component, only, is permitted to drop with the elevator.

Continued downward displacement of the elevator **101** permits the elevator-supported component to be seated and supported by the upper surface of the conveyor **130**. This conveyor includes a pair of continuously driven coplanar conveyor chains **131**. As the components are seated on the conveyor chains **131**, the elevator shaft **104** continues to be retracted therebeneath for thus accommodating a release of the vertical component for thus permitting the component to be advanced by the conveyor.

Therefore, for each cycle of operation, the machine control circuit **24** selects, in accordance with intelligence signals received from the tape reader **22**, a component to be fed. As a result of this selection, the associated selector valve **106** is energized for delivering fluid through a selected actuator **102** of an elevator **101**, whereupon the shaft **104** thereof is driven upwardly for engaging the lowermost component within a hopper **100**. As upward displacement of the shaft is achieved, the associated rod **114** causes the microswitch **112** to be activated. Activation of this switch initiates a retraction of the clamping feet **108**, whereby the feet are withdrawn from engagement with the lowermost component of the hopper **100** for thereby releasing the stack of components. As the shaft **104** ultimately descends, the microswitch **112** is again actuated, through a disengagement of the collar **118** fixed to the rod **114**, for causing the clamping feet **108** to again be actuated. As the feet **108** are again actuated, the component disposed opposite thereto, which, as a practical matter, is the component supported directly above the component engaged and supported by the shaft **104**, is engaged by the feet. As the elevator shaft **104** descends beneath the level of the conveyor **130**, the conveyor **130** engages and advances the component in a direction transverse to the longitudinal axis of the component. Continued advancement of the component by the conveyor **130** delivers the component to a pair of support rails **132**, FIG. **9**, disposed in a throat defined by a pair of laterally spaced guide plates **133**, FIG. **4** and **6**, which engage the end surfaces of the advancing components. A pair of switches MS1 having an arm **134**, FIG. **6**, are arranged adjacent the support rails, whereby as the components sequentially are advanced by the conveyor **130**, they are positioned on the arms **134** for actuating the switches MS1 for thus initiating further advancement of the components from the station **10** to the component assembly station **11**.

Each of the switches MS1 operatively is connected, through a circuit which includes a drum switch DS, with an hydraulic selector valve **130** which dictates activation of an hydraulic actuator **136**. The actuator **136** is of a suitable type and includes a piston head to which

is fixed an output shaft, not designated. In practice, a double-acting hydraulic actuator has served quite satisfactorily. The actuator **136** is connected to the machine frame at its heel through a pivoted coupling **138**, and at its shaft, through a pivoted clevis coupling **140**, to a crank arm **142**, FIG. **4**. The opposite end of the crank arm **142** is fixedly secured to an oscillatable drive shaft **144** which operatively is supported by suitable journal bearings **146**.

Extending from the shaft **144**, in fixed relation therewith, there is provided a pair of rigid crank arms **148**. The distal ends of the crank arms **148** are pivotally coupled to a pair of drive rods **150**, FIG. **4**, by a coupling including pivot pins **152**. Consequently, as the actuator **136** is pressurized for extending its shaft **144**, the crank arm **142** is driven in rotation for thus rotating the shaft **144**, whereupon the distal end of the crank arm **148** is caused to describe an arc for laterally displacing the drive rods **150**, as they are pivoted about the pivot pins **152**.

Each of the rods **150** is connected through a pivot **154** to a rectilinearly reciprocating carriage **156**. The carriage **156**, in turn, is supported on suitable guide rails **158**, FIG. **10**, by convenient roller bearings **160** coupled thereto through pins **161**. Hence, as the drive rods **150** are displayed through an oscillating displacement of the crank arm **148**, the rods **150** serve to displace the carriages **156** in rectilinear displacement along the guide rails **158**.

Pivotally mounted on each of the carriages **156**, by a pivot pin **162**, there is an elevated dog **164**. Each of the dogs **164** is urged into and maintained in an operative elevated orientation by a tension spring **166** and a stop **168** fixed to the carriage **156**, FIGS. **10** and **11**. The dog **164** includes a planar face **170** adapted to engage a vertical face of a support member as the member is seated and supported by the rails **132**. By employing a tension spring **166** for urging the dog **164** in rotation about the pin **162** and into seated engagement against the stop **168**, the dog is caused to be spring-biased into an operative position, while being adapted to be depressed as it is retracted beneath the various hoppers **100**. As best illustrated in FIG. **4**, each of the rods **150** is adapted to be retracted for positioning the face **170** of the dog **164** just rearward of the first-in-line hoppers, while accommodating a forward displacement of the dogs **164** for advancing and positioning a selected vertical component at the component assembly station **11**.

Therefore, as the vertical components are positioned by the conveyor **130**, on the actuator arm **134**, a closing of a circuit through the microswitches MS1 is achieved, whereupon the pusher actuators **136** are energized for operatively displacing the crank arm **142**. A rate of rotation thus is imparted to the shaft **144** causing the crank arm **148** to be oscillated for advancing the drive rods **150**, and therefore the face **170** of the dogs **164**, into displacing engagement with the components seated on the arm **134** for thus effecting a feeding of the component from the feed station **10** to the assembly station **11**.

(Stud Feed)

As best illustrated in FIGS. **2** and **4**, the studs **40** are delivered to the component feeder **32** by a conveyor **171** of a type including an elongated endless conveyor chain **172** trained about a plurality of suitably mounted sprockets **174**. As the chains **172** are advanced, the studs **40** are advanced and delivered vertically through a guide chute **176** to the hopper **100**, which receives therein the studs in superimposed and stacked orientation. While the chain **172** may be continuously driven and the studs **40** gated into the chute **176**, in a manner similar to the feeding of the plates **34**, it has been found practical to manually energize an intermittently operable motor, not shown, for indexing the chain **172** to achieve an advancing of the studs in a direction normal to their longitudinal axes. Additionally, if desired, the studs **40** may be delivered to the chains **172** by an endless delivery conveyor **178**, FIG. **2**, arranged adjacent thereto and adapted to discharge onto the conveyor **171**.

Conceivably, the remaining vertical components could be delivered to the feeder **32** by a conveyor similar in design to the conveyor **178**, however, it has been found practical to supply the components by manually stacking the components in the hoppers **100**. This results from the fact that, as a practical matter, normally the quantity of studs employed in framing a wall relatively is much greater than the quantity of any of the other single types of components employed in framing a wall.

COMPONENT ASSEMBLY STATION

(Pressure Track Assembly)

As the wall plates **34** are advanced by the conveyor chains **86** they are presented to the component assembly station **11**. However, since the plates **34** are randomly fed, as required by the microswitch **96**, positive control over the feed of the plates must be assumed since, in order for the components to be positioned at selected intervals, it is necessary that the plates be advanced through the assembly station **11** in predetermined increments. Therefore, as each of the plates **34** is delivered to the station **11**, it is received within a pressure track assembly **180**.

The track assembly **180** includes a drive system **181**, FIG. **6**, coupled with a lower endless track **182** having track-like links **183**, FIG. **5**, and a matching upper endless track **184**. Each of the pressure tracks **180** is arranged within a plane parallel the plane of the conveyor chain **86** so that plate advancement may be accommodated. Each of the upper tracks **184** is trained about a pair of spaced sprockets **185** supported in a vertically adjustable cradle **187**, while the lower track **182** is supported by a pair of spaced sprockets **186**. The sprockets **186** are mounted on shafts **188** and driven by a drive shaft **190**, while the sprockets **185** are supported by suitably journaled shafts **191**, FIG. **12**, and also are driven by the shaft **190** of the drive system **181**.

The spacing between the tracks **182** and **184** may be varied as required for gripping the plates therebetween. However, it is important to understand that, due to the required accuracy, the surfaces of the links **183** must be forced into engagement with both the upper and lower surfaces of each plate **34**, as the plate is advanced between the chains **182** and **184** to preclude any lost motion or tendency for the surfaces of the tracks to slip relative to the surfaces of the plates.

(Hold-Down Roller)

As a practical matter, the upper and lower tracks **182** and **184** of the assembly **180** also serve to advance wall

sections after a partial assembly at the station 11. Therefore, significant pressure is, in practice, applied at both the upper and the lower surfaces of the plates 34 to assure accuracy in wall advancement as they are advanced between the tracks.

It can be appreciated that due to the limited spacing between the tracks, it is quite difficult to insert the leading ends of the plates 34 into the space between tracks simply by driving the conveyor chains 86. Therefore, a driven hold-down roller 192 is disposed above each of the chains 86 in a position to engage the upper surface of the plates 34 as they are advanced toward the assembly 180 to force the plates 34 into engagement with the chain 86.

In practice, the roller 192 is supported by an axle at the distal end of a pivotal support 194, FIG. 12, pivoted about a pivot point 196. The roller 192 is driven through a chain drive system including a pair of chains 198 and 199, FIG. 5, interconnected through a pair of coaxially aligned sprockets 200 fixedly secured to a suitably supported drive shaft 201. The sprockets 200 are driven through the chain 199 which, in turn, is trained about a drive sprocket 202, FIG. 5, fixedly secured to a driven drive shaft 204. The shaft 204 is coupled with an idler 205 having peripheral teeth mated with the lower run of the chain 86, as best shown in FIG. 12, and adapted to be driven thereby.

In order to achieve a desired pressure for the roller 192, there is provided a piston-type pneumatic actuator 206, having a reciprocating output shaft 208 coupled through a suitable clevis 210 to a vertically disposed roller actuating arm 212. In practice, the roller actuating arm 212 and the pivotal support 194 collectively form a bell crank, as illustrated in FIG. 5. The heel of the actuator 206 is coupled with an upright frame member through a pivoted coupling 214, fixedly secured to the frame of the machine at an elevation sufficient to accommodate a downward displacement of the clevis 210, upon extension of the shaft 208, for pivotally displacing the arm 212 downwardly to achieve an oscillatory displacement of the support 194 about its pivot 196.

Control of the actuator 206 is achieved through a suitable selector valve 216, FIG. 28, actuated in response to an actuating signal delivered to the drive 181 for initiating an advance of the assembly 180.

(Track Drive)

The drive 181, as employed in driving the track assemblies 180 located at opposite sides of the machine, includes an electrically energizable drive motor 220 coupled with the drive shaft 190 through a suitable drive coupling, not shown. As best shown in FIGS. 5 and 6, each of the shafts 190 is journaled in suitable bearing supports 222 and extends outwardly from the frame of the machine. To the distal end of this shaft there is fixed a chain drive sprocket 224, FIG. 5. The sprocket 224, in turn, is coupled to a driver sprocket 226 through a drive chain 228. The sprocket 226, in turn, is fixedly secured to a drive input shaft 230 journaled in a bearing 232. The bearing 232 is suitably mounted on a vertical support beam of the machine frame, not designated. As best shown in FIGS. 5 and 6, collectively the input shaft 230 is coupled through a universal joint 234 to a drive shaft 236 which, in turn, is drivingly coupled to a shaft 191 through a universal joint 238. By employing the universal joints 234 and 238 in driving shafts 236, the upper track 184 of the pressure track assembly 180 may be elevated and lowered for purposes of adjusting the spacing between the tracks 182 and 184 whereby the pressure applied to opposite surfaces of the plates may be varied.

(Track Adjustment)

In order to adjustably position the upper track 184 relative to the lower track 182, each of the cradles 187 is pivotally supported from the lowermost end of a vertically arranged pressure shaft 240. The shaft 240 is coupled with the cradle 187 by a suitable coupling not designated welded or otherwise suitably connected to the upper portion of the cradle 187. Each of the shafts 240 is resiliently urged downwardly by the constant pressure actuator 244 welded or otherwise supported at opposite sides of the machine frame. The actuator 244 is of a suitable design including an air-loaded dash-pot 245 having therein a spring-supported, reciprocating piston head, not shown, fixed to the shaft 240 and adapted to continuously urge the shaft 240 downwardly.

(Hold-Down Foot)

With particular reference to FIG. 12, therein is illustrated a hold-down foot 246 having a downwardly directed sliding surface for accommodating a feeding of the vertical components as they are advanced between the parallel guide plates 133. The purpose of the hold-down feet is to assure a seating of the vertical components when they are received to be nailed. Therefore, a hold-down foot is provided at opposite sides of the machine. Each hold-down foot 246 is provided with an inclined guide plate 250 having a guide surface defining, in conjunction with the rails 132, a throat 252 for receiving the vertical components for thus assuring a seating of the component against the upper surface of the support rail 132 as the component is advanced through the machine. The opposite end of the guide plate 250 is pivotally supported by a suitable pivot 254 to a depending cantilevered beam 256, which serves to support the guide plate 250 in a selected orientation.

In order that the foot 246 continuously be urged downwardly for forcing the vertical component into seated disposition against the upper surface of the rails 132, there is provided a pneumatic dash-pot actuator 258, similar in design to the dash-pot 245, including a downwardly depending shaft 260 which is pinned to the foot 246 by means including a pin coupling 261. It is to be understood that the dash-pot 258 rigidly is supported to the frame of the machine in a suitable manner which includes welded brackets and the like, not shown.

In view of the foregoing, it should readily be apparent that as the plates 34 are fed to the component assembly station 11 they are forced downwardly by the actuators 244. Concurrently therewith, the vertical components are continuously forced downwardly by the dash-pot 258, located at the opposite sides of the machine, for thereby effecting a coplanar seating of the plates and the components. Longitudinal positioning of the components is effected by the end surface guide plates 133 which serve to guide the components as they are advanced by the pusher.

The vertical components are advanced to the assembly station **11** with their advancement being terminated at the forwardmost position of the face of the dog **164** of the pusher. At this point all relative displacement between the vertical component and its associated plate is terminated in order that the component may be joined with the plates **34** through an operation of a pair of automatic nailers **262**. The nailers are arranged at opposite sides of the machine at a nailing station **263**, and simultaneously drive a selected pattern of nails through the plates into the end portions of each vertical component for securing the component between parallel plates **34** at opposite sides of the machine. Once a vertical component is coupled with the parallel plates, the pressure tracks **180** are actuated for advancing the plates and, consequently, the associated vertical component from a position directly opposite the nailers **262**.

Therefore, since the extent of the component advancing displacement of the dog **164** is limited by the throw of the drive rods **150**, the position of the nailers **262**, relative to the track assemblies **180**, is fixed to coincide with the position assumed by the dog at its forwardmost position relative to the machine.

However, it can be appreciated that in order to achieve the precise spacing between the vertical components, it is necessary that the tracks of pressure track assemblies **180** advance the plates **34** in a precisely controlled manner for achieving selected spacing intervals for the vertical components. Should the pressure track assemblies **180** fail to advance the plates properly to achieve an accurate spacing of the vertical components, cumulative error necessarily is introduced in the total dimension of the wall being fabricated. Hence, it is of utmost importance that the wall plates be precisely advanced as they are delivered through the assembly station **11**. Since the drive for both of the pressure track assemblies **180** is initiated through the drive of the motor **220**, acting through the drive shaft **190**, control over the advance of the plates can accurately be dictated by precisely controlling the duration of the period of operation for the motor **220**.

In practice, the weight of the wall being fabricated is substantial, therefore the inertial effect of the load imposed on the motor, at the beginning and termination of the periods of intermittent operation thereof, creates a problem of underfeed and overfeed as the wall is accelerated to an advancing speed and then decelerated to zero speed. To overcome the problems imposed by the inertial effects of the intermittently advanced load, control over the motor **220** is achieved through a two-stage switching circuit, best illustrated in FIGS. **19** and **28**.

(Motor Control)

In practice, the motor **220** is an electrically energizable polyphase induction motor having high starting torque characteristics. While not illustrated, the motor includes a plurality of induction or field windings which are energized for purposes of imposing a rotating magnetic field about its output rotor. By increasing the flux density of the rotating field, the speed of the motor may be varied. This is achieved by varying the number of windings which are energized at any given point in time simply by sequentially connecting a first and a second number of coils to a source of electrical potential. By sequentially energizing a second set of coils in phase with the first set of coils, an increased flux density is imposed on the rotating field for thereby increasing the torque output. Conversely, by de-energizing one set of coils, the imposed torque serves to decrease the speed of the motor. In practice, the motor **220** is energized through a suitable source of electrical potential, preferably an alternating current source, not designated, delivered thereto through a first and a second circuit switch LS2' and LS2''.

As best illustrated in FIGS. **17**, **18** and **19**, the switch LS2' is supported for rectilinear displacement by a screw-threaded worm gear **264**, having threads formed about a rotatable shaft **265**, extended through an internally threaded block **266**, adapted to accept the threads of the worm gear **264** in a mated relationship.

It is to be understood that the block **266** is so supported by the gear **264** that as the shaft **265** is rotated in a first direction, the worm gear advances the block **266** in a first direction, and as the worm gear **264** reversely is driven, the block **266** is advanced in an opposite direction. Of course, in order to render the worm gear effective, means must be employed in supporting the block **266** against rotation, for thereby assuring rectilinear displacement as the shaft **265** is rotated. Therefore, a suitable guide rail **268**, having a guide groove **269** formed therein, is arranged adjacent the block **266** and fixed thereto for limiting the degree of rotation imposed on the block. As a practical matter, a guide track **270** is seated in the groove **269** formed in the guide rail **268**, in a mated relationship therewith, for thus limiting block rotation.

The switch LS2' includes an extended resilient actuating lever **272**, FIG. **19**, extended axially therefrom adapted to engage a rigid face of the cam **274** for effecting a closing of a circuit within the switch. In practice, the cam is stationary and the lever **272** is pivotally displaced through the camming action of the face of the cam **274**.

The switch LS2'', on the other hand, rigidly is mounted on a support plate **276** arranged adjacent to the path of the block **266** and includes a normally extended actuating button **278**. This button is disposed within the path of a spring-biased actuating lever **280** pivotally depending from the block **266** and coupled thereto by a convenient pivot pin **282**. The lever **280** is biased towards the actuating button by a suitable tension spring **284** which accommodates overtravel of the block **266**.

The shaft **265** of the worm gear **264** is journaled in suitable bearings **286**, located at opposite ends thereof, and is driven in rotation by a bevel gear **288** of a planetary gear **289** provided for a differential **290**, journaled on the shaft **265** and extended at right angles therefrom. In practice, the gear **288** is journaled employing a stub shaft **292** fixed to the shaft **265** by a pin and sleeve coupling **293**.

Hence, by driving the bevel gear **288** thereby causing the coupling **293** to be rotatingly advanced in a first direction, the shaft **265** is driven in a first direction for causing the worm gear **264** to advance the internally threaded block **266** in a first direction. By reversing the direction of rotation imparted to the coupling **293**, the block **266** is caused to be retracted or displaced in a second direction. Therefore, it is to be understood that,

initially, the shaft **265** is rotated in a first direction for advancing the switch LS2' in a direction such that the lever **272** disengages the face of the cam **274** for closing the circuit to the motor **220** for thereby energizing a first set of windings within the motor whereupon operation thereof is achieved at a given output torque. Continued displacement of the block **266** effectively displaces the lever **280**, relative to the actuator button **278** of the switch LS2'' for thereby permitting a second circuit to close within this switch. As the second circuit closes, a second set of windings is energized within the motor **220** for thereby increasing the flux of the rotating field for thus imposing increase in motor speed and in the torque applied to the output shaft of the motor. As the speed of the motor is increased, the rate of rotation of the shaft **190** is increased to a selected rate for thus increasing the rate at which the plates **34**, and the partially assembled wall, are advanced. Simply by reversing the direction of travel of the block **266**, the circuit which last energized a set of windings within the motor **220** is first interrupted within the switch LS2'', as the lever **280** engages the actuator button **278** for thereby opening the circuit within the switch. However, electrical energy continues to be delivered through the switch LS2' to the motor **220** for causing the motor to drive the shaft **190** until such time as the lever **272** engages the face of the cam **274** for interrupting a circuit within this switch, whereupon the motor **220** is de-energized. By controlling the duration of the energization of the motor **220** the distance through which shaft **190** drives the pressure track assemblies **180** for advancing the plates **34**, relative to the nailing station **263**, may be precisely controlled.

Control over the direction of rotation imparted to the shaft **265** is achieved through the use of a stepping motor **294**. The motor **294** is of any suitable design, such as a DC (Direct Current) stepping motor which responds to a train of pulses suited for advancing its output shaft through a series of steps, dictated by the number of pulses delivered to the winding of the motor.

The motor **294** operatively is connected with the machine control circuit **24** through a convenient lead, not designated. The circuit **24** responds to input signals from the tape reader **22** to provide a series of pulses, the number and duration of which dictate a period during which the shaft **265** effects a closing of the switches LS2' and LS2'' for directing an electrical energization current to the windings of the motor **220**. This dictation is achieved through a drive train including an input drive shaft **300**, to which is pinned a gear **302** drivingly meshed with a first system input gear **304** of a second differential system **306**. The input gear **304**, in turn, is supported by a bearing supported shaft **308** and coupled through a suitable bevel gear **310**. This gear is coupled to a driven planetary gear **311** including a bevel gear **312** rotatably mounted by a stub-shaft **313** pinned to the shaft **308**. The gear **312** is meshed with a coaxially aligned bevel gear **314** fixedly secured to a differential output gear **316** of the differential **306**. If desired, the shaft **313** may be pinned to the shaft **308** by a pin and collar connection **315** similar to the connector **293**.

The output gear **316** is journaled on the shaft **308** and serves as a means for imparting a rate of rotation to the gears **312**. The combined purpose of the gears **304** and **316** is to advance the stub-shaft **313** through a circular path in order to impart a rate of rotation to the shaft **308** for thus acquiring an output rotation from the differential **306** at an output gear **318**. The gear **318** rigidly is fixed to the shaft **308** through a pinned coupling **319** so that any rate of rotation imparted to the shaft **308**, regardless of direction, is delivered to the gear **318**.

The output rotation acquired from the gear **318** is delivered to the shaft **265**, through an idler gear **320** and a meshed gear **322**. The gear **322** is journaled for free-running rotation about the shaft **265** by a suitable sleeve **323**. The gear **322** also has fixedly secured thereto an input bevel gear **324** mounted for rotation about the shaft **265** and meshed with the bevel gear **288**. The gear **288** further is meshed with a bevel gear **326** which, in turn, is fixedly secured to an operatively fixed gear **328**. The gears **326** and **328** are journaled on the shaft **265** for accommodating relative rotation therebetween.

Consequently, as the motor **294** is stepped in response to a series of pulses delivered from the machine circuit **24**, a rate of rotation is imparted to the shaft **308**, so long as the gear **316** remains stationary, through an advancement of the planetary gear **311**. As the planetary gear **311** advances the shaft **308**, gears **318**, **320** and **322** are driven to impart rotation to the planetary gear **289** for effecting rotation of the shaft **265**, so long as the gear **328** is fixed against rotation. Therefore, it should be understood that by securing the gears **316** and **328** against rotation, a selected rate of rotation may be imparted to the shafts **308** and **265**, simply by stepping the shaft **300** through a series of pulses delivered to the motor **294** from the circuit **24**. This rotation of the shaft **265** serves to advance the block **266** in a direction for initially closing the circuits of a switch ls2' and subsequently the circuit within the switch LS2''. As the switches LS2' and LS2'' sequentially are closed, the tracks **182** and **184** of the track assemblies **180** are accelerated for advancing the wall for a period determined by the duration of the operation of the stepping motor **294**. By sequentially closing and opening the switches LS2' and LS2'', a two-stage acceleration is imposed on the shaft **190** for overcoming the effects of inertia.

Since the spacing between the vertical components is of primary importance, it is necessary that the electrical circuit be capable of de-energizing the motor **220** at an appropriate instant in time for terminating the advance of the wall by the track assemblies **180**. This de-energization is achieved by accommodating a reversing of the direction of rotation of the worm gear **264** and, hence, displacement of the block **266**. Reverse rotation is imparted to the shaft **265** through a drive train including an input drive chain **330** coupled with a suitable sprocket **332**, FIGS. **5** and **17**, and driven by a sprocket **333** mounted on the idler shaft **188** by means including a rigid coupling of suitable design, not designated. The drive chain **330** is coupled to the differential **306** through a suitable input shaft **334** which is journaled for rotation in a suitable bearing structure **336**. To the shaft **334** there is pinned an output gear **338** meshed with the second input gear **316**. The gear **338** is operatively driven in a reverse direction relative to the gear **302** as the motor **220** drives the pressure

track assemblies **180**, due to its coupling with the shaft **188**. The gear ratio established between the sprocket **333** and gear **338** is such that the speed of the gears **304** and **316** cancel at operating speeds, due to the rate of reverse rotation.

Therefore, assuming the gear **304** remains stationary, and a reversed rate of rotation is imparted to the gear **338**, a reverse rate of rotation is imparted to the shaft **265** for retracting the block **266** through the gear train employed in driving the shaft in the block extending direction. This retraction of the block **266** serves to interrupt the circuit to one set of windings for the motor **220** at the switch LS2', while continued rotation of the shaft **265** serves to retract the block in a position for forcing the lever **272** against the face or camming surface of the cam **274** for finally interrupting the circuit of the motor **220**. As the circuits to the motor **220** now are opened at switches LS2' and LS2'', a driving rotation of the motor **220**, and, consequently, the shaft **188**, is terminated and advance of the plates **34** is arrested.

By employing a pair of differentials, a simultaneous input may be delivered from the motor **220** and the motor **294** for simultaneously urging the block **266** in opposite directions of displacement in canceling or simultaneous add and subtract modes. So long as the motor **294** is driven at a rate such that the gear **302** advances with a peripheral speed greater than the peripheral speed of the gear **338**, the block **266** is extended as a consequence of a driving rotation of the shaft **265**. However, as the peripheral speed of the gear **338** attains the peripheral speed of the gear **302**, due to a driving of the shaft **188**, stabilization of the block **266** occurs. As operation of the motor **294** is terminated in response to a cessation of the circuit **24**, the peripheral speed of the gear **302** decreases relative to the peripheral speed of the gear **338**, due to the continued energization of the motor **220**. Therefore, a retracting displacement is imparted to the block **266** for displacing the block through a sequential circuit interrupting displacement, relative to switches LS2' and LS2''.

For purposes of adjusting the duration of plate advancement, the gear **328** is provided with a ratchet including a spring-biased lever **340** pivotally supported at a pivot pin **342** and biased into operative position by a tension spring **344**. The distal end of the lever **340** includes a ratchet dog **346** pivoted thereto and so disposed as to engage the teeth of the gear **328**. In practice, the teeth of the gear **328** are formed as teeth normally employed by a ratchet wheel and serves to support the differential **306** at one side thereof for accommodating an output through the shaft **265** in reverse directions.

(Timing Adjustment)

In practice, it may be desired to vary the timing between the opening and closing operations of the switches LS2' and LS2''. This is achieved through a gear advance **327** employed to advance the gear **328** during each revolution of the shaft **265**. This is achieved simply by providing an adjustable camming collar **350** adjustably on the shaft **265**. The cam **350** engages the lever **340** causing the dog **346** to advance the gear **328**, during each revolution of the shaft **265**, through a selected angle of rotation. A manually operable setscrew **348** is provided and mounted in a manner such that the positioning of a segmented lever may be adjusted for adjusting the throw imposed thereon by the can **350**. Therefore, by employing the cam **350**, the rate at which the block **266** is advanced or retracted between the actuation of the switches LS2' and LS2'' may be varied by advancing the ratchet wheel-like gear **328** through a selected angle of rotation at a given point in each cycle of operation of the cam **350** for thus causing the cam to oscillate the segmented lever **340** about the pivot pin **342**.

Hence, as the plates **34** are advanced relative to the pressure track assemblies **180**, a spacing between the vertical components is achieved by controlling the duration of the operation of the motor **294**, in response to signals applied from the machine control circuit **24**, to control the operation of the differential **290**.

By way of summary, it is to be understood that at the initiation of advancement of the plates **34**, the switches LS2' and LS2'' are closed due to a complete retraction or seating of the block **266** and that the positions of gears **316** and **326** are fixed. At the instant a train of out signals is delivered from the circuit **24**, the motor **294** begins an indexing drive of the gear train including gears **302**, **304**, **311**, **318**, **320**, **322**, **324** and **289** for imparting rotation to the shaft **265**. As the shaft **265** is advanced, the worm gear **264** advances the block **266** for unseating the lever **272** from the face of the cam **274** for thereby closing a circuit to one set of field windings within the motor **220**. As the motor is energized, for initial slow speed operation, the gear **338** is driven at a first speed, slower than the gear **302** whereby a rotation of the shaft **265** is continued even though at a lesser speed, due to the subtracting effect of the input at the gear **338**, acting on the gear **316** for slowing advancement of the planetary gear **311**. The continued advancement of the planetary gear **311** serves to drive the block **266** outwardly until the switch LS2'' is closed whereupon motor speed of the motor **220** is accelerated. As the motor **220** comes up to operating speed, the advancement of the planetary gear **311** is arrested, due to the fully operative subtracting effect of the gear **338**. Upon cessation of operation of the motor **294**, a reverse mode of operation is imposed on the block **266** through the differentials **290** and **306**.

Before nailing can be achieved, it is imperative that the plates be completely stationary and that the vertical components be positioned in place relative to the plates. Positioning of each of the vertical components is sensed by a pair of limit switches MS2 and MS2, FIG. **28**, connected with the drum switch DS. As illustrated in FIG. **12**, where only one of the limit switches is shown, it can be seen that as a vertical component comes to rest opposite the nailer **262**, the operative lever of the limit switch MS2 is depressed, whereby a circuit is completed for effecting operation of the nailer. Since it is imperative that both ends of the component be properly oriented, the switches are mounted to be actuated by the opposite ends of an advancing component as it comes to rest. Additionally, it is preferred that advancement of the plates **34** cease prior to performance of a nailing operation. Therefore, the switches MS2 and MS2, FIG. **28**, are connected in circuit series with the switch LS2' in a manner such that the circuit is closed through the switch LS2'' to the switch MS2 when the block **266** has been fully retracted to a position for opening the circuit LS2' to

the motor **220**. Of course, it should be readily apparent that the switch LS2' is provided with contacts for closing a circuit to the switch MS when the button **278** is depressed.

Once a proper relative position between the plates **34** and a vertical component is assumed, each of the nailers **262** is actuated in response to the closing of the switches MS2 and MS2, as well as LS2', for advancing the drum switch DS for driving nails through the plates into the ends of the vertical components.

(Nailing)

While various nailing devices could be employed, each of the nailers **262** is adapted to select a nail pattern of two or four nails, depending upon the type of nailing operation to be performed. For example, if only a single stud is presented to the nailer, only two nails are required for joining the stud with the plate **34**. On the other hand, where a pair of studs are presented in a side-by-side relationship, it is necessary that the nailer **262** insert a pattern including four rectangularly oriented nails for simultaneously joining both studs to the plate. Therefore, the tape **23** is provided with indicia suitable for selectively actuating the control circuit **24** for achieving a pattern selection of the nailer **262**, whereby a pattern is set prior to the actuation of a nailer so that the appropriate number of nails are inserted in the stud at a given instant in time.

Basically, each of the nailers **262** includes a nail tray **352**, FIG. **5**, adapted for intermittent oscillation, by means not shown, to deliver nails to a pattern selector **354**. The selector **354** includes four pivoted arms **356**, FIG. **12**, which are mounted in lateral directions. The arms, upon being pivoted, open corresponding gates for delivering the nails to nail chutes **358**, FIG. **5**, disposed beneath the arms. The manner in which the arms are actuated can be varied as required, however, in practice, each nailer **262** is provided with four vertically extendible fingers **360**. The fingers are adapted to be elevated relative to the distal and portions of the arms **356**, by electrically energizable solenoids **362**, in response to signals delivered from the machine control circuit **24**. As selected fingers are elevated, through a selective actuation of the associated solenoids **362**, they are positioned adjacent the distal ends of selected pivoted arm **356** for establishing a nail pattern. In practice, the solenoids **362** and the fingers **360** are mounted for rectilinear reciprocation on a laterally displaceable picker bar **364** which, in turn, are adapted to be displaced by a suitable actuator **366**. As the picker bar **364** is driven in a first direction, the elevated fingers engage the distal ends of adjacent arms **356** for thus causing the arms to pivot about a given pivot, not shown, whereby selected gates are opened for delivering nails through the chutes **358**. As the nails are delivered downwardly, they are appropriately oriented and are seated point-first in a plurality of nail driving guides **368**. The guides **368** are of tubular construction and are arranged in the path of a plurality of reciprocating, telescoping rams **370** which are inserted into the guides **368**. The rams are coupled with a head **371** driven through a pneumatic actuator **372**, FIG. **6**, for forcing the nails inwardly through the plates **34** for joining the plates with the positioned vertical components.

Since each of the nailers **262** is of a known design and is readily interchangeable with other available nailing devices, a detailed description thereof is omitted in the interest of brevity. However, it is to be understood that each of the nailers **262** is provided with means adapted to establish selected patterns of nails, in response to an input of electrical signals, and, subsequently, to be actuated in response to an input of electrical signals for effecting a "nailing" operation. Once the nailing operation has been completed, the tracks of the track assemblies **180** are indexed for advancing the wall through a selected increment for positioning the plates preparatory to receiving the next vertical component.

It will be recalled that the guide plate **133** serves as a guide plate for positioning the ends of the vertical components as they are advanced to the nailing station **263**. Consequently, as the vertical components come to rest opposite the nailer station **263**, the guide plates **133** initially are positioned between the nailers and the opposite ends of the components. Therefore, means must be provided for retracting the plates from between the path of the nails as they are inserted through the plates **34** into the ends of the vertical components disposed therebetween.

(Guide Plate Retraction)

To achieve retraction of the guide plates **133**, each is mounted for reciprocation in suitable guide brackets **374**, FIG. **12**, whereby rectilinear, fore and aft reciprocation may be imparted thereto. In practice, the guide plates **133** are urged forwardly into an operative disposition through the use of a tension spring **376** coupled at one end to the bracket **374**, by a pin **378**, and at the opposite end thereof to the plate at a suitable pivot pin **380**. Retraction of the plate **133** is effected through a linkage including a reciprocating push rod **382** coupled to the plate **133**, also at the pivot pin **380**. Therefore, it is to be understood that while the push rod **382** advances the plate **133** rearwardly the spring **376** urges the plate forwardly into an operative, component guiding disposition.

Actuation of the push rod **382** is achieved in response to an operative advancement of the pneumatic actuator **372** as the actuator serves to drive a selected pattern of nails into the ends of components positioned adjacent thereto. In practice, as best illustrated in FIGS. **12**, **14** and **15**, the push rod **382** is coupled by means including a suitable pivot pin **384** to a crank arm **386**. The crank arm, in turn, is fixedly secured to a rocker shaft **388**. This rocker shaft is supported by a spaced pair of suitable bearings **389**, rigidly supported by the frame of the machine through suitable support means, not designated. As oscillation is imparted to the shaft **388**, oscillation also is imparted to the crank arm **386** to an extent dictated by the oscillation imparted to the shaft **388**. As the crank arm **386** is oscillated in a first direction, the push rods **382** are displaced in a first preselected direction for thus displacing the plate **133** in a plate retracting direction. Of course, the springs **376** are tensioned as they act against the rods **382** when the plates **133** are retracted, but as a reverse oscillation is imparted to the shaft **388**, the plates are returned to an operative component guiding position. Hence, reciprocation accommodates both a guiding of the vertical components into position to be nailed and a nailing of the vertical components.

As best shown in FIGS. 14 and 15, the shaft 388 is oscillated through a crank arm 390 rigidly fixed to the shaft and extending radially therefrom. Secured to the distal end of the crank arm 390 there is pivotally coupled a push-pull link 392. The crank arm 390 is secured to the link 392 by any suitable coupling device including a right angle pin connection extended through an appropriate opening, not designated, and pinned to the crank arm 390 by any suitable pin, such as a cotter pin, not designated. The opposite end of the link 392 is pivotally connected to an oscillating crank arm 394 which is rigidly fixed to and extends radially from a shaft 396 journaled for oscillation in bearing brackets 398. As the shaft 396 is oscillated, the arm 394 is oscillated so that the end portion thereof describes an arc dictated by the extent of oscillation imparted on the shaft 396 for thereby imparting a push-pull actuation of the push-pull link 392. As a push-pull actuation of the link 392 is achieved, it is accompanied by a push-pull actuation of the push rod 382 for thereby achieving selected displacement of the plates 133.

Each of the shafts 396 is provided with an actuator foot 400 extended radially therefrom, FIG. 15. This foot extends into the path of the associated head 371 as it operatively is displaced by the associated actuator 372 for driving the rams 370 for achieving a nailing operation. In practice, the actuator foot 400 includes an abaxially extended distal portion 402 so positioned as continuously to maintain contact with the top surface of the heads 371 throughout the major portion of the reciprocating strokes imparted thereto in order that the shaft 396 is maintained in a rotated operative disposition throughout the nailing stroke of the ram 370 and permitted to return only after the head 371 has been retracted by the actuator 372. While the spring 376 is employed for displacing the plates 133, it should be understood that, where desired, the foot 400 also may be spring-biased in a selected direction for causing the shaft 396 to rotate in a direction opposite to that imparted thereto as the head 317 is extended in a nail inserting direction.

Since the operative displacement of the head 371 serves to impart oscillation to the shaft 396, it should be appreciated that through the linkage located at opposite sides of the machine both of the plates 133 simultaneously are retracted out of the path of the nails as the rams 370 are advanced in nail driving directions and, subsequently, returned for receiving a vertical component therebetween, as the rams are returned under the influence of the spring 376.

(Wall Plate Severing)

Upon the insertion of appropriate numbers of vertical components between the wall plates 34, it is preferred that the plates 34 be severed to a predetermined length. This is achieved by driving a circular saw 404 through the trailing portions of the plates at points determined by the machine control circuit 24, in accordance with intelligence supplied thereto through the punched tape 23.

The saw 404 is journaled, FIG. 14, and supported by a suitable bracket 406 and a driven axle 408. The axle 408 is rigidly coupled to the saw and extended into the bracket 406 in any suitable fashion. The brackets 406 operatively are supported by a terminal portion of the right angle rocker arm 410. The rocker arm 410, in turn, is rigidly secured for oscillation about the longitudinal axis of a support shaft 412, which is seated in spaced bearings 413.

It is to be understood that by imparting oscillation to the shaft 412, the rocker arm 410 causes the saw 404 to advance through the adjacent plate 34 for effecting a severance thereof. In practice, the saw 404 operatively is driven by an electrical motor 414 connected with the saw through a pair of suitably supported sheaves including driven and driving sheaves 416 and 418, respectively, interconnected through a V-belt coupling 420.

(Guide Plate Displacement)

As is the case with respect to the nailer 262, it is necessary to displace each of the guide plates 133 from the path of the adjacent saw 404 in order to accommodate a severance of the wall plates 34 by an operation of the saw. This is accomplished through a convenient linkage coupled to the external face of each of the plates 133 through a coupling 422 of a suitable design, which accommodates an oscillatory displacement of the plate. It is intended that the coupling 422 be displaced inwardly for tilting the associated plate and retracted outwardly for thus returning the plate 133 to a vertical disposition.

The coupling 422 for each plate 133 is driven by a bar 424 pivotally coupled thereto. The bar 424 is coupled to a drive bar 425 supported by a pair of parallel support arms 426 and 428, FIG. 14, between spaced pivots 430 while the arms 426 and 428 depend from pivots 432 secured to upright machine frame members, not designated.

The bar 425 is reciprocated by means including a vertical camming bar 434 depending from a driven link 436 at a pivot 438. The link 436 is rigidly secured to the shaft 412 and is adapted to be oscillated in rotation thereby. Hence, oscillation of both the links 436 occurs simultaneously with oscillation of the arm 410. The depending camming bar 434 extends downwardly adjacent to a rigid inclined cam 440 and is provided with a cam follower 442 adapted to engage and ride along an inclined face provided for the cam as the bar is displaced in vertical directions. Adjacent the lowermost end of the bar 434, for engagement therewith, there is disposed a protruding cam 444 fixedly secured to the bar. Therefore, it is to be understood that as the shaft 412 is rocked, for thus causing the saw 404 to advance toward the adjacent wall plate 34, the drive link 436 is displaced downwardly, in an arcuate path, so that the camming bar 434 is displaced vertically for causing the cam follower 442 to engage the inclined face of a cam 440, whereupon the bar 434 is pivoted at pivot 438 and the lowermost distal portion of the bar 434 is displaced and brought into engagement with the cam follower 444 for forcing the bars 425 and 424 in axial displacement for causing the associated plate 133 to pivot outwardly away from the path of the saw 404 as it is advanced by the arm 410.

Of course, it is readily apparent that the angle of the cam face of the inclined cam 440, relative to a vertical axis, will determine the extent to which the plate 133 is pivoted from the path of the saw 404. Further, in order to assure a return of the linkage for repositioning the plate 133 to a vertical orientation, a convenient tension spring 446 may, if desired, by included for causing the

linkage to retract, once the bar **434** is elevated through a reverse rotation of the shaft **412** and as the saw **404** is returned to an inoperative position.

While various means may be employed for rocking the shaft **412**, a pneumatic, piston-type actuator **448**, FIG. **15**, coupled with the shaft **412** through a crank arm **450** has been found to function quite satisfactorily. The actuator **448** is pivotally suspended at its heels by a pivoted clevis coupling **452** in a manner such that its output shaft **454** may operatively be extended for rotating the shaft **412**. A pivoted coupling **456** is provided for joining the shaft **454** with the arm **450**. A selective operation of the actuator **448** is acquired through a selector valve **457** coupled with the actuator in a suitable manner for dictating reciprocation of the shaft **454**.

Turning, for a moment to FIG. **28**, it will be noted that the selector valve **457** of the actuator **448**, which serves to advance the saw **404**, and the motor **414**, which drives the saw **404**, are interconnected with a machine control circuit through the limit switch LS2'. While not imperative, it is preferred that switch contacts be incorporated in the circuit for assuring the operation of the saw **404** only when the tracks of the assemblies **180** are totally inactive. Therefore, the switch LS2' is provided with a second pair of contacts, not illustrated, for closing the circuit to the selector valve **457** and to the saw motor **414** only when the switch LS2' is seated in a position for assuring an inactivation of the motor **220**. Therefore, should the switch LS2' be closed for driving the motor **220**, and, consequently, advancing the plates **34**, the actuator **448** and motor **414** cannot be activated, since the energizing circuit from the control circuit **24** is interrupted at the switch LS2'.

Through the foregoing operation of the machine at the component assembly station **11**, the plates **34** and the various vertical components selected and fed from the component feed station **10** are secured together and advanced from the component assembly station **11** by the track assemblies **180**, to the header station **12** as a unitary wall, with the saw **404** being selectively employed to sever the wall plates **34** according to predetermined dimensions provided through an input derived from the tape **23** and fed to the machine control circuit **24**.

HEADER INSERTING STATION

Also included in the intelligence punched, or otherwise encoded, on the tape **23** is instructive intelligence for imposing additional selected functions on the machine, subsequent to the component assembly at station **11**, including the insertion of headers for various openings including doors, windows and the like. This is achieved at station **12**.

At station **12** there is provided a pair of pressure track assemblies **500**, FIG. **20**. This assembly is quite similar in design and function to the pressure track assemblies **180**. Since each track assembly is operated in a manner quite similar to the assemblies **180**, a detailed description thereof is omitted in the interest of brevity. However, it should be understood that precise control over the wall feeding function is acquired at the station **12** by employing the assembly **500**.

Above each track assembly **500** there is provided a header feeder **502** into which are stacked a plurality of pre-dimensioned headers **504**. It is intended that the headers operatively be deposited between the plate **34**, which serves as the upper wall plate, and the adjacent ends of the trimmers coupled with the stud-trimmers **44** and trimmer-studs **46** supplied by the station **10** and included as vertical components of the wall at station **11**. The feeder **502** is quite similar in design to the hoppers **100** of station **10**, except that it is so oriented as to have its longitudinal axis extending parallel to the path of the advancing wall, rather than transversely of the longitudinal axis.

The header feeder also employs elevators quite similar to the elevators **101**, which are employed in feeding the components at station **10**, for positioning the headers **504** in appropriate positions on the trimmers. Since the feed mechanism employed at the station **10** has been described in detail, a detailed description at this point is omitted in the interest of brevity. However, it is to be understood that the plate **122** includes two separate and operatively abutting members, which, for the sake of simplicity, are not shown, adapted to be spaced when the elevator is lowered for accommodating passage of the wall.

The tracks of the assemblies **500** are driven through a suitable drive train including an electrically energizable motor **503** coupled with the tracks through a shaft and sheaves, similar in design and function to those employed in driving tracks **182** and **184**.

In order to appropriately position the wall to receive the headers **504**, a limit switch LS3, similar to the switches MS1 and MS1, is disposed in the path of the advancing walls in a manner such as to extend its operative arm to be engaged by the wall as it is advanced by the tracks of the assemblies **500**.

However, in order to achieve a feeding of a header from the feeder **502**, a signal is delivered from the machine control circuit **24** to a control circuit **508** connected in circuit series with the limit switch LS3. The limit switch is connected through a suitable circuit with the motor **503** so that as the control circuit **508** is activated, the closing of the limit switch LS3, through an engagement with the advancing wall, serves to interrupt a circuit to the motor **503** of the drive train for the track assemblies **500** for thus deactivating the motor and thereby arresting wall displacement. Simultaneously, actuation of the elevator **501** for lowering a head in place is achieved through a closing of the switch LS3 to a selector valve **509**.

Due to the normal massiveness of the headers **504** there is a tendency for the headers to "seat" under their own weight. Therefore, by properly dimensioning the headers they may be "dropped" into position relative to the ends of the trimmers. As the headers are seated, a pair of switches HS1 are engaged thereby and closed in response to the weight of the delivered header. As the switch HS1 is closed an actuator **510**, FIG. **21**, of a nailer assembly is actuated, through a selector valve **511**, FIG. **28**, for extending the shaft **512** of the actuator **510**. The distal end of the shaft **512** is coupled through a convenient pivoted coupling **514** to a pivotally supported nailer **516** mounted on suitable trunions **518**. The nailer **516** may be of any convenient design, however, a pair of operatively coupled, pneumatic nailers may be coupled for simultaneous operation so that depression thereof, by the actuator, is ac-

commodated. Consequently, the resulting nailer operatively is depressed in pivotal rotation about the trunions **518**, for causing the nail inserting heads of the nailer to be properly positioned relative to the adjacent trimmer-stud and the stud-trimmer which are located at opposite sides of the delivered header **504**.

As the nailers **516** operatively are pivoted about their trunions **518** each is activated through suitable linkages, including stops **520**, for initiating an insertion of a nail through the adjacent studs and into the header **504**. As a practical matter, the nailers **516** are "ganged" so that a plurality of nails are simultaneously driven through the studs into the header in a single operation and in a desired pattern. A limit switch, not shown, is mounted on the stop **520** and is incorporated in the nailer **516** to detect completion of the driving of nail insertion operations, whereupon a signal is delivered back to the selector valve **511** for effecting an elevating of the head of the nailer. As the nailer head is elevated, a limit switch HS2 is actuated for closing a circuit to the motor **503** for causing advancement of the tracks of the assemblies **500** to be resumed for advancing the thus completed wall from the station **12** to the adjacent window box inserting station **14**.

As a practical matter, frequently a header **504** will not be required for a given wall, and, in such instances, no signal will be delivered from the control circuit **24** to the control circuit **508**. Therefore the actuation of the limit switch LS3 is ineffective for interrupting the advance of the pressure tracks of the assemblies **500** so that operation of the elevators **501** will not be initiated.

While not shown, it is to be understood that in the event difficulty is encountered in seating the headers on the distal ends of the trimmers, the nailers **516** may be displaced from adjacent the feeder **502** so that nailing may be achieved at a second station with the headers being seated by mechanisms employing hydraulic rams being adapted to seat the headers on the trimmers. However, as a practical matter, the weight of the header is, in most instances, sufficient to cause the header to seat on the trimmers as it is fed from the header feeder **502**, particularly in those instances where both the headers and trimmers are appropriately dimensioned.

WINDOW BOX INSERTION STATION

The window box insertion station **14**, as best shown in FIG. **22**, includes a conveyor **600**, which serves to receive advancing walls from the assemblies **500** of the header station **12** and serves to intermittently advance the wall through the station. The conveyor **600** is of any suitable design, however, a pair of parallel chains including vertically extended dogs **602** serves quite satisfactorily for this purpose. The chains simultaneously are driven through a drive train **604** of a suitable design which includes an electrically energizable motor **605**, similar in design to the motor **503**. This motor, in turn, is connected with a limit switch LS6 of a design and function quite similar to the switch LS3.

The window boxes **42** are delivered serially from the opposite sides of the conveyor **500** by transverse conveyors **606**, as best illustrated in FIG. **22**. Each of the conveyors **606** preferably is a gravity conveyor including suitable rollers **607**. A solenoid operated, reciprocating stop **608** is disposed at the discharge ends of each of the conveyors and serves as gates for accommodating a release and passage of the window boxes from the conveyor. In practice, the gates are mounted for reciprocation by suitable bearing structure, not shown, and are responsive to an actuation of the solenoids **610** for effecting release of the window boxes.

As a practical matter, the window boxes **42** are directed and are delivered to the conveyors **606** by any suitable means, including a manual operation. In order to deliver the window boxes **42** from the conveyors **606** to appropriate dispositions relative to the studs and plates of an advanced wall, a pair of movable stops **612** are provided in the path of the boxes as they are delivered. The stops are so positioned as to arrest lateral displacement of the window boxes, relative to the wall, for causing them to "drop" into place as they are delivered by the conveyors **606**. As the window boxes are delivered transversely above the conveyor **600**, they are permitted to seat within the wall and to be retained therein. While not mandatory, it is preferred that a pressure assembly be provided for assuring a seating of the window boxes **42** within the wall, between selected studs. Therefore, there is provided a pair of fluid actuated rams **614** supported by suitable means, not designated, having laterally extended feet **616** adapted to be driven by the rams for seating the window boxes.

Mounted on each of the movable stops **612** there is a limit switch WS1 which, when depressed, serves to actuate the pair of seating rams **614** through an actuation of a selector valve **617**, coupled with a pressure system, not shown, suitable for driving the pair of feet **616** downwardly to engage and force the window boxes into a seated disposition.

Once the window boxes **42** are seated, four pairs of "ganged" nailers **618** are provided and employed for joining the window boxes with the advanced wall. Each of the nailers is mounted on a suitable trunion **620** in a manner similar to the mounting of the nailers **516** employed at the header inserting station. The pairs of nailers **618** pivotally are driven through a suitable supporting linkage, including bracket links **621** and actuators **622** adapted to depress the nailers into operative position.

Control of the actuators **622** is achieved through a plurality of selector valves **623** and a plurality of limit switches WS2 which are depressed as the window boxes are seated and function to close a circuit to the selector valves **623** for causing the nailers **618** to be depressed about their trunions **620** into an operative position.

As the nailers are depressed, they are actuated through suitable linkages, not shown, for inserting nails as required. As a practical matter, each of the nailers **618** is provided with suitable limit switches, also not shown, which serve to reverse the direction of activation of the actuator **622** for causing the nailers **618** to be returned to an inoperative position once the nailing operation is completed. As the nailers are returned to an inoperative position, a plurality of limit switches WS3 are actuated for re-closing the drive circuit for the motor **605** for thereby activating the drive train **604** to effect an advancement of the wall having window boxes inserted therein to the adjacent routing station **16**.

It is to be understood that initiation of the window box inserting operation is achieved in response to an intelligence signal delivered to a control circuit **624**, from the machine control circuit **24**, all in a manner similar to that described with respect to the header insertion operation. The circuit **624** operatively is associated with the limit switch LS6. In the event no signal has been delivered from the control circuit **24** to the control circuit **624**, operation of the limit switch LS6 is rendered ineffective and the conveyor **600** continues to deliver the wall through the station **14**. However, in the event a window box is required as determined by the intelligence of the tape **23** and dictated by the control circuit **24**, a closing actuation of the limit switch LS6, by the advanced wall, serves to initiate operation of the machine for selectively inserting window boxes at opposite sides of the wall being delivered through the station **14** by the conveyor **600**.

Once the window boxes have been seated and nailed in response to an actuation of the various nailers, the conveyor **600** is reactivated, through a closing of the switch WS3, so that the conveyor **600** now serves to deliver the wall to an adjacent conveyor **700** which traverses the adjacent routing station **16**.

THE ROUTER STATION

Turning now to FIGS. **23** and **24**, it will be seen that the conveyor **700** at the routing station **16** also includes parallel chains **701** having appropriately formed dogs **702** mounted thereon and oriented in a wall engaging and advancing disposition. The chains are driven through a drive train assembly **704**, of any suitable design, including a motor **705**, which selectively is activated for advancing a wall through the routing station **16**.

Above the conveyor **700** there is provided an adjustable router supporting structure including a pair of parallel, laterally extended guide rails **706** supported by a truss **707**. These rails operatively support a laterally displaceable router **708**, of any suitable design, including a router blade **709**. The router is mounted for displacement in a plane parallel the plane of the wall advanced by the conveyor. In practice, the router **708** operatively is advanced in opposite directions by a reversible motor **710** acting through an endless cable **712** trained about conveniently supported idler sheaves **714** and a drive sheave **716**. Hence, it is to be understood that as the motor **710** is activated, for driving the sheave **716** in a selected direction, the router **708** is advanced across the width of the conveyor **700** and, consequently, across the wall supported by the conveyor. The motor of the router **708** operatively is powered from a suitable source of electrical energy, not shown, which serves to drive the router blade **709** by imparting driven rotation thereto for forming recesses in the vertical components sufficient to receive diagonally disposed let-in braces, the purpose of which is to impart rigidity to the resulting wall structure.

Near the opposite ends of the rail-supporting truss **707** there is provided a mount **718** and an electrically energizable motor **719** slidingly supported for displacement along longitudinal support rails **720**. The motor **719** includes rack and pinions **721** for achieving adjustment. The rails **720** are extended along opposite sides of the routing station **16** while each mount **718** includes a setscrew **722** to be tightened for securing the mount **718** relative to the rails **720**. A mounting bracket **724** is coupled with the mount **718** and serves to support a vertically disposed pneumatic actuator **726**. Each of the actuators includes an axially displaceable piston defining an expandible chamber, the pressurization of which is controlled by a single selector valve **727**. Extended from the piston head is an upwardly directed, axially displaceable shaft **728** coupled to the truss **707** by a suitable swivel coupling **730** which accommodates a pivoting displacement of the truss relative to the longitudinal axes of the shafts.

The truss **707** is adapted to pivot about the swivel coupling **730** at the opposite ends thereof, while a channeled bearing bracket **734** is provided at one end portion of the truss for slidingly supporting the truss for accommodating transverse displacement of the truss relative to the rail **720** as the position angle of the truss, relative to the longitudinal axis of the wall, is adjusted. Hence, by pivoting the truss about the swivel coupling **730**, and by shifting the position of a mount **718** along the rails **720** through a selective activation of the motor **719**, it is possible to adjust the path to be traversed by the router **708**. Furthermore, by simultaneously activating the pair of actuators **726**, through the selector valve **727**, for thus extending and retracting their shafts, lowering and elevating the truss **707** and, consequently, the blade **709** of the router **708** is achieved. Thus, the blade **709** of the router is lowered into an operative position, preparatory to traversing the adjacent surface of a wall, in a plane parallel to the plane of the wall, and is elevated for a return to its initial or starting position upon completion of the routing operation.

A limit switch LS10 is provided adjacent the path of the wall as it is advanced through the routing station **16**. This switch is mounted in a manner such that its actuating lever is disposed in a wall intercepting disposition, in a manner similar to switches LS3 and LS6. The switch LS10 is connected with the motors **705** and **710**, as well as a solenoid of the selector valves **727**. Hence, the actuation of the switch LS10 serves to interrupt the operation of the driving function of the motor **705** for thus arresting advancement of the conveyor **700**, in a manner similar to that heretofore described with respect to the control imposed on the conveyor **600**. As the conveyor **700** comes to rest, the motor **710** simultaneously is activated, in response to the actuation of the switch LS10, for initiating a driving translation of the router **708** along the rails **706** and, concurrently therewith, the motor of the router **708** is energized for effecting a rotation of the blades **709**, as the selector valves **727** for the actuators **726** are activated for lowering the truss **707** and the router into an operative disposition relative to the wall.

A control circuit **735**, quite similar in design and function to the circuits **508** and **624**, is provided for rendering the switch LS10 operative when a routing of the vertical components of a wall at the routing station **16** is to be effected, while rendering the operation of the switch ineffective when no routing is to be performed, as determined by the intelligence provided by the tape **23**.

Therefore, it should be appreciated that as the control circuit **735** is energized, in response to an input from the circuit **24**, the switch LS10 is rendered operatively effective for arresting displacement of the wall and dropping the router **708** into an operative engagement with the vertical components of the wall, while simultaneously energizing the motor of the router and initiating the driving operation of the motor **710** for advancing the router along the rails **706**. Where desired, brakes of any suitable design, such as well-known magnetic brakes, may be employed for assuring the advance of the conveyor is arrested prior to the operation of the router **708**. However, as a practical matter, there is very little likelihood that significant overrun of the conveyor **700** will be experienced sufficient to warrant inclusion of brakes.

Once the router **708** has completed an operative translation of the wall, it is preferred that the router **708** be returned to its initial position. This is achieved simply by employing an adjustably positioned limit switch RS1 arranged adjacent the path of the router in a manner such that its operative lever is adapted to be activated by the router as the router completes its translation of the wall. The manner in which the switch RS1 is mounted is a matter of preference, however, it is important that the switch be adjustably supported in order that the cutting stroke of the router may selectively be varied. The output signal derived from the switch RS1 is delivered to the router **708** for de-energizing its motor, to the selector valves **727** for the pneumatic actuators **726**, for effecting a truss elevating operation thereof, to the motor **710** for reversing the direction of the drive applied to the sheave **716**, for returning the router to its initial position, and to the motor **705** and drive train **704** of the conveyor **700** for reactivating and causing the conveyor **700** to advance. As the conveyor **700** again is activated, the wall is advanced from the routing station **16** with a plurality of diagonally aligned recesses being formed in each of the vertical components intercepted by the rotating blade **709** of the router **708**.

Of course, in the event no let-in brace is required, no signal is delivered to the control circuit **735** and, consequently, the conveyor **700** remains activated for delivering the wall therethrough in an uninterrupted fashion.

As the conveyor **700** delivers the thus completed wall from the routing station **16**, the wall is received by a conveyor **800** driven by a drive train, including an electrically energizable motor **801** at the brace inserting station.

BRACE INSERTING STATION

Turning to FIGS. **25** and **31**, therein is illustrated a laterally disposed hopper **802** which is employed for serially delivering the braces from a stack of let-in braces to recesses formed by the router at station **16**.

The hopper **802** is supported at one end by a pivoted support **804** mounted on a sliding bracket **806**. The bracket **806**, in turn, is mounted for longitudinal displacement along a suitable support rail **808** in a manner quite similar to that employed in supporting the mount **718**, as employed at the routing station **16**. The opposite end of the hopper **802** operatively is supported by a pivoted support **810**, which is vertically supported by a sliding bracket **812** mounted on a guide rail **814**, also in a manner quite similar to the mount **718**, as employed at the routing station. As a practical matter, each of the brackets **806** and **812** is provided with an assembly **815** which includes a motor and an associate rack and pinion for achieving angular adjustment. A plurality of setscrews, not shown, are provided for fixing the position of the bracket relative to the guide rail in a manner similar to that employed in positioning the router.

Near the opposite end portions of the hopper **802** there is provided a pair of solenoid actuated support fingers **816**. These fingers are positioned, through an employment of adjustable brackets, not designated, at selected locations along the lower plane of the hopper in order that the fingers simultaneously are extracted from beneath the hoppers for accommodating a downward discharge of the braces supported thereby. A pair of solenoids **817** are provided and operatively coupled with the fingers for achieving an actuation thereof. Also coupled with the hopper **802** is a pair of clamping feet **818** quite similar, in design and function, to the clamping feet **108**. The feet operatively are actuated through suitable pneumatic actuators **820** and are controlled by a microswitch BS1 associated with the fingers **816** through control linkage **822**. The microswitch BS1 operatively is coupled between the actuators and the fingers. While the manner in which the fingers **816** and feet **818** are interconnected may be varied, it is to be understood that as the solenoids **817** are actuated for extracting the fingers **816** from beneath the lowermost brace contained within the hopper **802**, while the clamping feet **818** simultaneously are urged into clamping engagement with the next-in-line brace supported within the hopper, in response to actuation of the switch BS1 through the linkage **822**. As a practical matter, the linkage **822** is quite similar to the rod **114**. As the solenoid **817** returns to a seated position, for thus repositioning the fingers **816**, the clamping feet **818** are caused to retract for accommodating a dropping of the stack of braces into a supported engagement with the repositioned fingers **816**.

If desired, the adjustable brackets **806** and **812** may be positioned by the assembly **815** in response to an output from the machine control circuit **24**, however, and as a practical matter, since the braces normally are inserted at somewhat a uniform angle, manual control thereof readily can be employed for positioning the brace dispensing hopper **802** across the wall at an appropriate angle.

Nailing

In addition to depositing the braces, it frequently is desirable to incorporate means for nailing the deposited braces within the recesses formed by the router **708**. This is achieved simply by providing, at the downstream side of the hopper **802**, a plurality of spaced trunions **826**, adjustably supported by a plurality of brackets **828**, as shown in FIG. **30**, each pivotally supporting a pneumatic nailer **830** therein. The spaced nailers are conveniently "ganged" together, through a pivoted linkage **832**, for simultaneous oscillation into operative disposition. Consequently, a pneumatic actuator **834** operatively is coupled with the linkage **832** for operatively pivoting the nailers into a selected

disposition relative to the let-in brace deposited in the router-formed recesses, whereby a nailing operation may readily be achieved for securing the brace with the recesses.

In order to provide for a selective delivery of the brace to the recesses formed in the walls, as well as to nail the braces therein, the conveyor **800** is provided with a limit switch LS12 similar in design and function to switch LS10. This switch is connected with the motor **801** of the drive train for the conveyor, and so positioned relative to the conveyor as to effect an arrest of the operation of the conveyor's drive train at an appropriate location, when required to do so in accordance with a signal from a control circuit **24**. The circuit **24** is coupled with a limit switch control circuit **835**, in a manner similar to that aforedescribed, with respect to the circuit **735** of the routing station. Once a wall being fabricated is positioned beneath the hopper **802**, the limit switch LS12 delivers a control signal to activate the solenoids **817** for displacing the fingers **816** and effecting an actuation of the clamping feet **818** through an operation of the limit switch BS1. The operation of the hopper **802** is quite similar to the operation of the hoppers **100**, therefore a detailed description is not believed necessary. However, as the fingers **816** are displaced, the feet **818** engage the stack of braces until such time as the fingers are repositioned.

As a brace is delivered from the hopper **802**, it is caused to engage and actuate a limit switch BS2, mounted on the hopper adjacent the path of the brace. This switch is connected with the motor **801** of the drive train through a suitable time delay mechanism TD, whereby the conveyor **800** is stepped through a predetermined distance for thus causing the wall to advance a predetermined distance. This stepping or indexing of the conveyor serves to position the braces directly beneath the ganged nailers **830**. As the indexing advance of the conveyor **800** is terminated, an electrical signal derived from a suitable source is delivered to the actuator **834** for initiating operation of the actuator to effect a rotation of the nailers into an operative position for effecting a nailing operation.

Again, as is the case with the nailers hereinbefore described, completed nailing operations are detected through suitable limit switches, not shown, for reinitiating the advancing operation of the conveyor **800**. Once the conveyor **800** is reactivated it serves to deliver the thus completed wall to an adjacent conveyor **900** at the sheathing station **20**.

Again, in the event no signal is received from the machine control circuit **24**, the control circuit **835** is rendered inactive, whereby actuation of the limit switch LS12 is rendered ineffective and conveyance of the wall through the brace inserting station **18** occurs without interruption.

SHEATHING STATION

The machine structure employed at the sheathing station **20**, FIG. **26**, for delivering sheathing to the wall is quite similar in design to the window box insertion station, as illustrated in FIG. **6**.

As the wall is conveyed from the brace inserting station **18** to the sheathing station **20**, it is received by a conveyor **900**, including a drive train having a motor **901** quite similar in design and function to the conveyor **800**. This conveyor includes dogs **902** similar to the dogs described in conjunction with the window box insertion station **14**. As in the case with the window boxes **42**, the sheets of sheathing **904** are supported on an inclined gravity driven conveyor **906**. Feeding advancement of individual sheets are intercepted by a reciprocating gating finger **908**. The finger **908** is controlled by an actuator **910**, in a manner quite similar to the operation of the gate **608**, as employed in delivering the window boxes, therefore a detailed description of the fingers **908** is omitted.

Mounted adjacent the sheathing station **20** there is a plurality of pneumatic nailers **912** which are mounted at selected locations and employ trunions **518** in a manner similar to that heretofore described with respect to the mounting of the nailers **830**, **618** and **516**, employed at various stations and adapted to be pivoted into an operative disposition through a plurality of actuators **916**, all in a manner heretofore described, with respect to the nailers of stations **12** through **18**, for effecting a nailing operation at selected points.

In practice, each sheet of the sheathing selectively is dimensioned and provided with suitable openings prior to its being fed to the station **18**. However, if desired, solid sheets of sheathing may be delivered to the wall and subsequently "cut-out," if desired, through an employment of any suitable cutting means. As a practical matter, quite often the specific wall being fabricated will not require openings defining windows or doors and in these instances the sheathing may be readily applied.

Mounted adjacent the sheathing station and connected with the actuator **910**, there is provided a limit switch LS14 which is connected with the motor **901** and the actuator **910**. The switch LS14 senses the presence of a wall at the station **20**, adjacent the gating finger **908**. As the limit switch LS14 is actuated by the advanced wall, the motor **901** is de-energized for arresting its advancement, while the actuator **910** is energized for withdrawing the fingers **908** from a blocking disposition relative to a supported sheet of sheathing **904** supported thereby. At the instant the fingers are withdrawn, the sheathing is delivered, by gravity, downwardly from the conveyor **906** into a seated disposition across the top of the advanced wall. Adjacent the wall, mounted on the frame and in the path of the sheet being delivered, there is provided a limit switch SS1 operatively associated with the actuators **916**. This switch serves to sense the seating of the sheathing and initiate the nailing operation. As the limit switch SS1 is activated, the actuators **916** are energized for pivoting the nailers **912** into an operative position through the linkage **915**, whereupon the nailers **912** are activated in a manner similar to that heretofore described. In response to a completion of the nailing operation, the nailers are returned and the conveyor **900** is again activated, in a manner similar to that heretofore described, for conveying a completed wall from the sheathing applicating station **20**.

In practice, a control circuit **920** also is provided for assuring operation of the switch LS14 in a manner quite similar to that heretofore described with respect to the circuits **835**, **735**, **624** and **508**. Therefore, a detailed description is omitted.

MACHINE CONTROL CIRCUIT

The circuit employed in imposing selective machine control heretofore has been described. However, at this juncture, it is deemed advisable further to describe the circuit in still greater detail.

As heretofore discussed, the tape **23** is coded, employing any one of several suitable coding techniques, and is fed through a compatible tape reader **22** which deciphers the coded tape and delivers a series of electrical impulses or output signals to the machine control circuit **24**. The circuit **24** is of a design compatible with the tape reader. Normally such circuits include a plurality of electrical switching circuits adapted to complete selected circuits in response to input signals delivered thereto from the tape reader. Normally, the switching circuits of the control circuit **24** are closed through a plurality of solenoids, each of which is driven in response to an input of an electrical pulse of a given voltage level. In any event, it is to be understood that the machine control circuit **24** selectively delivers command signals to the various machine stations in accordance with the intelligence borne by the tape **23**, as deciphered by the reader **22**.

While numerous functions are initiated by the variously employed microswitches, as hereinbefore described, by way of summary, it is noted that the control circuit **24** primarily is devoted to initiating selected functions at appropriate intervals during each cycle of operation for the machine. This is achieved by initiating a feeding operation at the station **10**, selecting and establishing selected nail patterns for nails to be driven during each cycle of the operation, selectively advancing the walls through the stations and driving the saw **404** when appropriate. Further, the tape **23** is encoded so that during selected cycles of operation the various control circuits **508**, **624**, **735**, **835** and **920** are activated, as required by the intelligence stored on the tape.

Each machine cycle is initiated by providing a command signal to the feed station **10** whereat a selector valve **106** is actuated for delivering a selected vertical component, as dictated by the intelligence of the tape **23**. In response to an operative actuation of the selector valves **106**, a selected elevator **101** is rendered operative for effecting a downward feed and forward delivery of the selected component. As the selected component is delivered forwardly, the pair of microswitches MS1 are activated by the component for delivering a component advancing signal to the indexing drum switch DS for thus initiating the component advancing function for the machine.

Drum switches are well known and are commercially available. Therefore, a detailed description of the employed drum switch DS is not deemed necessary to provide a complete understanding of the disclosed embodiment of the invention. However, as best illustrated in FIG. **30**, the drum switch DS is of a cylindrical configuration, adapted to be driven by a pair of drum circuits **958** and operatively supported by suitable journaled axles **959**. The drum is adapted to be selectively rotated through a selective use of suitable electrical stepping motors, not designated, located within the drum driver circuits **958**. The motors serve to step the cylinder through a predetermined series of rotation steps in a manner dictated by an electrical input signal delivered thereto in any suitable manner.

About the periphery of the drum DS, there is provided a plurality of raised button-like protuberances **960**. These protuberances engage resilient supports for electrical switch contacts **962** for thus effecting a closing of the contacts as the engagement is achieved. Hence, by positioning the protuberances **960** at selected locations about the periphery of the drum DS, selected contacts **962** are closed at a given step and by controlling the stepping of the drum through the drive of the circuits **958**, a timing control is imposed on the circuit.

Therefore, a driving signal is delivered to a circuit **958** as the switch MS1 is closed for thus imposing on the drum switch DS a stepping rotation. As illustrated in the chart of FIG. **29**, the drum switch, as it responds to a signal from the switch MS1, begins a stepping advance through three steps in sequence. As the drum is advanced, one of the protuberances **960** engages a support of a selected one of the contacts **962** for thus closing the associated contacts for completing an electrical circuit to the component pusher selector valve **135** for initiating an operation of the component pusher **136**. As the drum DS is advanced through its second step, the nail picker bar **364** is activated, as another set of the contacts **962** is closed, whereupon the pattern of the nails to be inserted through the plate **34** into the ends of the advanced vertical component is established. As the switch DS comes to rest at its fourth step, the pusher **136** will have advanced a component to a delivered position, whereat the advanced component serves to depress and thus close a circuit through the pair of microswitches MS2 in order that a signal may again be delivered to the drive circuit **958** of the drum switch DS for initiating a subsequent operation of a nail driving operation for the machine.

However, it should readily be apparent that a signal should be delivered from the machine control circuit **24** to the circuit **958** of the drum switch DS for effecting an operation of the pneumatic actuators **372** only when the plates **34** and the vertical components are rendered stationary. Hence, a circuit is closed through the switch LS2′ to the drum switch DS for advancing the drum from its fourth step only when the switch LS2′ is actuated for assuring a total inactivation of the motor **220**. With a circuit completed through a switch LS2′ and the microswitch MS2, it is assured that the plates **34** are stationarY and that the vertical components are properly positioned for nailing and are stationary, whereupon the switch DS is stepped to the sixth step. At the fifth step of the drum switch DS, through which the switch is stepped in response to the closing of the switches LS2′ and MS2, a circuit to both of the nailer selector valves **373** is closed for initiating an actuation of the actuators **372** for advancing the heads **371** and effecting a nailing operation.

Each of the heads **371** is provided with a mount **464** which supports a pair of microswitch actuators **966** and **968**, FIG. **6**. As the heads **371** are advanced, each actuator **966** advances to close a microswitch MS3 located adjacent the position assumed by the microswitch actuator when the nails are fully seated. At this point, a signal is delivered through the pair of closed microswitches MS3 to the drive circuits **958** for again advancing the drum switch DS through an additional step. As the drum switch DS is rotated through

the eighth step, in response to the closing of the switches MS3, the protuberances **960** serve to close a circuit to the selector valve **135** of the component pusher for effectively reversing the operative position of the component pusher as well as for reversing the direction of fluid flow through the selector valve **373**, whereupon the operative positions of the actuators **372** are reversed for thus retracting the heads **371**. At a selected point in the stepping of the drum switch, a circuit is completed through the switch DS back to the tape reader **22** and to the drive, not designated, for spools **26** to thus achieve an advancement of the taPe **23** and the reader circuit, whereupon a new reading of the tape **23** is initiated and a new cycle of operation is introduced to the machine. This new reading is achieved subsequent to driving of the nails which is detected by switches MS4.

Subsequent to this point in the operation of the machine, the nail pattern previously established by a signal delivered from the circuit **24** is canceled through a retraction of the fingers **360** so that a new nail pattern may be established in response to a subsequent actuation of the control circuit.

Of course, at the appropriate instant in time determined by the coded intelligence of the tape **23**, a circuit is completed through a switch LS2' whereby the machine control circuit **24** is afforded the opportunity to deliver a drive signal through the switch LS2' to the saw motor **41** and to the saw actuator **448** for effecting a selected severance of the trailing end portion of the plates **34**. Since this signal is delivered through the switch LS2' , the actuation of the saw can occur only when the wall is rendered stationary through an operation of the motor **220**.

At this point, it is to be understood that a basic wall structure has been completed and that the wall is now prepared for finishing to a desired configuration or selected status of completion.

While it is entirely feasible to devise circuitry wherein each of the selected subsequent functions are controlled through an operation of the drum switch DS, it is preferred to drive the various control circuits **508**, **624**, **735**, **835** and **920** directly from the machine control circuit **24** for initiating selected operations at the various slaved systems located at stations **12** through **20**, which selectively serve to complete the assembly of the walls to a predetermined configuration. These control circuits are of a relatively simple design in that they each include a solenoid adapted to function, when energized, for performing a holding function for thus assuring a completion of a circuit through the associated limit switches LS3, LS6, LS10, LS12 and LS14. In the event no signal is delivered to a control circuit, the associated limit switch is rendered inoperative due to the fact that the circuit remains open through the control circuit and therefore no signal is transmitted upon the closing of the limit switch. Upon the closing of the various limit switches, in the presence of an activated control circuit, the operation at each of the succeeding stations is achieved in response to the closing of microswitches at selected stations.

Since the operation and functions of the circuit at the various stations have hereinbefore been set forth, a detailed description is not here deemed necessary.

OPERATION

It is believed that in view of the foregoing description, the operation of the device will be readily understood, however, it will be briefly reviewed at this point. With reference particularly to FIGS. **1**, **2** and **28**, it is assumed that plates **34** have been fed from the feeder assembly station **10** to the component assembly station **11** through the plate feed **30**, with the leading ends thereof being aligned, manually, or through a suitable stop, not shown. Also, it is assumed that each of the hoppers **100** of the vertical component feed systems **32** selectively has been filled with a plurality of appropriate components **36**, **38**, **40**, **44** and **46** to be incorporated in a completed wall and joined with the plates **34** s they are fed by the plate feed **30**. It is also assumed that the nail tray **352** has been filled with appropriately sized nails and that the hoppers of the header inserting station **12**, the window box inserting station **14**, a brace inserting station **18** and the sheathing inserting station **20** have been filled with appropriate materials, and that the truss supporting the guide rails **706** which are employed in supporting the router **708** in translational displacement has been adjusted to an appropriate angle relative to the longitudinal axis of the path of the wall. It further is assumed that the brace delivering hopper **802** has been adjusted for depositing a brace in the recesses formed by the router and that the nailers **830** have been positioned for nailing the braces in position within the recesses, as ultimately required.

With the machine thus assembled and adjusted, it is assumed that there is supplied an intelligence bearing tape **23** encoded preferably by punching for optical reading in a manner appropriate for coding the various machine operations which are to be performed in response to operation of the control circuit **24**. This tape is supplied to and fed through the tape reader **22** in predetermined increments. Feed of the tape is dictated by the operation of the drum switch DS. As the tape **23** is read by the tape reader, a series of machine control signals is delivered from the reader to the machine control circuit **24** which in turn delivers electrical output signals to initiate selected machine operations.

For each machine operation, the first output signal delivered from the circuit **24** is directed to a selected one of the selector valves **106** for causing an associated elevator **101** to effect delivery of a selected vertical component from one of the hoppers **100**. As the selected vertical component is discharged from the hopper **100** it is seated upon a pair of conveyor chains **131** of the conveyor **130**, which now delivers it to a first microswitch MS1. An output signal is initiated and delivered from the microswitch MS1 to the drive **458** of the drum switch DS for achieving an indexing thereof. An output is acquired from the operation of the drum switch and applied to a selector valve **135** of the component actuator **136**. The actuator **136** is rendered active and advances the delivered component, now resting on the microswitch MS1, to a position between the wall plates **34** supported at the component assembly station **11**. As the vertical component comes to rest, the nailer **262**, having a previously selected pattern established in response to an output from the machine

control circuit **24** is actuated in response to a signal delivered from the drum switch DS. As the nailer head **371** advances for effecting a driving of the nails, for thus joining the plates **34** and the guide plates **133** are retracted in order that the nailer **262** may insert the pattern of nails through the plate into the adjacent component.

Once a cycle for the nailer head **371** is completed, that is fully seated and then retracted, the motor **220** is activated for driving the pressure track assemblies **180** for advancing the wall plates **34**, having the vertical component secured therebetween, for a duration and through a distance dictated by the operation of the stepping motor **294**.

The stepping motor **294**, in conjunction with the motor **220**, serves to drive the pair of differentials **290** and **306** in a precise manner for achieving control over the advancement of the plates **34** and the associated vertical components disposed and secured therebetween. At the termination of the driving of the track assemblies **180**, in response to a deactivation of the motor **220**, a component selecting signal again is delivered from the machine control circuit **24** to the component feed station **10**, whereupon another vertical component is delivered to a position between the plates **34**, in a manner similar to previously that described, whereupon the component is secured to the plates **34** and the wall again is advanced through a driving of a motor **220**, in response to a combined input to the differentials **290** and **306**.

At the completion of the insertion of the appropriate number of components, as dictated by the tape **23**, the actuators **448** for saws **404** and their associated motors **414** located at opposite sides of the machine are activated for causing the saws to swing into an operative disposition along a path extending transversely relative to both of the plates **34**, for serving the ends of the wall plates at positions determined by the extent of their advancement, as determined in response to actuation of the pressure track assemblies **180**. As the saws **404** advance toward the wall plates, the guide plates **133** are pivoted out of the path of the saws for accommodating a passage thereof. On completion of the severance of the plates **34**, the wall is advanced to the header feeder station **12**, and additional wall plates **34** are fed by the rollers **192** into an abutting relationship with the trailing portions of the wall prior to its advancement.

As the wall is delivered from the assembly station **11**, the machine control circuit **24** delivers a command signal, in accordance with the input from the tape reader **22**, to a control circuit **508** whereupon the limit switch LS3 is conditioned for activation.

As the wall is delivered to the station **12**, the conveyor **500** serves to receive the wall and transport it through the station. In the event no circuit conditioning signal is delivered from the control circuit **24** to the control circuit **508**, the conveyor will deliver the wall to the next-in-line station **14** for receiving a window box therein. However, in the event a signal from the circuit **24** is received at the control circuit **508**, actuation of the limit switch LS3 causes the conveyor **500** to cease to advance the wall and an actuation of an elevator **501** is initiated.

The elevator **501** now delivers a header **504** in much the same manner as the elevators **101** deliver the vertical components from the hoppers **100**. Due to the massiveness of the headers, the headers tend to seat under their own weight.

Once the headers are seated, the limit switches HS1 are actuated for activating the nailers **516** which are pivoted into an appropriate position by the actuator **510**. The nailers **516** deliver nails through the adjacent studs into the ends of the headers **504** as they are seated at the distal end of the trimmers provided therefor by an insertion of a stud-trimmer **44** followed by a trimmer-stud **46**. Once a nailing of the header is completed, the limit switch HS2 is activated for causing the conveyors **500** to advance the thus completed wall. While it is feasible to employ tracks utilizing dogs rather than the pressure conveyors **500** which are quite similar in design and operation to the tracks of the pressure track assemblies **180**, the positioning of the wall relative to the hopper of the header feeder renders their use desirable.

Subsequent to the delivery of the wall from station **12**, the wall is delivered to and received by a conveyor **600** which serves for advancing the wall through the window box inserting station **14**. At this point in the machine's operation, a signal received at the control circuit **624**, in response to an output signal from the machine control circuit **24**, serves to render the limit switch LS6 effective for causing the advance of the wall to be arrested. As the advance of the wall is arrested, the prefabricated window boxes are fed and seated within the wall, whereupon a plurality of nailers **516** are rendered effective for nailing the window boxes in place.

In response to a completion of the nailing operation at the station **14**, the wall again is advanced. As the wall is discharged from this station, it is delivered by the conveyor **600** to the adjacent conveyor **700** which delivers the wall through a router station **16** which includes the router **708**. Here the router blade **709** provides a plurality of brace-receiving recesses in the various vertical components.

Subsequent to the formation of the recesses, in response to an output signal from the switch RS1, the wall is advanced to a brace inserting station including conveyors **800** whereupon a brace is delivered into the recesses formed by the router **708**. This is achieved in response to a deactivation of the conveyor **800**, through coaction of the control circuit **835**, operating under the direct control of the machine control circuit **24** and a limit switch LS12.

As the conveyor **800** is deactivated, the hopper **802** serves to deposit a brace in the recesses formed at the router station **16**. As the braces are delivered, a limit switch BS1 is activated for stepping the conveyor **800** through a distance sufficient for positioning the deposited brace beneath a plurality of ganged nailers **830** which are coupled together by pivotal linkage **832**, through a common actuator **834**. The actuator **834** pivotally displaces the nailers to an operative disposition, whereupon the nailers are rendered effective for nailing the braces in place and for subsequently reactivating the conveyor **800** for advancing the wall from the brace applicating station **16**.

As is the case with stations **12** through **16**, in the event no brace is to be applied at the station **18**, the control circuit **835** serves to render the limit switch

LS12 ineffective, whereby the conveyor **800** is permitted to continuously advance a wall through the brace applicating station without encountering any interruption.

Subsequent to the application of the brace, the wall is delivered by the conveyor **800** to a conveyor **900**. This conveyor delivers the thus completed wall through the sheathing applicating station **20**. The station **20** is quite similar in many respects to the stations **12** through **18**, in that it is provided with a control circuit **920** for rendering a limit switch LS15 effective for deactivating the conveyor **900** and for activating the actuator **910** to effect a delivery of the individual sheets of gating sheathing. As the sheathing is seated, a limit switch SS1 is actuated, through an engagement of the sheathing for initiating operation of actuators **916** which serve to actuate the nailers **912** supported by a plurality of trunions **914** for bringing the nailers into operative disposition and effecting an operation thereof for joining the sheathing with the wall.

As the nailers **912** complete a nailing operation, they again are elevated, through the operation of the actuator **916**, and the conveyor **900** again is activated, whereupon a completed wall is discharged from the station and from the machine. Of course, in the event no sheathing is to be delivered to the wall at the station **20**, the control circuit **920** remains inactive so that the switch LS14 is rendered inoperative for permitting the conveyor **900** to deliver the wall through the station without interrupting its advances. The completed wall is now removed by any suitable mechanism.

In timing the operation of various machine components employed at the various stations, it should readily be apparent that differences in time deviation exist in achieving a completion of the various operations. However, fabrication of the wall at the stations **10** and **11** require the greatest quantity of time. Therefore, the remaining stations **12** through **20** may be spaced and operated in a manner such that an expiration of delivery time between the various stations serves to accommodate completion of the succeeding wall fabricating functions without creating an obstruction, through a completion and a delivery of preceding operations prior to the completion of the succeeding operations.

Furthermore, various time delay circuits, not shown, but of suitable design, may be incorporated, as required, in the various control circuits and, if desired, additional limit switches can be incorporated in the overall circuits in a manner consistent with assembly line control techniques. Since these techniques are deemed to be well within the skill of the art, a detailed description is omitted in the interest of brevity.

In view of the foregoing, it is readily apparent that the present invention provides a simplified process and machine for fabricating a plurality of unique walls to be employed in framing construction.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred process and apparatus, it is recognized that departures may be made therefrom within the scope of the invention.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a machine for fabricating a series of walls of individually predetermined dimension and configuration comprising:

A. intelligence storage means including means bearing encoded intelligence defining each wall of a series of walls in terms of structural component configuration, number of structural components required, component spacing and orientation;

B. means for decoding the stored intelligence and providing electrical output signals indicative of the stored intelligence;

C. means defining a machine control device including electrical circuits for converting the output signals into a series of machine control signals; and

D. a series of machine stations electrically connected with the control device, including a plurality of component hoppers each of said stations including therein special purpose operative devices including means responsive to the control signals for effecting a selective delivery of said components and a joining of selected structural components for thereby forming a wall in accordance with the encoded intelligence.

2. The machine of claim 1 further comprising:

A. operatively associated conveyor means for advancing the wall between the series of stations; and

B. control means responsive to said output signals connected with said conveyor means for interrupting the advancement of the wall.

3. A machine for fabricating a wall of a predetermined configuration from a plurality of structural components sequentially selected from a source of components, each having predetermined configurations comprising:

A. feed means for feeding a pair of wall plates to the machine;

B. means for maintaining the pair of plates in a coplanar and parallel relationship;

C. a selectively operable component hopper for feeding to said machine a plurality of wall components of predetermined configurations including means responsive to control signals for initiating a selective feeding of the components;

D. selectively operable control means connected with said hopper for providing a series of control signals for initiating a feeding of the components;

E. means for receiving the components as they are fed to said machine and for advancing the components along a path extending substantially parallel to the longitudinal axis of symmetry of said plates to preselected positions between said plates; and

F. means for coupling the components with the plates for thereby forming a wall having a configuration dictated by the control means.

4. In a machine for fabricating walls the improvement comprising:

A. plate delivery means for delivering and orienting wall plates in a parallel, substantially horizontal and spaced relationship;

B. plate indexing means for advancing the plates in a horizontal plane to a first operative station;

C. means for sequentially delivering a plurality of horizontally oriented, vertical support members to the first operative station into coplanar relation-

ship with said plates as they are supported in said plane whereby the selected vertical support members are horizontally extended between the plates as the members come to rest;

D. means operatively associated with said first operative station for joining said vertical support members with said plates whereby structure defining a wall is fabricated; and

E. wall advancing means for advancing the wall through the machine at a preselected incremental rate.

5. The machine of claim **4** wherein said vertical support members includes stud-trimmers and trimmer-studs.

6. The machine of claim **5** further comprising means for selecting the vertical support members in a manner such that each delivery of a stud-trimmer is followed by a delivery of a trimmer-stud, whereby the wall being fabricated is provided with a door defined between a pair of trimmers arranged in adjacent and parallel relationship with adjacent distal ends of the trimmers being disposed in coplanar alignment to receive a door header.

7. The machine of claim **6** further comprising:

A. means responsive to the advancing of the wall for delivering a header to the distal ends of said trimmers; and

B. means associated with the wall advancing means for securing the header to the distal ends of the trimmers.

8. The machine of claim **7** further comprising:

A. means associated with the wall advancing means for delivering window boxes to said wall being formed; and

B. means for securing said window boxes in place within said wall, whereby a wall having window and door openings formed therein is provided.

9. The machine of claim **4** wherein the wall advancing means includes:

A. a motor adapted to drive the plate indexing means;

B. a first switch adapted to close to impart a first rate of rotation to said motor;

C. a second switch adapted to close to impart a second rate of rotation to said motor;

D. switch actuating means including a worm and a rectilinearly reciprocating block coupled with the worm adapted selectively to be shifted in response to a selected directional rotation of the gear from sequentially closing said first and second switches;

E. a first drive means connected with said shaft adapted to be actuated to drive the shaft in a first direction for effecting a closing of said switches; and

F. a second drive means connected with the plate indexing means and with said shaft adapted to be actuated to drive the shaft in a second direction as the plates are indexed past said station for effecting a sequential opening of said first and second switches when the plates have been advanced through a preselected interval.

10. The machine of claim **9** wherein the first drive means comprises an electrically energizable, stepping motor and the second drive means includes an interconnected drive operatively coupled with the plate indexing means.

11. The machine of claim **10** wherein the first and second drive means operatively are interconnected through a differential drive coupling.

12. The machine of claim **4** wherein the plate indexing means includes:

A. a pair of tracks comprising a first endless track having a first substantially horizontal pressure surface, and a second endless track having a second substantially horizontal working surface vertically spaced a predetermined distance from said first pressure surface;

B. means for adjusting the distance between said first and second pressure surfaces; and

C. intermittently operably means for simultaneously advancing the first and second pressure surfaces in a common direction and through common increments of travel.

13. In a machine for fabricating walls, the improvement comprising:

A. plate advancing means for simultaneously advancing a pair of plates along substantially coplanar, linear and parallel paths extending through an assembly station;

B. component delivery means for delivering structural members along a path extending between the linear paths of the plates into a contiguous relationship with said plates as the plates are advanced through said assembly station; and

C. means for affixing the structural members to said plates.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,688,965 Dated September 5, 1972

Inventor(s) Raymond M. Kellner Minor E. Gee

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 53,	---a--- should be inserted after the word "of".
Column 8, line 1,	"shaft" should be changed to ---shafts---.
Column 10, line 55,	"FIG." should be changed to ---FIGS.---.
Column 10, line 65,	"130" should be changed to ---135---.
Column 18, line 38,	"1s2'" should be changed to ---LS2'---.
Column 20, line 2,	"can" should be changed to ---cam---.
Column 36, line 49,	"stationarY" should be changed to ---stationary---.
Column 37, line 31,	"41" should be changed to ---414---.
Column 38, line 16,	"s" should be changed to ---as---.

Signed and sealed this 30th day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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