

May 22, 1951

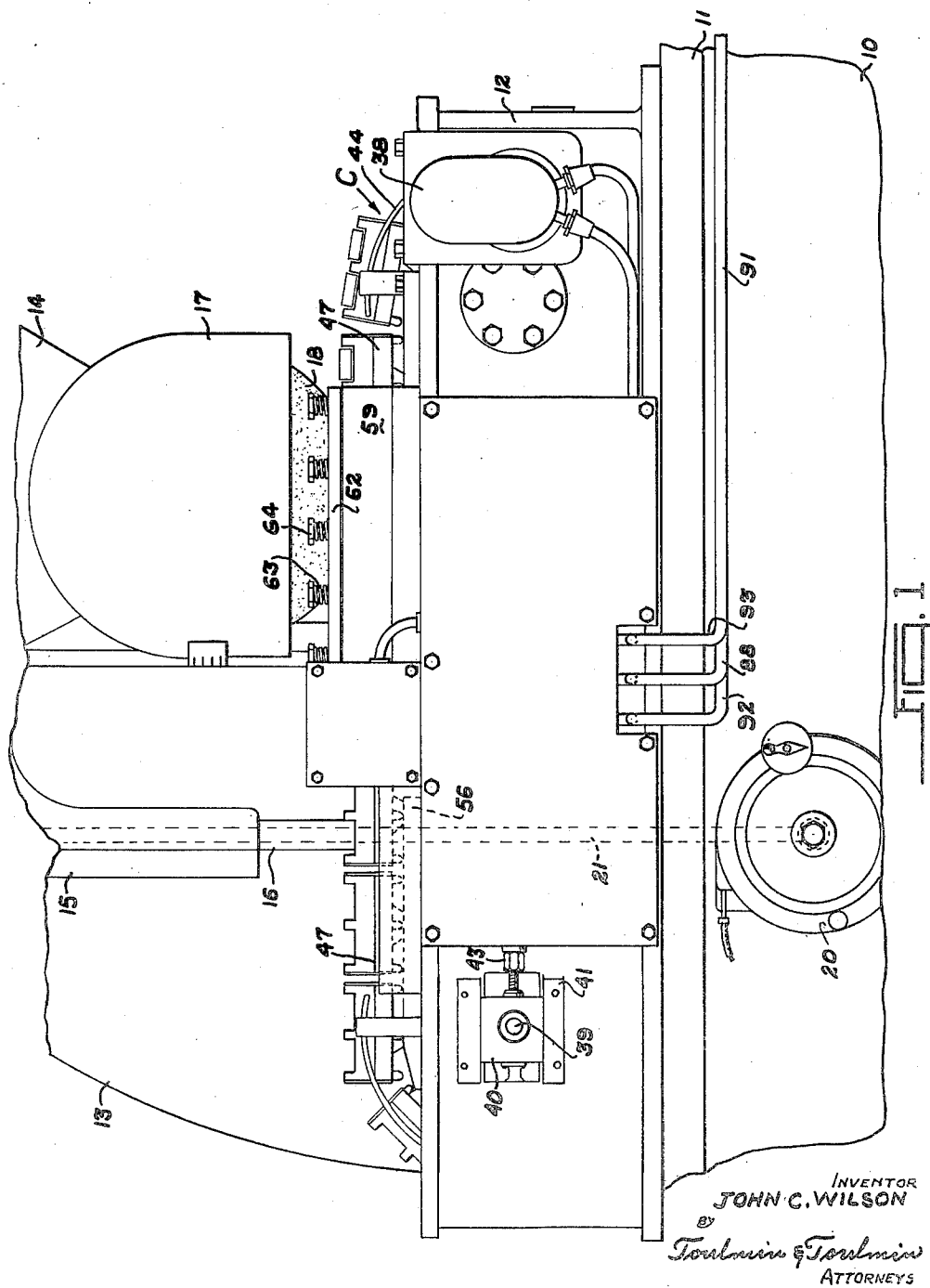
J. C. WILSON

2,554,079

METHOD AND APPARATUS FOR CONTINUOUS FORM GRINDING

Filed June 10, 1948

5 Sheets-Sheet 1



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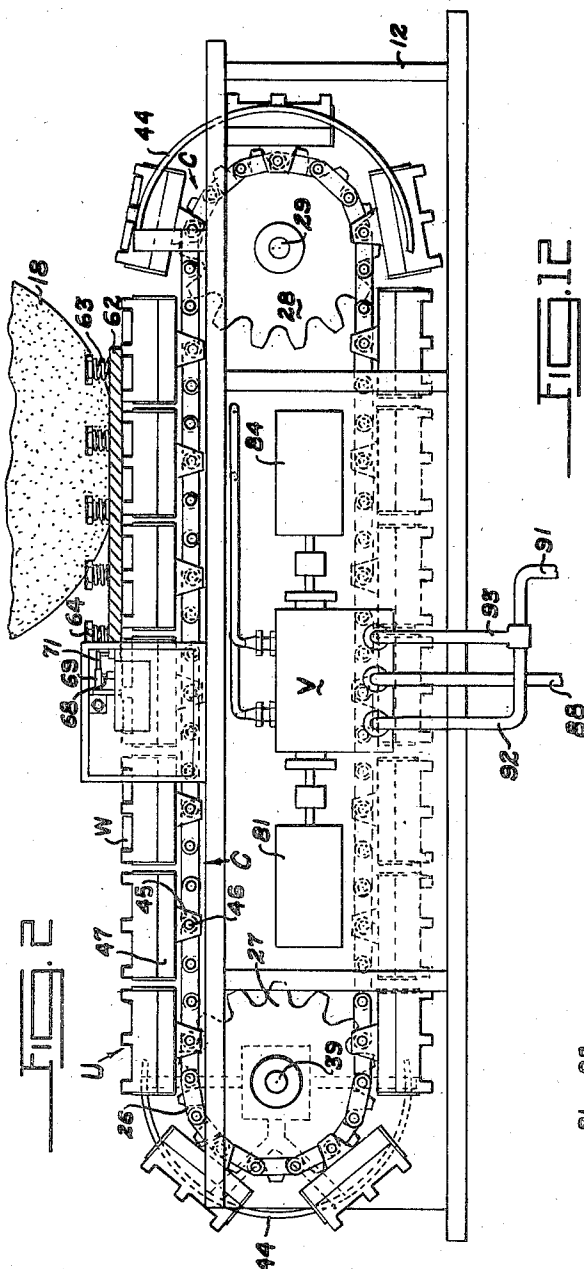
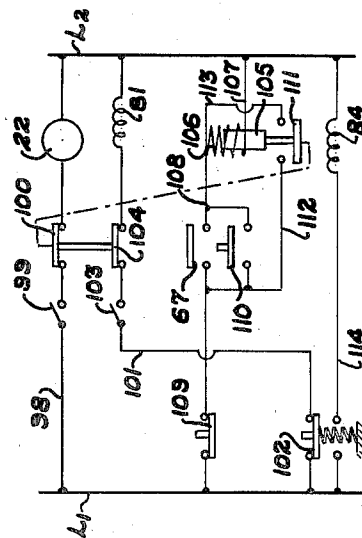
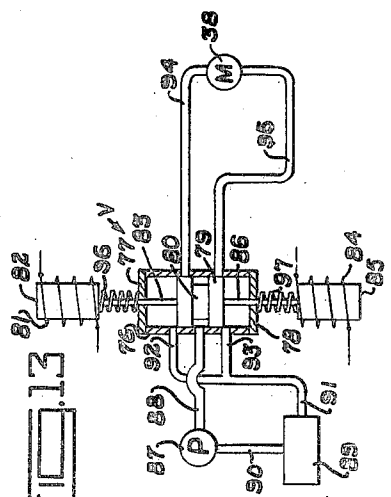
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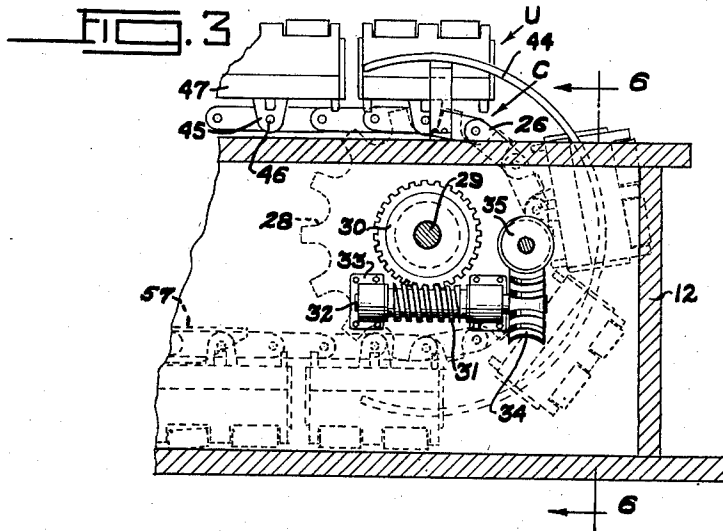
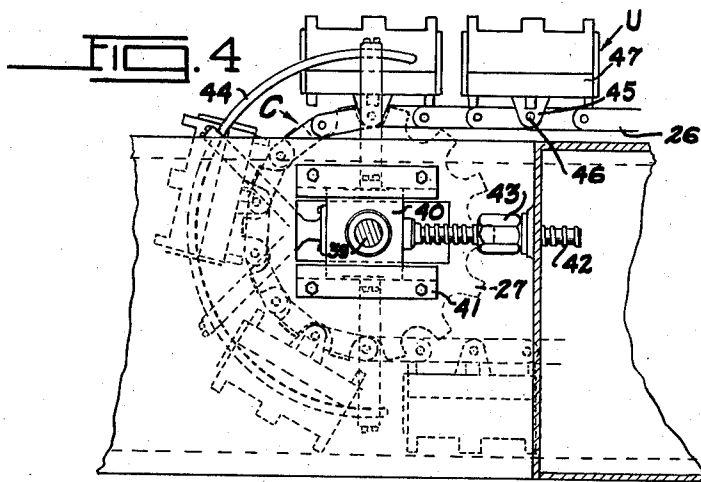
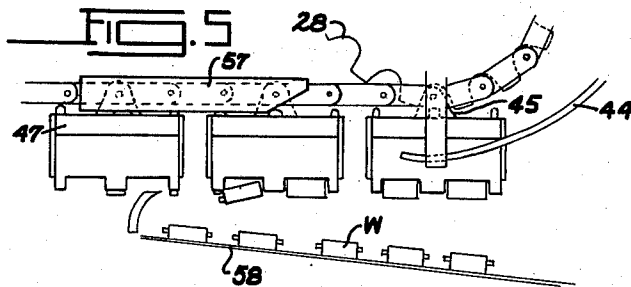
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5 Sheets-Sheet 3



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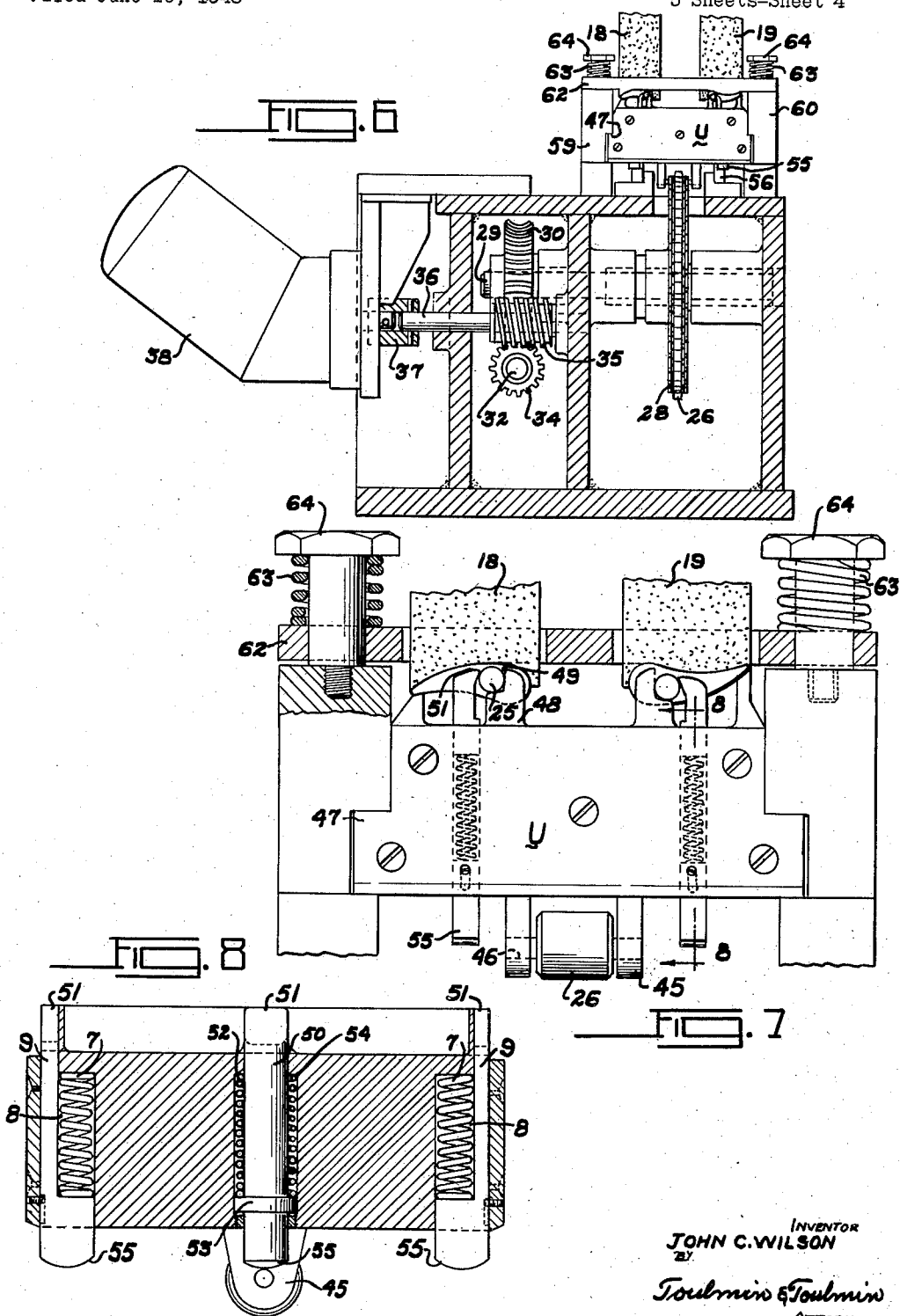
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5 Sheets-Sheet 4



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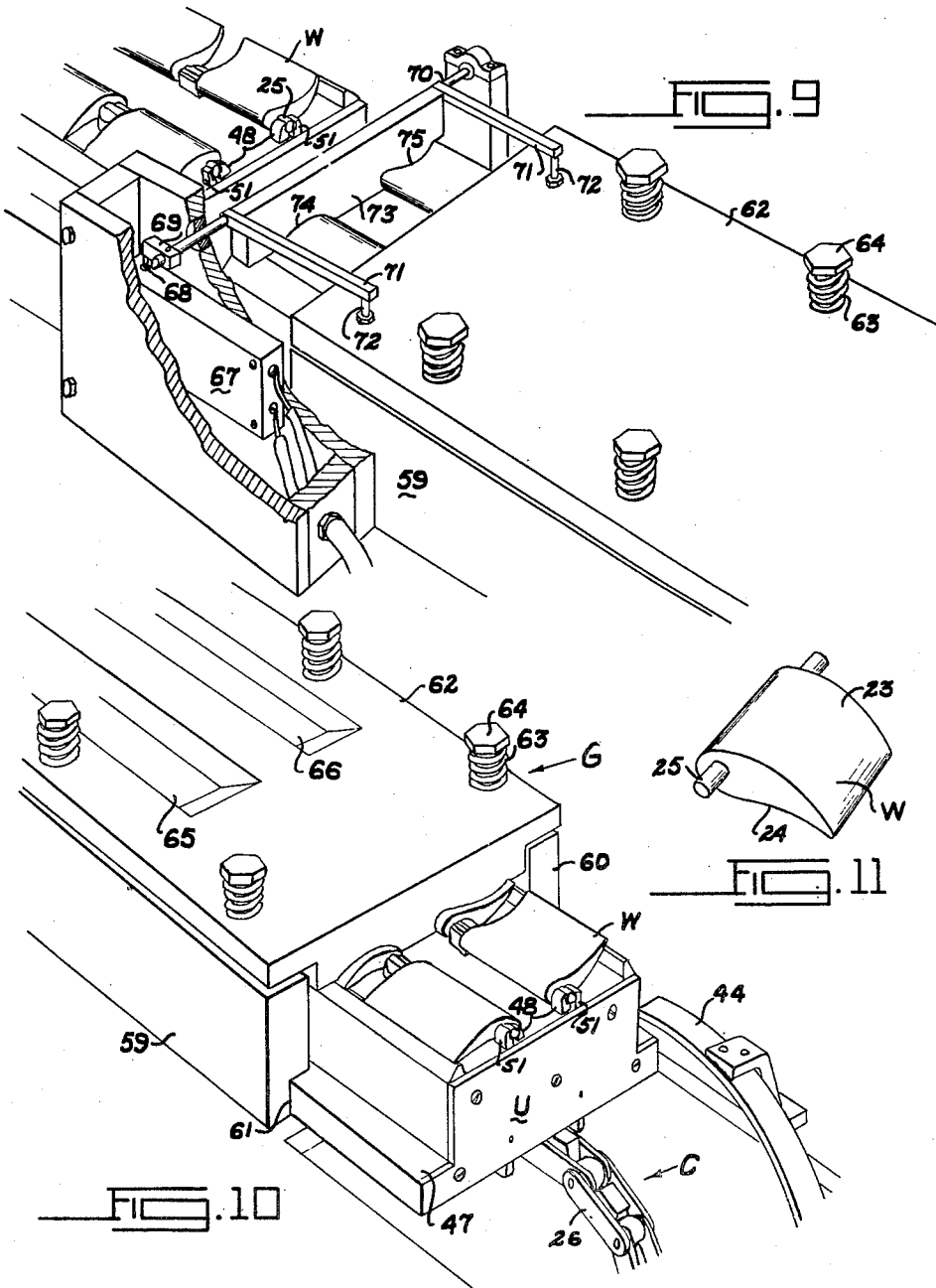
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METHOD AND APPARATUS FOR CONTINUOUS FORM GRINDING

Filed June 10, 1948

5 Sheets-Sheet 5



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2,554,079

METHOD AND APPARATUS FOR CONTINUOUS FORM GRINDING

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Application June 10, 1948, Serial No. 32,123

21 Claims. (Cl. 51-76)

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The present invention deals with the grinding of certain articles intended to have a predetermined form, and is concerned primarily with the method and apparatus designed to provide a continuous process.

At the present time modern manufacturing processes call for the production of a large number of articles all of the same size and shape and which are intended to have a final finished form which can be achieved only by grinding.

The present invention is predicated on the belief that manufacturing costs may be considerably reduced if the grinding of such articles is carried out as a continuous method.

The present invention has in view as its foremost objective the provision of a continuous grinding process which is characterized by the inclusion of the step of firmly positioning an article in an desired predetermined position as it passes a grinding station. This insures that the grinding will produce the proper form.

Still another object of the present invention is the provision of a method of the character above indicated which includes the steps of initially loading the articles to be ground on a continuously moving conveyor, firmly positioning the articles as they pass the grinding station, and then releasing the articles to permit their discharge from the conveyor.

Various other more detailed objects and advantages of the invention that are associated with the method itself will in part become apparent and in part be hereinafter stated as the description proceeds.

Another highly important object of the present invention is the provision of apparatus intended to effect continuous grinding and which consists essentially of a grinding station and an endless conveyor for taking the articles to be ground and moving them past the grinding station.

More in detail the invention has as an object the provision of apparatus of the type indicated which includes an endless conveyor provided with a plurality of work-holding units. Each of these units is designed to receive one or more of the articles to be ground.

Another highly important object of the invention is the provision, in continuous apparatus of the type indicated, of an endless conveyor having work-holding units of the type indicated and with which are associated means for rigidly clamping the workpieces in position just before they reach a grinding station and which means is released at an appropriate point after the articles have passed the grinding station to per-

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mit of their discharge from the work-holding units.

From the very nature of the operation being performed, it is highly important that each of the workpieces be properly positioned in the work-holding unit as it passes the grinding station. If a workpiece should not be properly positioned, either at a point immediately before it reaches the grinding station or at any time while the grinding operation takes place, it is desirable that the operation of the machine be immediately brought to a stop. Accordingly, a further object of the invention is the provision, in a continuous grinding apparatus of the character aforesaid, of a templet located immediately in advance of the grinding station and having one or more openings exactly conforming to the shape of the workpieces and the position which they are to assume in the grinding operation. Operatively associated with this templet is a control switch which will be actuated to stop the operation if any workpiece is not properly positioned as it passes through the templet.

Another object of the invention is the provision in continuous grinding apparatus of yieldable means for holding the workpieces in position at the grinding station and which means is operatively connected with the control switch aforesaid. Thus, if any workpiece becomes displaced from its proper position during the grinding operation, the limit switch will stop the operation.

In providing continuous grinding apparatus of the type with which this invention is concerned, it is important that the entire apparatus be under the ready control of the operator. Not only is it important that the automatic stops be provided as above indicated, but the operator must be able to reverse the operation so as to jog back any workpiece which might be displaced and remove the condition which has caused the machine to stop. He must be able to quickly start the machine in operation.

Accordingly, another highly important object of the invention is the provision, in continuous grinding apparatus of the type aforesaid, of control devices which may be available manually to start or stop the machine, automatically stop it if a workpiece is not properly positioned, and provide a reverse operation, if necessary, for eliminating a condition which stopped the machine.

Various other more detailed objects and advantages of the invention such as arise in connection with providing apparatus which will carry out the above noted ideas, will in part

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become apparent and in part be hereinafter stated as the description of the invention proceeds.

The invention, therefore comprises a method and apparatus for carrying out a continuous grinding operation on a multiple of workpieces intended to have a final finished size and shape that is achieved by grinding.

For a full and more complete understanding of the invention reference may be had to the following description and accompanying drawings wherein:

Figure 1 is a view in side elevation of continuous grinding apparatus designed in accordance with the precepts of this invention;

Figure 2 is another side view similar to Figure 1 with outer casing parts removed and showing more particularly the endless conveyor;

Figure 3 is an enlarged detailed view partly in section and partly in elevation of the driving mechanism at one end of the conveyor;

Figure 4 is a similar view bringing out the takeup mechanism at the other end of the conveyor;

Figure 5 is a fragmentary showing of a portion of the conveyor at the bottom bringing out the workpiece releasing and discharge action;

Figure 6 is a transverse section taken normal to the showing of Figure 3 at the driving end, this view being taken about on the plane represented by the line 6-6 of Figure 3;

Figure 7 is an enlarged detailed transverse section through the work-holding units at the grinding station;

Figure 8 is an enlarged detailed section taken about on the plane represented by the line 8-8 of Figure 7;

Figure 9 is an enlarged detailed perspective view bringing out the position of the workpieces just before they reach the grinding station;

Figure 10 is a perspective similar to Figure 9 but showing the workpieces immediately after they leave the grinding station;

Figure 11 is an enlarged detailed perspective of one workpiece which may be continuously ground by the method and apparatus of this invention;

Figure 12 is a diagrammatic illustration of the control circuit; and

Figure 13 is a diagrammatic illustration of the hydraulic circuit used in controlling the hydraulic motor which drives the machine.

General arrangement

The general arrangement of a continuous grinding machine designed in accordance with the teachings of this invention is depicted in Figure 1.

A bed is shown at 10 and this bed is adapted to rest on any suitable support. Carried by the bed 10 is a table 11 and upstanding from the table 11 is a supporting framework 12 which operatively supports the endless conveyor and associated instrumentalities. This endless conveyor is referred to generally by the reference character C.

Upstanding from the table 11 is a column 13 and supported by the column 13 is a saddle 14 which is adjustable as to its height through the medium of a saddle extension 15 which is slidable in a way 16. A wheelhead 17 is carried by the saddle 14 and one or more grinding wheels are operatively mounted in the wheelhead 17.

In the form of the invention illustrated in the drawings two grinding wheels 18 and 19 are operatively mounted in the wheelhead. Obviously

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on this particular number there is no limitation in the invention. Only a single wheel might be employed or a number in excess of two might be used.

A handwheel is shown at 20 and is operatively connected to the saddle extension 15 through the broken line connections shown at 21. This handwheel is availed of as a means to raise and lower the wheelhead 17 in a manner well known in this art.

The wheels 18 and 19 may be driven from any appropriate source of power, although the invention has particularly in mind the use of an electric motor such as is represented diagrammatically at 22 in Figure 12. The actual driving of the wheels is not a part of the present invention and is conforming with well known practice in this art.

Referring now for the moment more particularly to Figure 11, one type of workpiece which may be ground by the apparatus hereof is illustrated. It is to be understood that the particular size and shape of this workpiece has no limitation of the invention. It is given purely for exemplary purposes.

The workpiece is designated W and in illustrated form is one of the vanes used in an air compressor of an electrical refrigerator. The workpiece W has a convex surface 23 and a concave surface 24, both of which are to be finished by a grinding operation. Outstanding from the side of the workpiece W are the trunnions 25 which, in the present instance, are used in conjunction with the means for holding the workpiece in position, as will be later described.

The conveyor

Referring now more particularly to Figures 2, 3, 4, and 6, the endless conveyor C is shown as being in the form of a chain 26 which passes over sprockets 27 and 28. The sprocket 28 is the driving sprocket as shown in Figure 3 and is drivably mounted on a shaft 29 which also drivably carries a worm gear 30. Meshing with the worm gear 30 is a worm 31 that is drivably mounted on a shaft 32 that is carried by brackets 33. One end of the shaft 32 projects beyond the bracket 33 and drivably mounted thereon is another worm gear 34. Meshing with the worm gear 34 is a worm 35 drivably mounted on a shaft 36. The shaft 36 is journaled in the supporting structure 12 and its free end is drivably connected as by the driving connection shown at 37 to a hydraulic motor which is represented diagrammatically at 38. Hydraulic motors are well known as such and the particular details thereof are not a part of this invention. It suffices to point out that the hydraulic motor 38 is effective through connection 37, shaft 36, worm 35, worm gear 34, shaft 32, worm 31, worm gear 30, and shaft 29 to drive the sprocket 28.

Referring now more particularly to the left hand side of Figure 2 which is considered in conjunction with Figure 4, it will be noted that the sprocket 27 is mounted on a shaft 39 that is journaled at each side in blocks 40 that are slidably mounted between guides 41 that are anchored to the supporting framework. Each block 40 carries a screw stem 42 which is passed through a nut 43 that is anchored to a part of the framework. Obviously the nuts 43 may be rotated to cause rectilinear movement on the part of the shaft 42 and thus impart a similar movement to the blocks 40 and shaft 39. Thus, a takeup for the chain 26 is provided.

It will be noted that a pair of curved guides

44 are located at each end of the machine for a purpose now to be described. The chain 26 carries a plurality of workholding units each of which is designated U. Each of the units U has a pair of ears 45 depending from the bottom thereof with each pair of ears pivotally connected to one of the pivotal connections of the chain 26 as shown at 46. Thus, each workholding unit U is pivotally mounted on the chain. Each workholding unit U has a pair of side flanges 47 extending outwardly from each side thereof which are received beneath the guides 44 at each end of the machine and properly guide the unit as the turn is being made. Each workholding unit U is designed to hold a pair of the workpieces W in side by side relation.

As is shown in Figure 6 one of the workpieces W has its convex surface 23 in the uppermost position in which it is exposed to the grinding wheel 18, the edge of which has a shape corresponding to this convex surface. On the other hand, the next adjacent workpiece W has a concave surface 24 exposed for cooperation with the grinding wheel 19.

As is pointed out more clearly in Figures 7 and 8 each of the units U is provided with a pair of ears 48 which upstand from the top face thereof, each of which ears is formed with a notch at 49. There are a pair of ears 48 at each end of each block and a pair at the center of each block. Each notch 49 on the ears at the end is intended to receive one of the trunnions 25 of the workpiece, while the notches 49 on the central ears each receive the trunnions from the workpieces on both sides thereof. A plunger 50 is associated with each central ear 48. Each plunger 50 carries a bill 51 at the top which cooperates with the notch 49 in gripping a trunnion 25.

Each plunger 50 is biased downwardly by an expansion coil spring 52 which is disposed about the plunger and which engages a flange 53 thereon at one end and a shoulder 54 of the unit U at the other end. At each end of the block there is a pair of plungers 9, each having a bill adapted to cooperate with the notch 49 of an end ear 48 with which each plunger is associated.

Each plunger 9 is cut away at one side and the unit U is correspondingly cut away to provide recesses 8 that accommodate springs 7 that actuate the plungers 9.

The lower end of the plungers 50 and 9 are rounded to provide surfaces at 55 which are adapted for cooperation with a cam 56. The cam 56 is located in advance of the grinding station. Thus, as the plungers 50 ride on to the cam the bills 51 are upraised which permits of the positioning of the workpieces W with the trunnions 25 received in the notches 49. Just before the grinding station is reached the plungers ride off the cam 56, whereupon the springs 52 and 7 urge the plungers downwardly to cause the bills 51 to grippingly engage the trunnions 25 and firmly position the work.

Referring now more particularly to Figure 5, it will be noted that another cam 57 is located at the bottom of the framework 12 and has its cam face downwardly exposed. Also an endless conveyor for taking finished workpieces is shown at 58. After each unit U leaves the grinding station it passes around beneath the guides 44 and as it approaches the cam 57 the rounded ends 55 of the plungers 50 and 9 ride onto the cam 57, thereby causing the bills 51 to become spaced from the notches 49 and to release the workpieces W. The latter then fall onto the endless conveyor 58.

Automatic stop.

Referring now more particularly to Figures 10 and 11, the grinding station is represented generally by the reference character G. At the grinding stations G the framework supports spaced side bars 59 and 60, both of which are cut away to provide corner notches shown at 61 that accommodate the side flanges 47 of the units U. Extending between the side bars 59 and 60 is a top plate 62 which is yieldably held in position by springs 63 and headed studs 64. This cover 62 is provided with a pair of slots 65 and 66 which accommodate the grinding wheels 18 and 19. It is evident that if any of the workpieces W are disarranged at the grinding station G, that is beneath the cover 62, the latter may be moved upwardly as such movement is permitted by the springs 63 and studs 64.

A control switch is represented at 67 and may be of any type of control switch now well known to the electrical arts. The switch 67 includes, as its operating member, a plunger 68 which is engaged by an arm 69 drivably mounted on a shaft 70. Also drivably carried by the shaft 70 are a pair of arms 71 which engage fingers 72 which upstand from the cover 62. Thus, if the cover 62 is moved upwardly as by the disarrangement of a workpiece W, one or both of the fingers 72 will be moved upwardly to rotate the shaft 70 and thus cause a corresponding movement of the arms 69. This causes operation of the plunger 68 and thereby affects the switch 67 to stop the operation of the machine in a manner to be later described.

Depending from the shaft 70 is a templet 73 that is formed with a pair of openings 74 and 75 designed to accurately conform to the shape of the workpieces W in the position in which they are intended to assume in the grinding station. Thus, if each workpiece W is properly positioned it will pass through the respective openings 74 and 75 without affecting the templet. However, should either of these pieces be not properly positioned it will strike against the templet, the latter will swing, and the shaft 70 rocked to render the control switch 67 effective.

Hydraulic circuit.

Referring now more particularly to Figures 2 and 13, the hydraulic circuit for controlling operation of the motor 38 will be described. A four-way valve is referred to in its entirety by the reference character V. It comprises a cylindrical casing 76 having heads 77 and 78. Slidable in the casing 76 is a piston 79 formed with an annular groove 80. A solenoid 81 has a plunger 82 connected by a rod 83 with the piston 79. Likewise, a second solenoid 84 has a plunger 85 connected by a rod 86 with the piston 79. The rods 83 and 86 pass through appropriate openings in the heads 77 and 78. A pump for building up pressure is shown at 87. A service line 88 connects the pump to the casing 76 substantially intermediate the ends thereof. A pressure tank 89 is shown at 89 and is connected by a conduit 90 to the pump 87. Another conduit 91 extends from the pressure tank to conduits 92 and 93 which lead into the casing 76 at ports on opposite sides of the piston 79 when the latter is equidistantly spaced between the heads 77 and 78. A service line 94 extends from one side of the motor 38 to a port in the casing 76 and another service line 95 extends from the other side of the motor to another port in the casing. When the piston 79 is in its midway position both the serv-

ice lines 94 and 95 are blocked off and the motor is inoperative. When the solenoid 81 is energized the piston 79 is shifted in one direction to cause the hydraulic medium under pressure to be supplied to the motor M and drive the latter in the normal direction of operation of the machine.

It will be noted that a pair of springs 96 and 97 are associated with the plungers 82 and 85. Thus, when the solenoid 81 is de-energized these springs will return the piston 79 to its intermediate motor stopping position. The solenoid 84 may be energized to impart a reverse drive to the motor M to give a jog back as will be necessary when it is desired to straighten out a misplaced workpiece.

Control circuit

Upon referring to Figure 12, it will be noted that a pair of power lines are represented at L1 and L2. Extending between these power lines is a line 98 including a manually operable switch 99 and a normally closed switch 100. Also included in the line 98 is the motor 22 which drives the grinding wheels 18 and 19. It is evident that if both of the switches 99 and 100 are closed the motor 22 will be energized to drive the grinding wheels. Another line 101 extends across the power lines. Included in this line 101 is a normally closed jog back switch 102, a manually operable switch 103, and a normally closed switch 104. It will be noted that the normally closed switch 104 is mechanically connected to the normally closed switch 100, so that when one is open the both are open. Both of these switches are mechanically connected as indicated by the broken line to a plunger 105 of a solenoid 106. The solenoid 106 is connected across the power lines by a line 107 going from one end of the plunger to the power line L2 and a second line 108 in which is included the switch 67 and a reset switch 109. An emergency stop switch 110 is connected in to bypass the switch 67 and energize the coil 106 when it is desired to stop the machine. A holding blade is represented at 111 and is connected to the line 108 by lines 112 and 113, to hold the machine in its stop condition until an undesirable condition has been eliminated and it is desired to again start the machine in operation.

The operation of the control circuit may be briefly described by noting that under normal conditions both the switches 100 and 104 are closed. When the operator is desirous of starting the grinding wheels into operation he closes the switch 99 and this completes the circuit to the motor 22. When he is desirous of starting the endless conveyor in its ordinary forward movement the switch 103 is closed. This energizes the coil 81, whereupon the plunger 82 is affected to shift the piston 79 and affects the valve V to start the motor 38 in the direction for normal operation of the machine.

If some of the workpiece W should not be in proper position as it reaches the templet 73 it will not pass through its respective openings 74 and 75 and the templet will be swung on the shaft 70. A similar movement is imparted to the shaft 70 if any of the workpiece is improperly positioned beneath the cover 62. This rotation affects the switch 67 to close that switch and completes the circuit to the coil 106. As the latter is energized the plunger 105 is actuated to open both of the switches 100 and 104 and thereby stop the operation of the grinding wheel and the motor 22 and de-energize the coil 81. As the latter is de-energized the valve V is returned to its neutral position, discontinuing the delivery of hydraulic power to the motor 38. Moreover, the holding plate 111 completes the circuit across the lines 112 and 113 to the coil 106 and maintains the open condition of the switches 100 and 104. Should the operator be desirous of jogging the conveyor backwards so as to eliminate the undesirable condition, he depresses the jog back switch 102. This switch instead of closing the line 101 now closes line 114 which includes the solenoid 84. The latter affects the plunger 85 to shift the piston 79 of the valve V to operate the motor 38 in a reverse direction. The operator will keep the switch 102 depressed as long as the reverse rotation is desired. Release of the switch will cause it to return to the position opening line 113 and closing line 101. When the machine is again ready for operation he first opens the reset switch 109 so as to de-energize the coil 106. This permits switches 100 and 104 to return to their normally closed position and the machine will again start into operation. If for any reason the operator should notice an emergency condition which requires stopping of the machine he merely presses switch 110 which has the same effect as the automatic control switch 67 because it completes the circuit to the coil 106 and thereby opens switches 100 and 104.

Operation

It is believed unnecessary to here go into a detailed operation of the machine because the same has been described in connection with pointing out the functions of the various elements. It suffices to briefly outline the operation by noting that as each workholding unit U comes to the cam 56 the rounded ends 55 engage the cam surface to raise the plungers 50 and 9 and make each unit U ready for the reception of the workpieces W. The latter are now properly positioned and as the rounded ends 55 of the plungers 50 and 9 ride off the cam the workpieces are securely gripped between the bills 51 and the notches 49 of the ears 48. In this position they go through the grinding station G and are subjected to the action of the grinding wheels 18 and 19. After passing the grinding station they pass down to the under side of the endless conveyor, whereupon the cam 57 releases the workpieces and they fall onto the endless conveyor 53. Obviously, each workpiece will have to be passed through the machine twice so that both the surfaces 23 and 24 thereof may be ground.

The machine is automatically stopped should any undesirable condition develop or the operator may stop it should an emergency arise by availing of the switch 110.

While a preferred specific embodiment of the invention is hereinbefore set forth, it is to be clearly understood that the invention is not to be limited to the exact methods, apparatus, and devices illustrated and described, because various modifications of these details may be provided in putting the invention into practice within the purview of the appended claims.

I claim:

1. In continuous grinding apparatus, means forming a grinding station, an endless conveyor arranged in a formation providing substantially parallel top and bottom joined by a bend portion at each end, a plurality of workpiece holding units arranged in series and pivotally connected to said conveyor, workpiece holding means on each of said units including multiple cam sur-

faces engagement of which actuates said holding means, cam means associated with the top of said conveyor immediately in advance of said grinding station engageable by the multiple cam surfaces of said holding units for rendering said holding means effective at a predetermined point in advance of said grinding station, cam means engageable by said cam surfaces for releasing said holding means and associated with the bottom of said conveyor substantially adjacent one of said bend portions, and a conveyor for receiving workpieces released from the unit.

2. In continuous grinding apparatus of the character described, a workpiece holding unit comprising a body member, an ear upstanding from said body member and formed with a notch adapted to receive a portion of a workpiece to be positioned in said unit, a plunger reciprocally mounted in said body in close proximity to said ear, a bill on said plunger complementary to said notch, and spring means associated with said plunger and body member for urging said bill toward said notch.

3. In continuous grinding apparatus of the character described, a workpiece holding unit comprising a body member, an ear upstanding from said body member and formed with a notch adapted to receive a portion of a workpiece to be positioned in said unit, a plunger reciprocally mounted in said body in close proximity to said ear, a bill on said plunger complementary to said notch, spring means associated with said plunger and body member for urging said bill toward said notch, and a cam surface on the lower end of said plunger adapted for cooperation with a cam to raise said plunger against the influence of said spring means.

4. In continuous grinding apparatus of the character described, a workpiece holding unit comprising a body member having an ear upstanding from each end thereof and a central ear substantially in alignment with the first two ears, each of said ears being formed with a notch, a plurality of plungers operatively carried by said body member, there being a plunger associated with each ear, each of said plungers having a bill complementary to the notch in the respective ear, and spring means associated with said plunger and body member for urging said plungers in a direction moving said bills toward said notches.

5. In continuous grinding apparatus of the character described, a workpiece holding unit comprising a body member having an ear upstanding from each end thereof and a central ear substantially in alignment with the first two ears, each of said ears being formed with a notch, a plurality of plungers operatively carried by said body member, there being a plunger associated with each ear, each of said plungers having a bill complementary to the notch in the respective ear, spring means associated with said plunger and body member for urging said plungers in a direction moving said bills toward said notches, and a cam surface on the lower end of each plunger adapted to be engaged by a cam means to raise the respective plunger against the influence of said spring means.

6. In continuous grinding apparatus, a workpiece holding unit comprising a body member, a pair of ears upstanding from said body member at each end thereof and a third pair of ears upstanding from the body member substantially midway between the ears at each end and in alignment therewith, each of said ears being

formed with a notch adapted to receive a portion of a workpiece, a plunger operatively associated with each ear, a bill on each plunger complementary to the respective notch, a spring for each plunger normally urging said plunger in a direction moving said bill toward said notch, and a cam surface at the end of each plunger remote from said bill.

7. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, a control switch controlling the operation of said driving means for said grinding wheel and said conveyor, a templet located in advance of said grinding station and having an opening through which a properly positioned workpiece is adapted to pass, and operative connections between said templet and said switch whereby said templet is affected by an improperly positioned workpiece to operate said switch and discontinue the drive to said grinding wheel and conveyor.

8. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, a control switch governing the operation of said grinding wheel and conveyor, a top plate adapted to cover workpieces at said grinding station, said plate being yieldably held in position and operatively connected to said switch whereby an improperly positioned workpiece at said grinding station raises said plate to affect said switch to discontinue the drive to said grinding wheel and conveyor.

9. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, a control switch governing the operation of said grinding wheel and said conveyor, instrumentalities located in advance of said grinding station operatively connected to said control switch and responsive to an improperly positioned workpiece to affect said control switch to discontinue the drive to said grinding wheel and conveyor, and additional instrumentalities located at said grinding station operatively connected to said switch and responsive to an improperly positioned workpiece at said grinding station to affect said switch to discontinue the drive to said grinding wheel and conveyor.

10. In continuous grinding apparatus of the character described the combination of an endless conveyor, a hydraulic motor for driving said conveyor, a four-way valve controlling the operation of said motor, said valve including a piston which normally assumes an intermediate neutral position cutting off the delivery of fluid under pressure to said motor, and means selectively

operable for moving said piston in either direction to cause the delivery of hydraulic medium under pressure to said motor in a proper direction to cause movement of said conveyor in any desired direction.

11. In continuous grinding apparatus of the character described the combination of an endless conveyor, a hydraulic motor for driving said conveyor, a four-way valve assembly for controlling the operation of said motor, said assembly comprising a cylinder, a piston in said cylinder normally assuming an intermediate position therein discontinuing the delivery of hydraulic medium under pressure to said motor, a solenoid having a plunger operatively connected to said piston for moving said piston in one direction to cause hydraulic medium under pressure to be delivered to said motor to drive said conveyor in one direction, and a second solenoid including a plunger operatively connected to said piston for moving it in an opposite direction to cause said hydraulic medium under pressure to be delivered to said motor in an opposite direction and cause movement of said conveyor in an opposite direction.

12. In a continuous grinding apparatus of the character described the combination of an endless conveyor, a hydraulic motor for driving said conveyor, a four-way valve assembly for controlling the operation of said motor, said assembly comprising a cylinder, a piston in said cylinder normally assuming an intermediate position therein discontinuing the delivery of hydraulic medium under pressure to said motor, a solenoid having a plunger operatively connected to said piston for moving said piston in one direction to cause hydraulic medium under pressure to be delivered to said motor to drive said conveyor in one direction, a second solenoid including a plunger operatively connected to said piston for moving it in an opposite direction to cause said hydraulic medium under pressure to be delivered to said motor in an opposite direction and cause movement of said conveyor in an opposite direction, and spring means associated with each of said solenoids for causing said piston to assume its intermediate position upon deenergization of said solenoids.

13. In continuous grinding apparatus, a grinding station including a grinding wheel and an electric motor for driving said wheel, an endless conveyor, a hydraulic motor for driving said conveyor, a hydraulic circuit for said motor including a control valve having a pair of solenoids associated therewith, and an electrical circuit for controlling the operation of said grinding wheel motor and said hydraulic motor, said circuit including a manually operable switch for said grinding wheel motor, a manually operable switch for energizing the solenoid which causes operation of said hydraulic motor to move it in its normal direction of operation, a pair of normally closed switches included in the circuits to said motor and solenoid, another solenoid having a plunger mechanically connected to said normally closed switches, and a control switch in the circuit to said last mentioned solenoid operatively connected with instrumentalities located at said grinding station to automatically energize said last mentioned solenoid as an incident to the improper positioning of a workpiece and thereby open both of the said normally closed switches and discontinue the operation of said grinding wheel motor and said hydraulic motor.

14. In continuous grinding apparatus, a grinding station including a grinding wheel and an electric motor for driving said wheel, an endless conveyor, a hydraulic motor for driving said conveyor, a hydraulic circuit for said motor including a control valve having a pair of solenoids associated therewith, and an electrical circuit for controlling the operation of said grinding wheel motor and said hydraulic motor, said circuit including a manually operable switch for said grinding wheel motor, a manually operable switch for energizing the solenoid which causes operation of said hydraulic motor to move it in its normal direction of operation, a pair of normally closed switches included in the circuits to said motor and solenoid, another solenoid having a plunger mechanically connected to said normally closed switches, a control switch in the circuit to said last mentioned solenoid operatively connected with instrumentalities located at said grinding station to automatically energize said last mentioned solenoid as an incident to the improper positioning of a workpiece and thereby open both of the said normally closed switches and discontinue the operation of said grinding wheel motor and said hydraulic motor, and an emergency stop switch also included in the circuit to said last mentioned solenoid to energize said solenoid and open both of said normally closed switches should an emergency condition arise.

15. In continuous grinding apparatus, a grinding station including a grinding wheel and an electric motor for driving said wheel, an endless conveyor, a hydraulic motor for driving said conveyor, a hydraulic circuit for said motor including a control valve having a pair of solenoids associated therewith, and an electrical circuit for controlling the operation of said grinding wheel motor and said hydraulic motor, said circuit including a manually operable switch for said grinding wheel motor, a manually operable switch for energizing the solenoid which causes operation of said hydraulic motor to move it in its normal direction of operation, a pair of normally closed switches included in the circuits to said motor and solenoid, another solenoid having a plunger mechanically connected to said normally closed switches, a control switch in the circuit to said last mentioned solenoid operatively connected with instrumentalities located at said grinding station to automatically energize said last mentioned solenoid as an incident to the improper positioning of a workpiece and thereby open both of said normally closed switches and discontinue the operation of said grinding wheel motor and said hydraulic motor, a holding blade carried by the plunger of said last mentioned solenoid and adapted to complete the circuit thereto to hold both of said normally closed switches open, and a jog-back switch adapted to energize the other of the solenoids associated with said valve to cause said hydraulic motor to move said conveyor in a direction opposite to its normal direction of operation.

16. In the art of continuous grinding the method which includes the steps of (a) delivering workpieces to recesses in a continuously moving support; (b) providing a limited free travel path; (c) interrupting movement of the support in event workpieces fail to seat properly in said recesses and extend beyond the limits of the free travel path; (d) abrading the upper surface of supported pieces during a portion of the travel of said support; and (e) automatically interrupt-

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ing movement of said support in event workpieces become demounted by abrading action.

17. In apparatus for continuous grinding, the combination of, a grinding wheel, an endless conveyor positioned adjacent the periphery of said wheel with the path of travel of at least a portion of said conveyor normal to a radius line through said wheel and in line with the direction of rotation of said wheel, a plurality of workholding units having laterally extending side flanges pivotally mounted on said conveyor for movement between said conveyor and said wheel, arcuate guide means at each end of said conveyor in longitudinal alignment with said flanges for contacting the flanges of said units upon movement of said units across said guide means, and releasable means carried by each unit for grippingly engaging a workpiece.

18. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, control means controlling operation of said conveyor and said means for driving said grinding wheel, template actuator means sensitive to correct positioning of a workpiece on said holding units and through which a workpiece passes in advance of said grinding station and movable by any improper positioning of a workpiece on a holding unit, and operative connections between said template actuator means and said control means actuating said control means upon movement of said template actuator means by any improper positioning of a workpiece on said holding unit to automatically stop said conveyor and the driving means for said grinding wheel.

19. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, control means controlling operation of said conveyor and said means for driving said grinding wheel, actuating means at said grinding station and engageable with a workpiece in the grinding station for continuously sensing the correct positioning of a workpiece in the grinding station and movable by any incorrect positioning of a workpiece in the grinding station, and operative connections between said control means and said actuating means operating said control means upon movement of said actuating means by any improper positioning of a workpiece at the grinding station to automatically stop said conveyor and said means for driving said grinding wheel.

20. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor,

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a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, control means controlling operation of said conveyor and said means for driving said grinding wheel, template actuator means sensitive to correct positioning of a workpiece on said holding units and through which a workpiece passes in advance of said grinding station and movable by any improper positioning of a workpiece on a holding unit, operative connections between said template actuator means and said control means actuating said control means upon movement of said template actuator means by any improper positioning of a workpiece on said holding unit to automatically stop said conveyor and the driving means for said grinding wheel, said drive means for said conveyor including means for reversely driving said conveyor, and a jog-back control means connected with said means for reversely driving said conveyor to render the same active.

21. In continuous grinding apparatus, a grinding station including a grinding wheel and means for driving said grinding wheel, an endless conveyor, means for driving said endless conveyor, a plurality of workpiece holding units arranged in series on said endless conveyor, holding means on each of said units adapted to grippingly engage a workpiece and properly position the same with respect to said grinding wheel, control means controlling operation of said conveyor and said means for driving said grinding wheel, actuating means at said grinding station and engageable with a workpiece in the grinding station for continuously sensing the correct positioning of a workpiece in the grinding station and movable by any incorrect positioning of a workpiece in the grinding station, operative connections between said control means and said actuating means operating said control means upon movement of said actuating means by any improper positioning of a workpiece at the grinding station to automatically stop said conveyor and said means for driving said grinding wheel, said drive means for said conveyor including means for reversely driving said conveyor, and a jog-back control means connected with said means for reversely driving said conveyor to render the same active.

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