

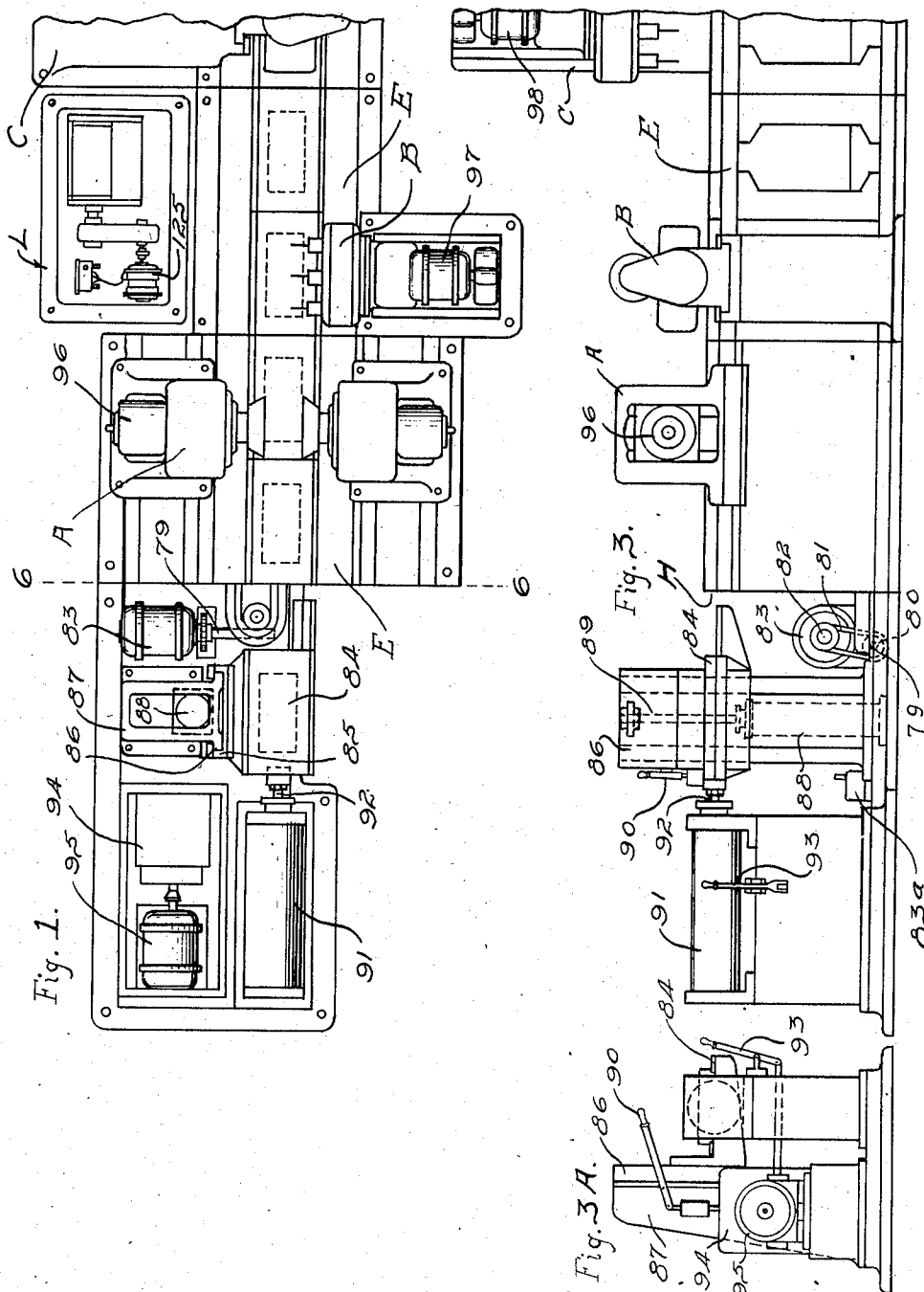
June 21, 1938.

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2,120,966

MATERIAL HANDLING APPARATUS FOR MACHINE OPERATIONS

Original Filed Feb. 4, 1932 8 Sheets-Sheet 1



INVENTOR

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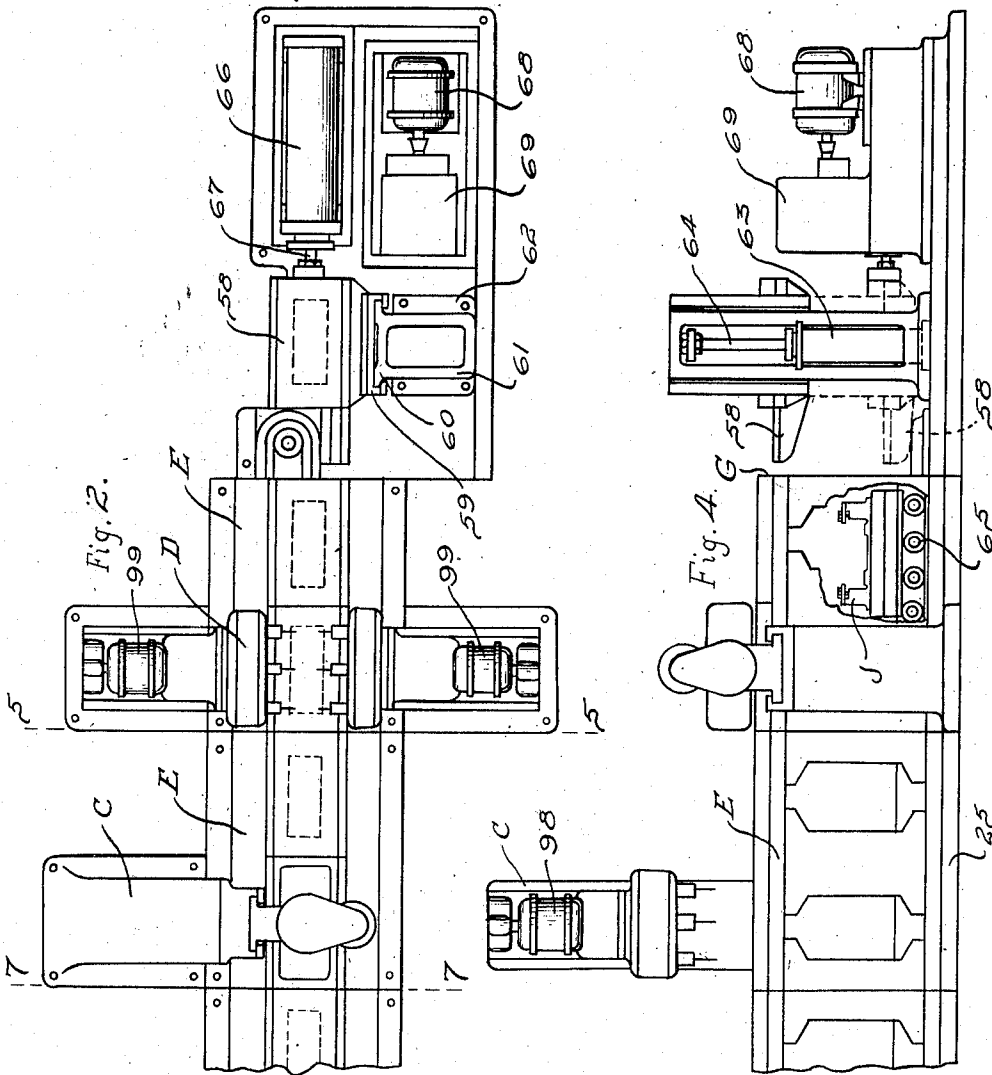
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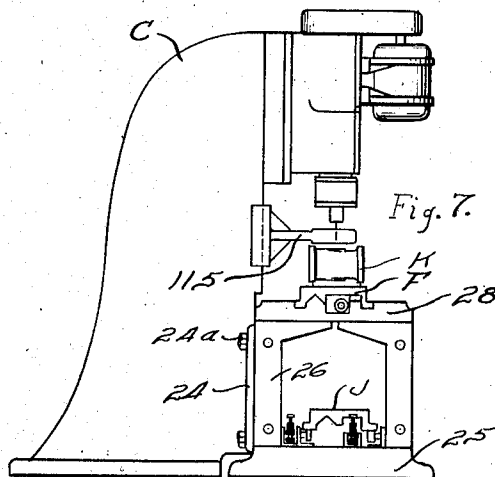
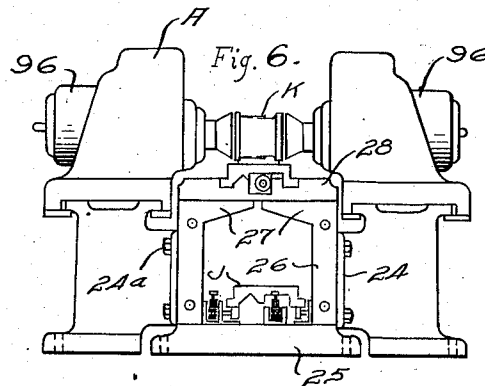
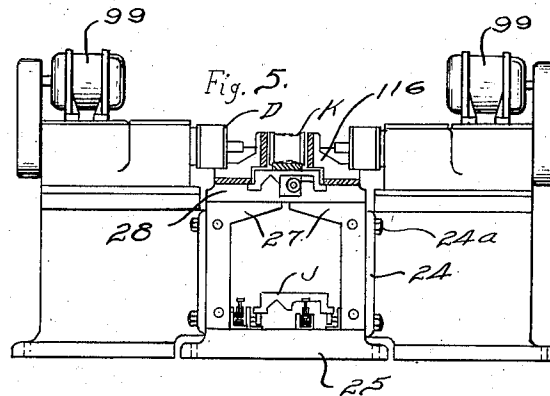
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8 Sheets-Sheet 3



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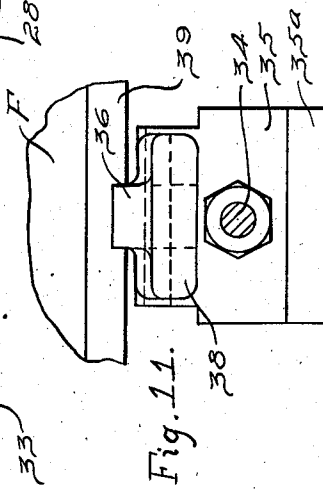
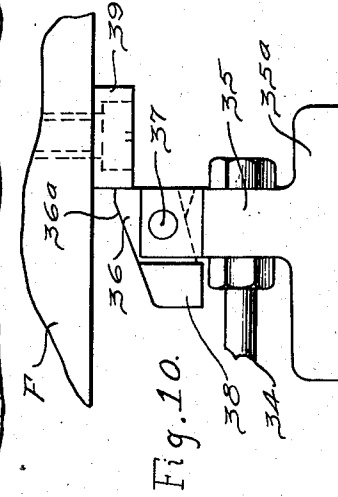
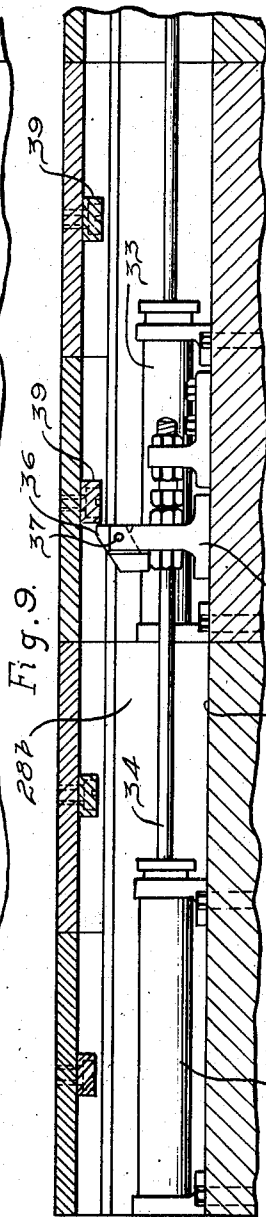
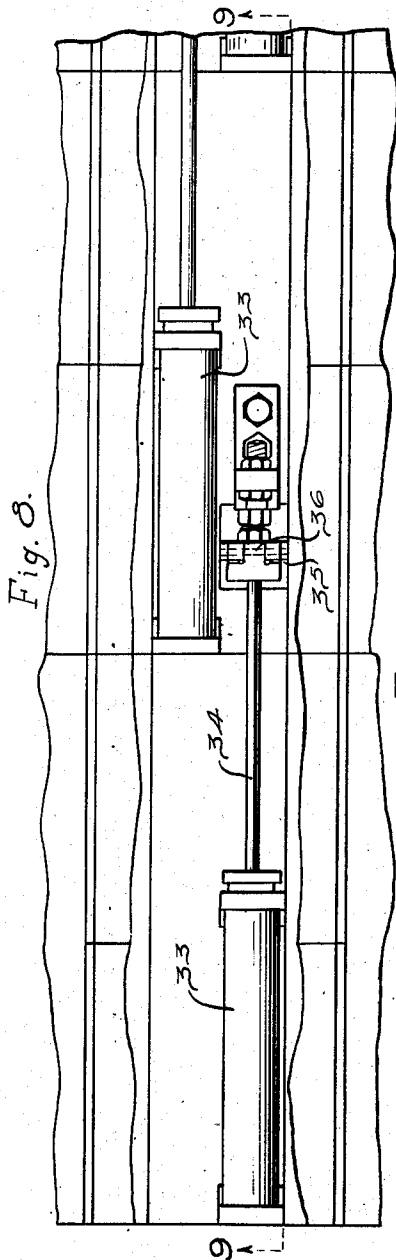
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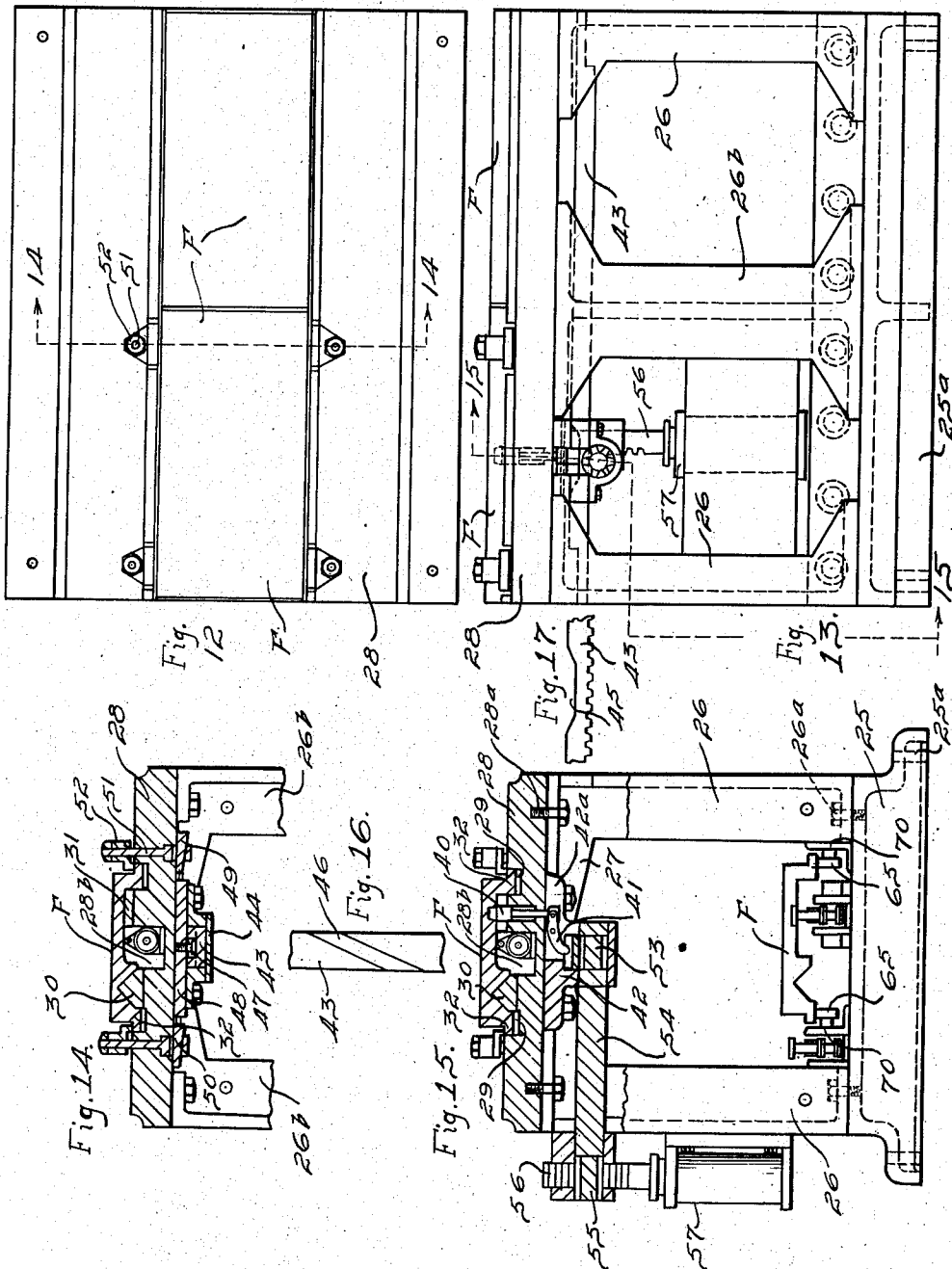
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8 Sheets-Sheet 5



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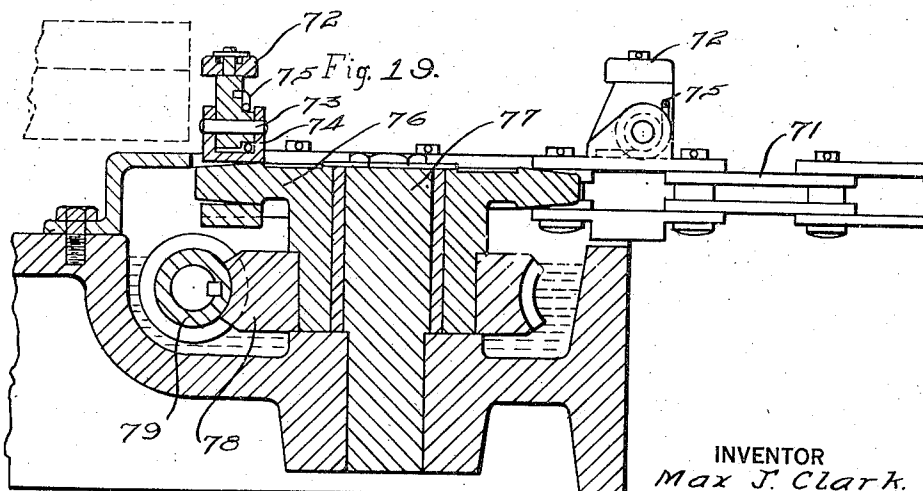
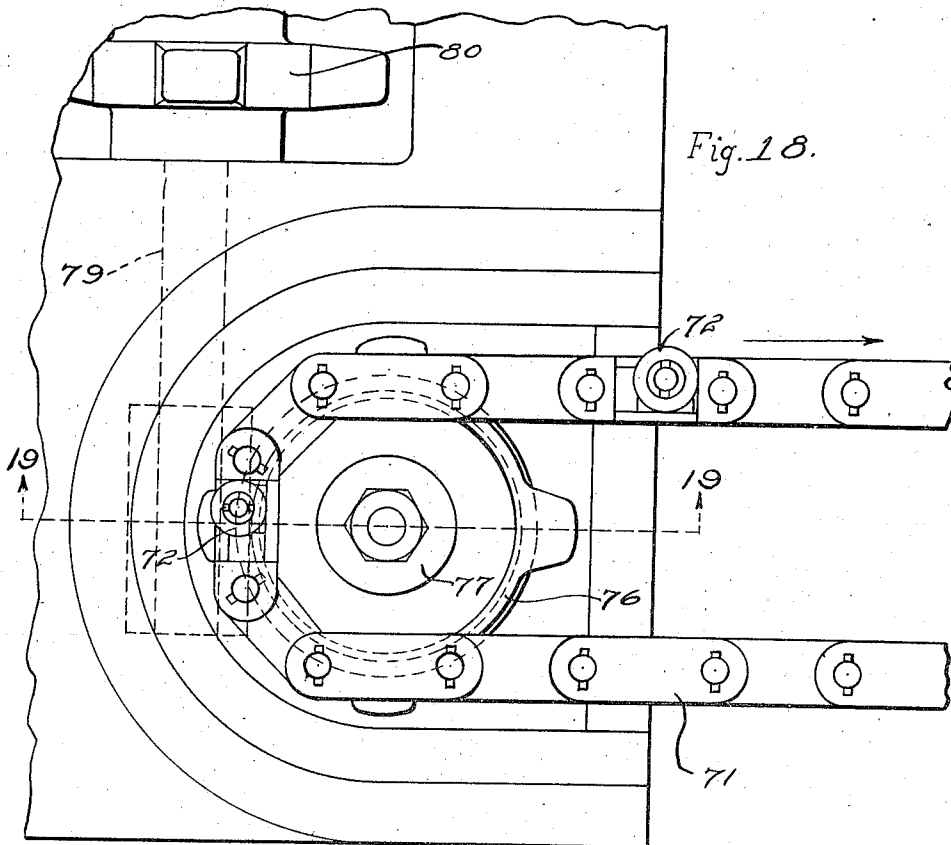
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8 Sheets-Sheet 6



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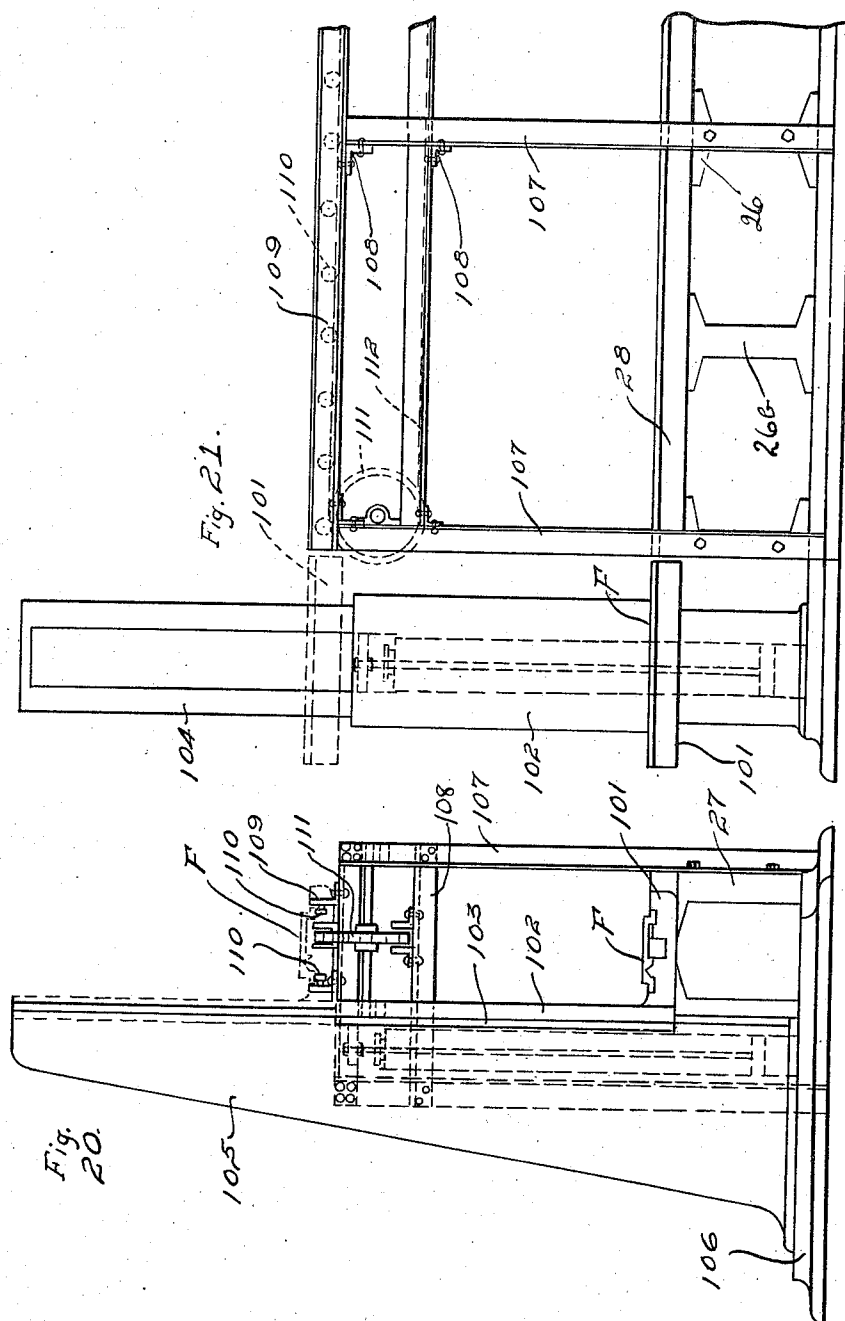
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MATERIAL HANDLING APPARATUS FOR MACHINE OPERATIONS

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8 Sheets-Sheet 8

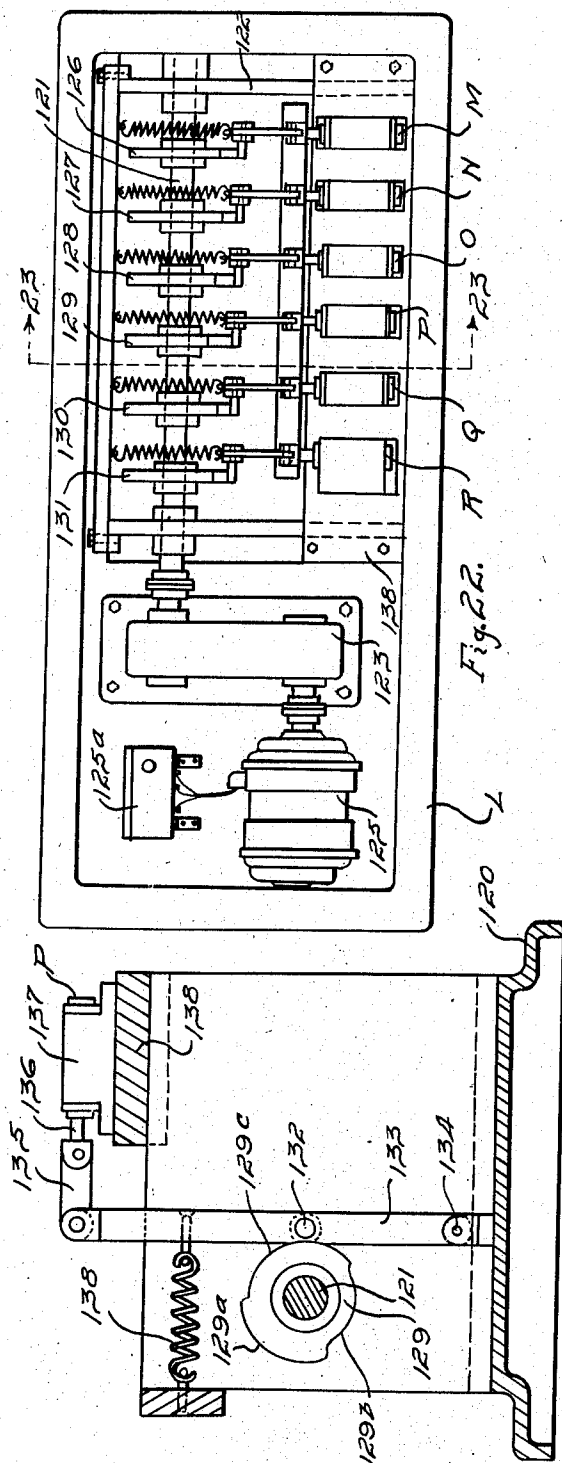


Fig. 23.

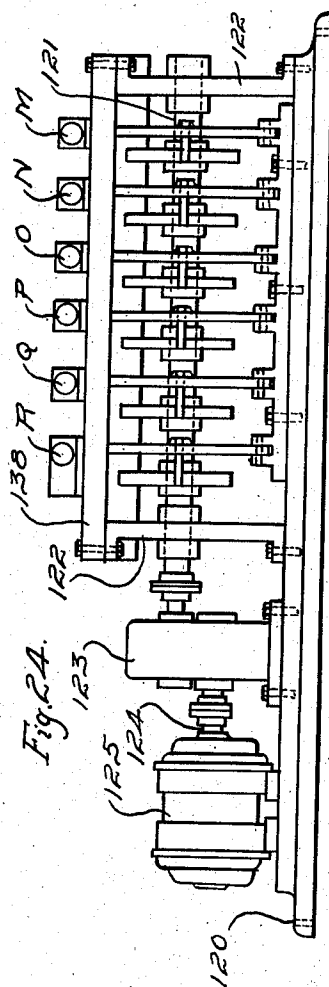


Fig. 24.

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UNITED STATES PATENT OFFICE

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MATERIAL HANDLING APPARATUS FOR
MACHINE OPERATIONS

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Application February 4, 1932, Serial No. 590,939
Renewed February 1, 1936

30 Claims. (Cl. 29—33)

This invention relates to a new method and apparatus for automatically handling metallic work pieces, parts or articles for the purpose of enabling a series of machine operations to be performed successively on each piece or part, the invention being especially adapted for application in connection with the machining of metal parts where mass production is conducted, such as cylinder blocks, cylinder heads, transmission housings, flywheel housings, etc., in the automobile industry.

An object of the invention is to provide a method and apparatus in which the work pieces may be conveyed in succession from one metal working machine or machine tool to another and the separate work holders handled in a continuous cycle, in which these work holders may be located and held at successive stations for machine operations on the work, in which the method of conveying and handling the work and work holders and the improved construction of the apparatus is such as to require no substantial increase in floor space while permitting ample flexibility to meet changes in machining requirements particularly in connection with line production; and in which full automatic handling is possible thus saving labor expense and speeding up production to a greater degree.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Figs. 1 and 2 are plan views which taken together illustrate the entire apparatus which may be utilized for carrying out the present invention.

Figs. 3 and 4 are side elevations of the construction shown in Figs. 1 and 2, which taken together illustrate the complete apparatus.

Fig. 3A is a left hand elevation of the front end of the machine shown in Fig. 3.

Fig. 5 is an end elevation taken through line 5—5 of Fig. 2 illustrating a section of the apparatus.

Fig. 6 is an end elevation taken through line 6—6 of Fig. 1 illustrating another section of the machine.

Fig. 7 is an end elevation taken through line 7—7 of Fig. 2 illustrating another section of the machine.

Fig. 8 is a fragmentary top plan view, partly broken away, illustrating the mechanism for propelling the work holder slides.

Fig. 9 is a longitudinal fragmentary section

taken through line 9—9 of Fig. 8 in the direction of the arrows.

Fig. 10 is a detail side view of the abutment members for propelling the slides.

Fig. 11 is a detail rear view of the construction shown in Fig. 10.

Fig. 12 is a plan view of one of the table sections.

Fig. 13 is a side elevation of the construction shown in Fig. 12.

Fig. 14 is a detail section taken through line 14—14 of Fig. 12 in the direction of the arrows.

Fig. 15 is a partial sectional elevation taken substantially through line 15—15 of Fig. 13.

Figs. 16 and 17 are detail views of the sliding cam bar.

Fig. 18 is a fragmentary plan view illustrating the return chain conveyor.

Fig. 19 is a section through line 19—19 of Fig. 18 in the direction of the arrows.

Fig. 20 is an end elevation illustrating a modified form of elevator mechanism for the work holder slides.

Fig. 21 is a side elevation of the construction shown in Fig. 20.

Fig. 22 is a plan view of the automatic control means for the several mechanisms of the apparatus.

Fig. 23 is a vertical section through line 23—23 of Fig. 22 in the direction of the arrows.

Fig. 24 is a side elevation.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

The apparatus is designed for use in factory production where a series or succession of machining operations are performed on similar metal parts or pieces. For example, in mass production a series of machining operations may be performed on a piece of work such as an automobile cylinder block, and where the same operations are carried out on each one of many thousand identical pieces, the present invention provides a method and means by which this can be accomplished automatically with the elimination of time and labor heretofore necessary in handling

parts from one operation to another. The apparatus however, is susceptible of wide flexibility and may be adapted readily to various machining operations in line production.

5 The invention is particularly applicable in connection with machines known as the unit type automatic cycle machines for performing certain typical machining operations, such as drilling, reaming, tapping, threading, boring, counter-
10 boring, counter-sinking, facing, milling, broaching, spinning, knurling, swaging, keyway cutting, etc.

In the drawings there is shown an apparatus representative of one way in which the invention
15 may be carried out. Standard types of metal working machines of the unit type are employed, four such machines being illustrated by way of example, although a greater or less number will be used depending upon the work to be done. A
20 duplex milling machine is shown at A, a multiple drilling machine at B, a vertical drilling or tapping machine at C, and a duplex drilling or tapping machine at D, these machines being arranged in line for a sequence of operations on
25 each work piece.

The work is conveyed with relation to the machines from one operating station to another by means of work holders mounted on slides adapted to travel in a horizontal guideway formed on the
30 top of a sectional table. Each section E of the table may be similar and any number may be bolted together end to end to provide a continuous conveyor way past the machines.

Referring particularly to Figs. 5 to 7 inclusive
35 and 12 to 14 inclusive, each table section E comprises in the present instance a base 25 adapted to be bolted to the floor at 25a. Mounted on the base at each longitudinal side of the section are upright side frames 26 and 26b terminating at
40 their upper ends in inwardly over-hanging top supporting portions 27. The frame members 26 and 26b are bolted to the base at 26a. Bolted at 28a to the upper flat surfaces of the portions 27 is a table top 28. This table proper is formed cen-
45 trally and longitudinally thereof with guideway portions 29. Also carried thereby is a V-shaped guide member 30 and a flat guide strip 31, these parts together with the ways 29 providing guide means for a series of slides F. As hereinafter de-
50 scribed, each slide F of the series carries a work holder which in turn supports the work in position for operation by the machine tools. Each slide F is formed with projecting guide portions 32 extending into the ways 29 and also has on its
55 under side a V-shaped groove into which the wedge member 30 fits and alines the slide. The slides F are thus held firmly in position within the alined guideways of the table sections and are capable of sliding longitudinally through the
60 guideways from one machine to the next.

In the present instance the construction is preferably such that the slides F are arranged in pairs in abutting relation, each pair of slides having a total length corresponding to the length
65 of each table section, and mechanism is provided in the present instance for shifting all of the slides simultaneously in pairs. This mechanism may be arranged to shift the slides singly where machine operations require a different dwell of
70 work holders at different stations. Such mechanism may be operated hydraulically, electrically, pneumatically, or through other suitable automatic mechanical means. In the present instance this is accomplished by means of rams
75 operated from hydraulic cylinders.

Referring particularly to Figs. 8, 9, 14 and 15, each table member 28 is provided with a central recess 28b within which is mounted an hydraulic cylinder 33 provided with a ram or piston rod 34 carrying at its forward end an abutment or head
5 35 having a flat base 35a adapted to slide freely, during reciprocation of the ram 34, on the flat bottom 28c of the recess 28b. Pivoted at 37 within a recess in the upper end of the member 35 is a dog or latch 36 which is weighted at 38 so as
10 normally to hold the dog in the position shown in Figs. 9 and 10 so as to engage a transverse abutment bar 39 bolted to the under side of each slide F. The dog 36 is provided with a cam sur-
15 face 36a so that when the ram is retracted the dog can pass the abutment bar of the preceding slide into position behind it. In the present instance the cylinders 33 of the several table sections are arranged in staggered relation, one
20 cylinder and ram being mounted within each table section 28, and all of the cylinders operated in timed relation by control mechanism herein-
after described.

Automatic means is also provided for locating and clamping each work holder slide F in exact
25 position opposite each machine for the machining operation on the work piece carried by the slide.

Referring particularly to Figs. 12 to 17 inclusive, there is mounted in a vertical recess in the
30 top of each table section 28 a spring pressed locating pin 40 which is adapted to mate with a recess in the under side of the slide F. This locating pin or plunger is pivoted at its lower end to one end of a pivoted lever 41 mounted within
35 a recess 42a in a block 42 bolted to the under side of the table top 28. This block has a central opening through which extends a bar 43 held in position by a bottom retaining plate 44. The central part of this bar at its under side is pro-
40 vided with rack teeth and at its upper face with a cam recess 45 cooperating with the free end of the lever 41. At the right and left of the recess 45 the bar 43 is also machined at its upper face to provide angular cam slots 46 within which extend pins and rollers 47 secured to a laterally
45 shiftable plate 48. Yieldably attached to opposite sides of this plate by springs (not shown) are a pair of wedge blocks 49 and 50 which extend through openings in the lower ends of pull rods
50 51 to the upper ends of which are secured clamps 52. The teeth of the cam bar 43 mesh with a pinion 53 cut into the end of a shaft 54 which at its outer end is provided with a pinion 55 meshing with teeth cut in a vertical piston rod 56
55 operated from an hydraulic cylinder 57. A single rack bar 43, or a series thereof extending end to end may be provided in the table sections and these may be operated by the single cylinder 57, or a plurality of cylinders may be employed which
60 are automatically controlled in timed relation to other mechanisms.

It will be understood from the foregoing that the slides F are propelled preferably, although not necessarily, in pairs, and in abutting relation
65 the length of the table sections. The length of the stroke of the ram 34 of each cylinder 33 is such as to move each slide one-half the length of a table section and a distance corresponding closely to the required travel necessary to position
70 any one of the slides at a given machine operation. When a slide reaches a position corresponding to the end of the stroke of the ram 34 the cylinder 57 will be automatically operated shifting the cam bar 43, causing the lever end 41 to
75

to drop into the recess 45 whereby the locating pin 40 will be pressed upwardly and will lodge in the locating hole in the slide F thus locating the slide in proper position. Thereupon the wedge 49 will be shifted laterally in the same direction to force the clamps 52 downwardly into engagement with the side flanges of the slide F, thereby clamping the slide rigidly in position.

Referring particularly to Figs. 2 and 4, the exit end G of the guide way through the table sections is open. At this point the work piece, having been operated upon successively by the machines A, B, C, and D, will be removed from the work holder carried by the slide F, and the slides with their work holders will be propelled in succession out of the guideway onto a table 58 having an aligned guideway into which the guide portions 32 of the slide will fit. The table 58 is carried by an upright back plate provided with guideways 59 cooperating with mating guides 60 carried by a column 61, the base 62 of which is bolted to the base of the apparatus. The table 58 is thus carried by a vertically movable slide attached to a vertically reciprocating ram 64 operated from an hydraulic cylinder 63.

After the slide has been propelled onto the table 58 the latter is lowered by the ram to the dotted line position shown in Fig. 4 and at this point the slide with its work holder is propelled onto rollerways 65 (see Figs. 4 and 15). This latter operation is carried out by means of an hydraulic cylinder 66 carrying a horizontally reciprocating ram 67. The cylinders 63 and 66 are controlled from an hydraulic pump 68 operated by an electric motor 69. This ram mechanism 64 and 67 is automatically operated and timed by the control mechanism hereinafter described.

The rollerways 65 comprise spaced longitudinally aligned rolls carried by angle brackets 70 secured to the base of the machine and this rollerway extends through a tunnel formed between the top, bottom and upright sides 26 and 26b of the table framework. When the slides F are successively propelled onto the rollerways 65 they are picked up in succession by a chain conveyor 71 (Figs. 18 and 19) traveling between the rollerways 65 and mounted on the base 25 of the sections. This endless chain conveyor may be of standard construction, traveling over sprockets at opposite ends of the machine. The chain is provided at intervals with upwardly projecting dogs 72 adapted to engage the ends of the slides. Each dog 72 is pivoted at 73 to a channel bracket 74 secured to a link of the chain and is normally held in upright position by means of a spring 75. The chain at the front end of the machine travels over a sprocket 76 journaled on a stud 77, and attached to the hub of the sprocket is a worm gear 78 operated from a worm shaft 79 (Figs. 1, 3, 18 and 19). The shaft 79 at its inner end carries a sprocket 80 which is operated by a belt or chain 81 from the drive shaft 82 of an electric motor 83.

It will be seen that the slides F are returned in succession from the exit end of the table guideway to the entrance end thereof for a succeeding series of operations. The slides are transferred from the level of the conveyor rollerways 65 to the level of the table guideway at the entrance end H (Figs. 1 and 3) by means of elevator mechanism similar to that previously described. Each slide will be pushed by a dog 72 of the conveyor chain onto a table 84. This table has an upright back plate carrying guideways 85 cooperating with vertical guides 86 carried by a column 87

the base of which is bolted to the base of the machine. Attached to the table is a ram 89 operated from an hydraulic cylinder 88. It will be understood that each slide F will be elevated on the table 84 into the horizontal plane of the horizontal guideway in the table sections E and will be propelled from the platen or table 84 onto the table section E at the entrance of the machine by means of an hydraulic cylinder 91 carrying a reciprocating ram 92. The cylinders 91 and 88 are supplied through an hydraulic pump 94 operated from an electric motor 95. The machines A, B, C and D, are operated in the conventional manner by means of electric motors 96, 97, 98 and 99.

In the preferred form the slide sections and their work holders are preferably returned from the exit end of the apparatus to the entrance end through a tunnel within the framework of the table sections. If desired these sections may be returned by an overhead conveyor above the table sections and machines, in the manner illustrated, for example, in Figs. 20 and 21. It is preferred that the return conveyor operate either above or through a tunnel below the table sections since this method has the advantage of conserving floor space in the plant and facilitating access to the machines.

Referring to Figs. 20 and 21, elevator mechanism is provided for transferring the slides and work holders from the level of the table 28 to a higher level. This elevator mechanism comprises a transfer table 101, similar to the tables 58 and 84, having an upright back plate 102 provided with guides 103 cooperating with guides 104 carried by a column 105 bolted to the base 106. Frame members 107 are bolted to the side frames 26 and 26b and to the upper ends of these frame members are bolted spaced horizontal supporting bars 108 forming an upper frame 109 carrying angle brackets 109 which support spaced lines of rolls 110 upon which the slides F travel. The slides are propelled in succession by means of a conveyor chain 112, traveling at opposite ends of the machine over sprockets 111. This conveyor chain carries at intervals a series of dogs similar to the dogs 72 which engage the ends of the slides. It will be understood from this construction that the elevator mechanism shown in Figs. 20 and 21 will be provided at each end of the apparatus, and at the exit end the slides will be transferred from the level of the guideway to the upper level of the gravity rolls 110; and at the entrance end the slides F will be transferred from the upper level to the lower level of the guideway.

The motor 83 for driving the return chain conveyor is controlled by a suitable switch 83a (Fig. 3) which has an operating part projecting into the path of the table 84 so that when the latter is lowered it will operate the switch and thereby the motor 83 to start the conveyor. At the opposite end of the apparatus at the entrance of the tunnel there is also a switch (not shown), which is actuated by a slide when propelled onto the conveyor rolls so as to start the motor 83. Another switch (not shown) is preferably located within the tunnel adjacent the first machine A which is operated by a slide so as to stop the motor 83. A control lever 93 may be provided (see Figs. 3 and 3a) for starting and stopping the hydraulic pump 94, and another lever 90 for starting and stopping the ram 89. These levers may be provided for emergency purposes, and similar hand control levers may also be provided at the exit end of the apparatus for the same purpose.

Each of the machines particularly adapted for use in the present apparatus is of the automatic unit type which is started by the operator through a push button switch and is fully automatic throughout one complete cycle of operation, the machine having a return limit switch operated when the spindle or tools back away from the work to stop the machine. The machines may be located on the line by accurately positioning the drill or other tools in proper relation to the work holder locating pin of the table section. The machine usually has a bushing plate or guide member for the drills so as to exactly center them relative to the work, such as the member 115 carried by the frame of the machine C, Fig. 7, or the member 116 attached to the table section as shown in Fig. 5.

It will be understood that each slide has attached thereto a removable work holder which will be of a kind adapted for the particular work. In the present case, by way of example, the work holders J (Fig. 4) are designed for holding automobile cylinder blocks K (Figs. 5-7 inclusive).

In Figs. 1, and 22-24 inclusive, I have illustrated a unit L for automatically controlling the various operating mechanisms of the apparatus in timed relation. This unit comprises a base 120 and a suitable housing (not shown) to enclose the mechanism of the unit. A cam shaft 121 is carried in suitable bearings in upright frame members 122, this shaft being driven through gearing of a reduction unit 123 from the drive shaft 124 of an electric motor 125. This motor is started or stopped by means of two push button switches forming part of a control box unit 125a. The cam shaft 121 carries a series of cams of required number for automatically operating any or all of the mechanisms. In the present instance the shaft carries six cams, 126, 127, 128, 129, 130 and 131. Each cam cooperates with a cam roller 132 carried by an upright swinging lever 133 pivoted at its lower end at 134 and at its upper end pivoted to a link 135 which in turn is connected to a rod 136 for operating a valve or switch, as the case may be, carried by a casing 137. The cams 126-130 operate, through the mechanism described, a series of valves M, N, O, P and Q mounted on a table 138 bolted on the supports 122. At R is shown an electric switch suitably connected to the control boxes of the motors 96, 97, 98 and 99 for starting these motors, this switch being actuated through the medium of the cam 131 and intermediate parts. Each of the valves M-Q is connected in any well known manner to the particular mechanism which each valve controls for the purpose of starting and stopping such mechanism. The valve M operates the hydraulic cylinder and ram 88, 89. The valve N operates the hydraulic cylinders 57 for controlling the locating pins or plungers 40 and the clamping members 52 for the slides. The valve O operates all of the hydraulic cylinders and rams 33, 34 and the cylinder and ram 91, 92, for propelling the slides at the upper conveyor level. The valve P operates or controls the hydraulic cylinder and ram 63, 64 at the exit end of the apparatus. The valve Q controls the hydraulic cylinder and ram 66, 67, at the exit end of the apparatus to propel the slides successively onto the conveyor rolls.

The cams 126-131 are designed and constructed with relation to one another so as to operate the valves M-Q and electric switch R in proper timed relation. One of the cams 129 is illustrated, for example, in Fig. 23. This cam

has a portion 129a which operates to open the valve through the roller 132 and lever 133, thereby operating the ram in a forward direction. The cam also has an operating surface 129b which in cooperation with the roller 132 permits a return spring 138 to reverse the valve and shift the ram in a rearward direction. The cam also has a cam surface 129c which in cooperation with the roller 132 causes a dwell and holds the ram inactive during a predetermined time.

In the present apparatus, herein shown for the purpose of illustrating one embodiment of the invention, the control mechanism for actuating the various parts of the apparatus as well as the line of metal working machines in proper timed relation preferably operates as follows. Assuming that the table 84 is in its upper position as shown in Figs. 3 and 3A on a level with the ways 29 in table section E, Figs. 5 to 7 inclusive, and that table 84 carries a work holding slide member F that has suitably mounted thereon a metallic work piece; also assuming that each of the table supports E, Figs. 1, 2, 3 and 4, are carrying two of the work slides F that likewise have metallic work pieces suitably mounted thereon, it will be seen that there will be a continuous line of work holder slides F in succession from entrance end H to exit end G of the main guideway 29 and also a work holder slide on table 84. At this time it is assumed that table 58 is empty and in its upper position as shown in Figs. 2 and 4 on a level with guideway 29. Cam 127 thereupon operates to open valve N, whereby the hydraulic cylinder 57 and rack ram 56, through connecting mechanisms, withdraw the locating pins 40 and release the clamping members 52 from the slides. Immediately following this in predetermined timed relation the cam 128 operates to open valve O, whereby the hydraulic cylinders and rams 33, 34 function to shift the slides in the main guideway simultaneously from one station to another, and the hydraulic cylinder and ram 91, 92 function to shift a work slide from the idle or loading station, represented by table 84, onto the main guideway 29, it being understood that one of the rams 34 shifts a work slide from the main guideway 29 to the idle or unloading station represented by table 58. At this time cam 128 has suitably revolved to reverse valve O, thereby retracting ram 92 into cylinder 91 and rams 34 into their respective cylinders 33. At the completion of this retraction of the rams cam 128 has suitably revolved to place valve O in a dwell position.

Simultaneously with the reversal of valve O by cam 128, cam 127 reverses valve N which in turn reverses the action of cylinder 57 and rack 56 whereby the locating pins are released for movement into their operative positions in slides F and clamping members 52 are drawn into clamping positions. Immediately following the foregoing operation cam 131 operates to close the electric switch R, which in turn releases the various control mechanisms on machines A, B, C, D, which in turn carry out one complete operation cycle on the work carried by the work slides located opposite the machines. At the completion of the work cycle, cam 131 has opened switch R and machines A, B, C, D, have returned to starting position and remain or dwell in this position until again actuated, in proper timed relation, by cam 131 and switch R.

During the time of the foregoing machine operation cycle cam 126 has actuated valve M caus-

ing hydraulic cylinder and ram 88, 89 to lower empty table 84 to the level of the return conveyor rollerways 65. The table 84 during its downward travel actuates the switch 83a which starts motor 83 and conveyor chain 71, causing the latter to shift a work slide onto the empty table 84 immediately after it has reached the level of the return conveyor. At this time cam 126 reverses valve M causing hydraulic cylinder and ram 88, 89 to elevate table 84 carrying the work slide to the level of guideway 29 in table E. Table 84 with its work slide dwells or remains at this elevation until the proper time to repeat its cycle, and during this dwell the work slide is loaded with another metallic work piece.

During the aforesaid machine operation cycle, table 58 at the exit end of the line is also completing its cycle. Immediately after receiving a work slide F which was previously shifted from the exit end of guideway 29 onto table 58 by hydraulic cylinder and ram 33, 34, this slide is relieved of its metallic work piece which has proceeded through the various machine operations in the line. At this time cam 129 operates valve P whereby hydraulic cylinder and ram 63, 64 lower table 58 with its work slide to the level of the return conveyor as shown in dotted lines in Fig. 4. Cam 130 thereupon operates valve Q which causes hydraulic cylinder and ram 66, 67 to push or shift work slide F onto the return rollerways 65. Cam 130 then reverses valve Q which retracts ram 67 into cylinder 66. At this time cam 129 reverses valve P which causes hydraulic cylinder and ram 63, 64 to elevate empty table 58 to the level of guideway 29 at the exit end of the main guideway. Table 58 dwells or remains at this elevation until it has again received a work slide F and then repeats its operating cycle in proper predetermined timed relation. Work slide F shortly after being shifted from table 58 onto roller guideways 65 is picked up by endless chain 71 through the medium of one of the dogs 72 and is conveyed to the opposite end of conveyor where slide F, at a suitable point, engages and actuates, an electric switch (not shown) which causes motor 83 and conveyor chain 71 to stop just before slide F reaches the exit end of the return conveyor. Slide F remains at the end of and just within the tunnel of the frame until table 84 during its descent again actuates switch 83a.

I claim:

1. An apparatus for handling metallic work pieces for successive machining operations, comprising a series of metal working machines arranged in line, a supporting table having a top horizontal guideway extending continuously from the first machine to the last in said line, said table comprising independently removable sections each having separate floor supporting means, a series of work holding members having portions fitting said guideway for predetermined travel on said table, power operated means for shifting said members to station them in succession opposite said machines, a conveyor for returning said members from the exit end of the guideway to the entrance end, and mechanism for clamping said work holding members in succession to said removable sections.

2. An apparatus for handling metallic work pieces for successive machining operations wherein a line of machines are arranged to operate one after the other on each work piece, comprising a frame having an open ended horizontal guideway extending continuously past each ma-

chine, a series of separate work holders guided in said guideway, longitudinally reciprocable members engageable successively with certain of the work holders beneath the same for shifting the work holders in a line through the guideway, and means for locating each work holder opposite a machine for an operation.

3. An apparatus for handling metallic work pieces for successive operations by a series of metal working machines arranged in line, comprising two horizontal conveyors, one lying in a vertical plane above the other; two vertical conveyors, one located at the end of each horizontal conveyor; one of said horizontal conveyors comprising a supporting table provided with a horizontal guideway and a series of work holding slides adapted to travel in the guideway; each vertical conveyor comprising an elevator between the ends of the horizontal conveyors for transferring each slide from one horizontal conveyor to the other without inverting the slide; and power operated means for operating all of said conveyors in timed relation.

4. In an apparatus for handling metallic work pieces for successive machining operations in which a series of metal working machines are arranged in line, the combination of a series of work holders, four independently operated conveyors for moving said work holders successively in a continuous cycle, each conveyor having a path of movement at right angles to the next adjacent conveyor, one of said conveyors comprising a horizontal stationary guideway and a series of slides movable in the guideway and each slide carrying a work holder, and power operated mechanism for operating each conveyor.

5. Work holding and conveying apparatus for a series of machines adapted for machining operations on metal parts, comprising a series of work holders, means for moving said work holders in succession from each machine to the next, a continuous guideway for guiding the work holders in a predetermined path with respect to said machines, power actuated devices for clamping the work holders at opposite sides of the guideway opposite the machines for simultaneous machining operations and for unclamping the work holders after the completion of said operations, a separate conveyor for returning the work holders from the last operation to the first operation and extending on a different level from said guideway, means for transferring the work holders from the level of the guideway to the level of said conveyor without changing the angular position of said work holders, and means for transferring the work holders from the level of said conveyor to the level of said guideway adjacent the first operation.

6. The combination of a line of machines, a series of work holder slides, mechanism including reciprocating devices beneath the slides for intermittently shifting said slides in succession in a predetermined path past said machines, mechanism for locating and releasably clamping the slides successively at operating stations opposite the machines, mechanism for operating said machines, and power driven means for controlling all of said mechanisms to effect the operation thereof in recurrent cycles.

7. In an apparatus for handling metallic work pieces for successive machining operations, the combination of a plurality of metal working machine units arranged in line, means forming a continuous main guideway from the first machine to the last machine, a series of work holder slides

adapted to travel in the guideway, means for locating and clamping a plurality of slides in fixed positions at operating stations opposite the machines, a support forming a loading station in advance of the first machine and a support forming an unloading station beyond the last machine, said supports having guideways extending in continuation of said main guideway, a return conveyor, and reciprocating devices for shifting the slides from said supports to the return conveyor and vice versa.

8. In an apparatus for handling metallic work pieces for successive machining operations, the combination of a plurality of metal working machines arranged in line, means forming a continuous main guideway from the first machine to the last machine, a series of work holder slides adapted to travel in the guideway, means for locating and releasably clamping a plurality of said slides in fixed positions at operating stations opposite the machines, a support in advance of the first machine and a support beyond the last machine, said supports having guideways adapted to extend in continuation of said main guideway to form idle stations for said slides and being shiftable from said stations to the return conveyor and vice versa, power driven mechanism carried by said guideway means for shifting said slides, power driven means carried by said guideway means for operating said locating and clamping means, and means for starting said machines.

9. In an apparatus for handling work pieces for successive operations at a series of stations opposite a series of machines arranged in succession, the combination of means forming a continuous guideway from the first machine to the last machine, a series of work holder slides adapted to travel in the guideway, means for locking a plurality of slides in fixed positions in the guideway at operating stations opposite said machines, a support located in advance of the first machine and a support located beyond the last machine, each of said supports being releasably secured in fixed position to said guideway means and adapted to form a continuation of said guideway to receive a slide and forming idle stations, and mechanism beneath the guideway for intermittently shifting the slides in the guideway.

10. In an apparatus for handling work pieces for successive operations at a series of stations opposite a series of machines arranged in succession, the combination of means forming a continuous guideway from the first machine to the last machine, a series of work holder slides adapted to travel in the guideway, means for locking a plurality of slides in fixed positions in the guideway at operating stations opposite said machines, a support located in advance of the first machine and a support located beyond the last machine, each of said supports being removably secured in fixed position to the guideway means and adapted to form a continuation of said guideway to receive a slide and forming idle stations, mechanism for intermittently shifting the slides in the guideway, and separate mechanism for shifting a slide from the first named support into the guideway and for shifting a slide from the guideway onto the last named support.

11. The combination of a series of work holder slides designed to carry work pieces adapted to be operated upon successively by a line of machines, a single level main guideway extending past said machines, a single level return guideway, a plurality of reciprocating devices beneath the main guideway for separately shifting said

slides in succession on the guideway, a straight line operating means for transferring the slides in succession from the exit end of the main guideway to one end of the return guideway, and straight line operating means for transferring the slides in succession from the opposite end of the return guideway to the starting end of the main guideway.

12. The combination, with a line of machines, of a series of work holders, mechanism for intermittently shifting said work holders in a predetermined path past said machines and for intermittently clamping said work holders in position at fixed operating stations opposite the machines during operation of the machines on the work, mechanism for transferring said work holders in succession from the last machine to the first machine, mechanism for controlling the operation of said machines, and power driven means for controlling all of said mechanisms to effect the operation thereof in recurrent cycles and to coordinate the operations thereof in timed relation.

13. In an apparatus of the class described, the combination with a plurality of automatic machines having separate electric power units, of a series of work holders, means for supporting said work holders for movement in a predetermined path past said machines, mechanism for intermittently shifting said work holders and for maintaining the same at fixed operating stations opposite the machines during predetermined periods of time, and means for automatically starting and stopping said power units whereby the machines will complete their cycles of operation on the work during said periods of time.

14. An apparatus for handling metallic work pieces for successive machining operations wherein a line of machines is arranged to operate one after the other on each work piece, comprising a frame having an open ended horizontal guideway extending continuously past each machine, said frame comprising a succession of table sections releasably secured together and provided with spaced vertical side supports forming a horizontal tunnel extending through the frame beneath the guideway, a series of separate work holders guided in said guideway, power means for shifting the work holders in a line through the guideway, means for locating and clamping each work holder opposite each machine for an operation, a return conveyor extending horizontally through said tunnel, means for independently transferring each work holder from the exit end of the guideway to the conveyor, and means for independently transferring each work holder from the conveyor to the entrance end of the guideway.

15. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous horizontal guideway, a plurality of work-holding slides slidable in succession in said guideway, a plurality of metal working machines mounted in line along said guideway, said machines having tools shiftable transversely of the guideway into and out of position to perform operations on a plurality of slides of work pieces carried by said slides, mechanism for intermittently shifting said slides in said guideway and including means for successively positioning the slides at fixed operating stations opposite the machines, releasable mechanism for clamping each slide at opposite sides of said guideway at each operating

station, and power driven means for actuating each of said mechanisms.

16. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous horizontal guideway, a plurality of work-holding slides slidable in succession in said guideway, a plurality of metal working machines mounted in line along said guideway, said machines having tools shiftable transversely of the guideway into and out of position to perform operations on a plurality of sides of work pieces carried by said slides, mechanism including a succession of reciprocating members for intermittently propelling said slides through said guideway and including means for successively positioning the slides at fixed operating stations opposite the machines, releasable mechanism for clamping each slide at opposite sides of said guideway at each operating station, and power driven means for actuating each of said mechanisms.

17. In an apparatus of the class described, in combination, a series of table sections having horizontal top portions provided with guideways and releasably secured together in line to form a continuous straight line slideway, said table sections including upright supports, a series of work-holding slides having means fitting into said slideway, a plurality of automatic cycle metal working machine units arranged in line and mounted to said table sections for operating on the work on said slides from the top and opposite lateral sides thereof, mechanism for intermittently shifting said slides through the slideway, mechanism for clamping the slides at opposite sides of the slideway at successive fixed stations opposite the machines.

18. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous horizontal slideway, said means comprising a series of table sections releasably secured together end to end, a plurality of work holding slides slidable in succession through said slideway, a plurality of metal working machines mounted in line along said slideway and releasably mounted to different table sections, said machines having tools shiftable transversely of the slideway into and out of position to perform operations on work pieces carried by said slides, a plurality of mechanisms cooperating successively with different slides for intermittently shifting said slides in said slideway, and means for positioning the slides at fixed operating stations opposite the machines.

19. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous straight line horizontal slideway, said means comprising a series of table sections releasably secured together end to end, a plurality of work-holding slides slidable in succession through said slideway, a plurality of metal working machines mounted in line along said slideway and releasably mounted to different table sections, said machines having tools shiftable transversely of the slideway into and out of position to perform operations simultaneously on a plurality of sides of work pieces carried by said slides, mechanism for intermittently shifting said slides in said slideway and including means for positioning the slides at fixed operation stations opposite the machines.

20. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous

straight line horizontal slideway, said means comprising a series of table sections releasably secured together end to end, a plurality of work holding slides slidable in succession through said slideway, a plurality of metal working machines mounted in line along said slideway and mounted to different table sections, said machines having tools shiftable transversely of the slideway into and out of position to perform operations on work pieces carried by said slides, mechanism for intermittently shifting said slides in said slideway and including means for positioning the slides at fixed operating stations opposite the machines, each of said machines including power mechanism for automatically shifting its tool into and out of operation with respect to the work, means for clamping said slides to the table sections, and means for automatically operating said clamping means and for starting said machines at predetermined times.

21. In an apparatus for handling work pieces for successive machine operations, the combination of a plurality of metal working machines, each machine comprising a tool or tools and separate mechanism including an electric power unit for shifting said tools toward and from the work, means forming a continuous main guideway from the first machine to the last machine, said machines being arranged at a plurality of different sides of said guideway to cause the tools thereof to operate on different sides of the work pieces, a series of workholder slides adapted to travel in succession through the guideway, mechanism for intermittently shifting said slides through the guideway into fixed operating stations opposite said machines, mechanism for starting said electric motors, and power driven means timed to control said mechanisms for operation at different times.

22. In an apparatus for handling metallic work pieces for successive machining operations, the combination of a series of table sections adapted to be positioned end to end and having cooperating means forming a continuous horizontal guideway, a plurality of work holder slides carried by each table section and slidable in said guideway, a plurality of metal working machines secured to certain of said table sections at opposite sides of the guideway, said machines having tools shiftable transversely of the guideway into and out of position to perform operations on opposite sides of work pieces carried by said workholder slides, mechanism for intermittently shifting said slides in said guideway to position the same at operating stations opposite the machines, mechanism for clamping opposite sides of each slide to the table at each operating station, and power means for actuating said clamping mechanism and for releasing the same at predetermined intervals of time.

23. In an apparatus of the class described wherein a plurality of metal working machines are arranged in line for successive operation on work pieces, a table comprising a series of table sections provided with guideways positioned in alignment to form a continuous straight line slideway, a series of work holding slides fitting said slideway for successive travel therethrough, some or all of said table sections being releasably secured together in line and removable independently of one another and also having successive stations for supporting at one time a plurality of slides, means carried by said table beneath the slides for intermittently shifting said slides through the slideway, and means for intermit-

tently positioning and also fixing successive slides opposite said machines.

24. In an apparatus of the class described, the combination of a plurality of metal working machine units, a table comprising a series of interchangeable table sections provided with guideways positioned in alinement to form a continuous straight line slideway, a series of work-holding slides fitting said slideway for successive travel therethrough, means for intermittently shifting said slides through the slideway into fixed operating stations, and means for interchangeably mounting said machine units to different table sections for operation at a plurality of sides of said slideway.

25. In an apparatus for handling metallic work pieces for successive machining operations, the combination of a series of table sections adapted to be positioned end to end and having cooperating means forming a continuous horizontal guideway, a plurality of work holder slides carried by each table section and slidable in said guideway, a plurality of metal working machines secured to certain of said table sections at opposite sides of the guideway, said machines having tools shiftable transversely of the guideway into and out of position to perform operations on opposite sides of work pieces carried by said work holder slides, mechanism for intermittently shifting said slides in said guideway to position the same at operating stations opposite the machines, and mechanism for clamping opposite sides of each slide to the table at each operation station.

26. In an apparatus of the class described wherein a plurality of metal working machines are arranged in line for successive operation on work pieces, a table comprising a series of table sections provided with guideways positioned in alinement to form a continuous straight line slideway, a series of work holding slides fitting said slideway for successive travel therethrough, some or all of said table sections being releasably secured together in line and removable independently of one another and also having successive stations for supporting at one time a plurality of slides, and means carried by said table beneath the slides for intermittently shifting said slides through the slideway.

27. In an apparatus for handling metallic work pieces for successive machining operations, the combination of means forming a continuous horizontal guideway, a plurality of work holding slides slidable in succession in said guideway, a plurality of metal working machines mounted in line along said guideway, said machines having tools shiftable transversely of the guideway into and out of position to perform operations on a plurality of sides of work pieces carried by said slides, mechanism including a succession of reciprocating members for intermittently propelling said slides through said guideway and including means for successively positioning the slides at fixed op-

erating stations opposite the machines, and power driven means for actuating each of said mechanisms.

28. In an apparatus of the class described, the combination with a plurality of automatic machines, each machine comprising a tool or tools and separate mechanism including an electric power unit for shifting said tool or tools toward and from the work, work carrying means for supporting a series of work pieces in predetermined spaced relation, and operable to shift said work pieces in succession in a straight line path relatively to said machines, said machines being arranged whereby the tools thereof will operate on a plurality of sides of the work pieces, mechanism cooperable with said work carrying means for intermittently and simultaneously shifting said work pieces from one series of operating stations to another series of operating stations opposite said machines, means for maintaining said work pieces at said stations during predetermined periods of time independently of said mechanism and means for starting and stopping said power units whereby said tools will complete their cycles of operation on the work pieces during said periods of time.

29. In an apparatus of the class described, the combination with a plurality of automatic machines having separate electric power units, of a series of work holders supported for travel in a straight-line path past said machines, mechanism intermittently cooperable with said work holders for intermittently and simultaneously shifting the same in said path relative to said machines and including means for positioning said work holders at fixed operating stations opposite the machines during predetermined periods of time, and means for automatically starting and stopping said power units whereby the machines will complete their cycles of operation on the work during said periods of time.

30. In an apparatus for handling work pieces for successive machine operations, the combination of a plurality of metal working machines, each machine comprising a tool or tools and separate mechanism including an electric power unit for shifting said tools toward and from the work, a series of work carrying members supported for travel in a predetermined straight-line path past said machines, said machines being arranged to cause the tools thereof to operate on different sides of the work pieces, mechanism cooperable with said work carrying members for intermittently and simultaneously shifting the same into fixed operating stations opposite the machines and for maintaining them at said stations during predetermined periods of time and means for automatically starting and stopping said power units whereby the machines will complete their cycles of operation on the work pieces during said periods of time.

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