

Sept. 28, 1965

K. E. WITZIG ET AL

3,208,127

TURNTABLE

Filed Nov. 22, 1961

6 Sheets-Sheet 1

Fig. 1

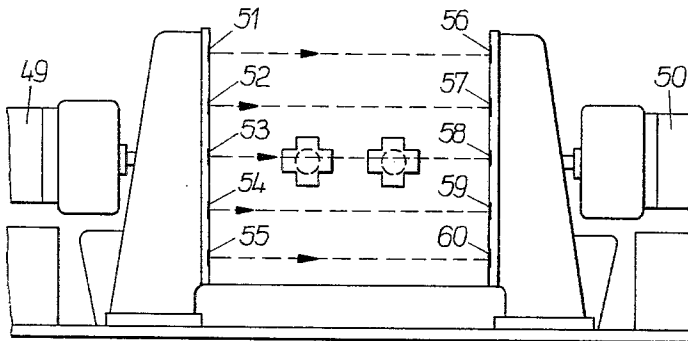
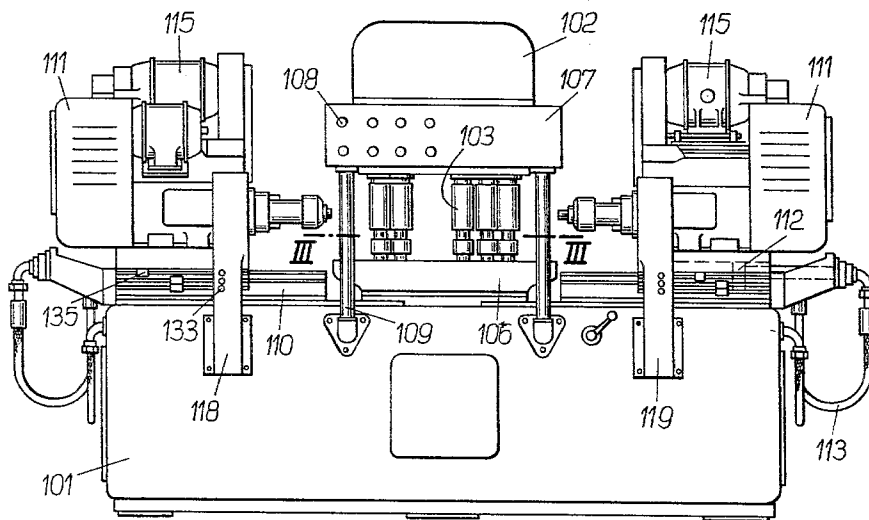


Fig. 10

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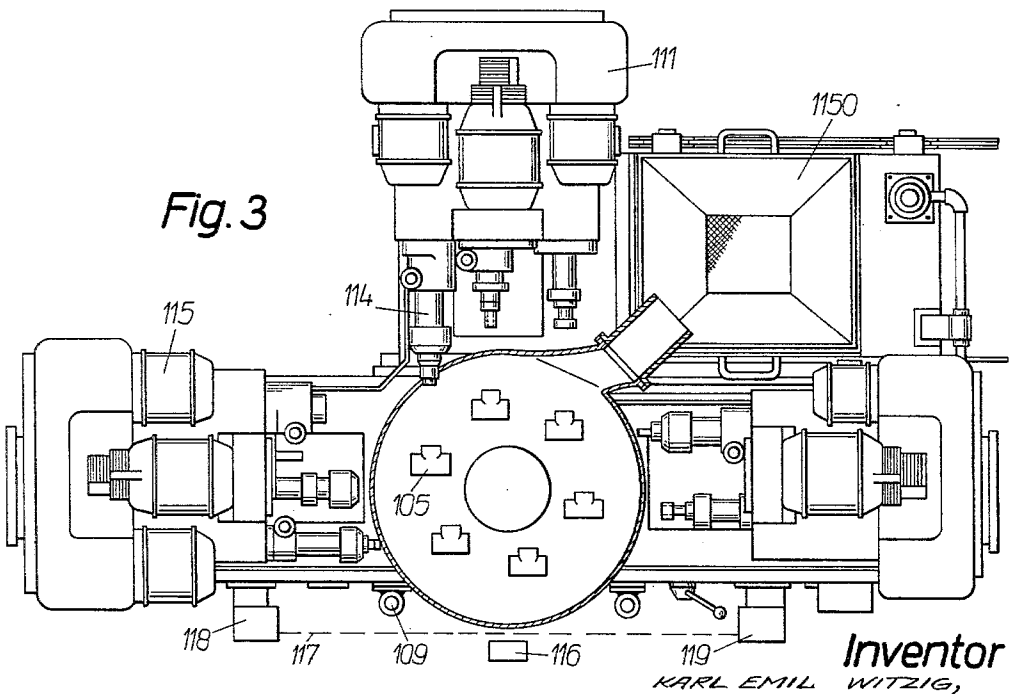
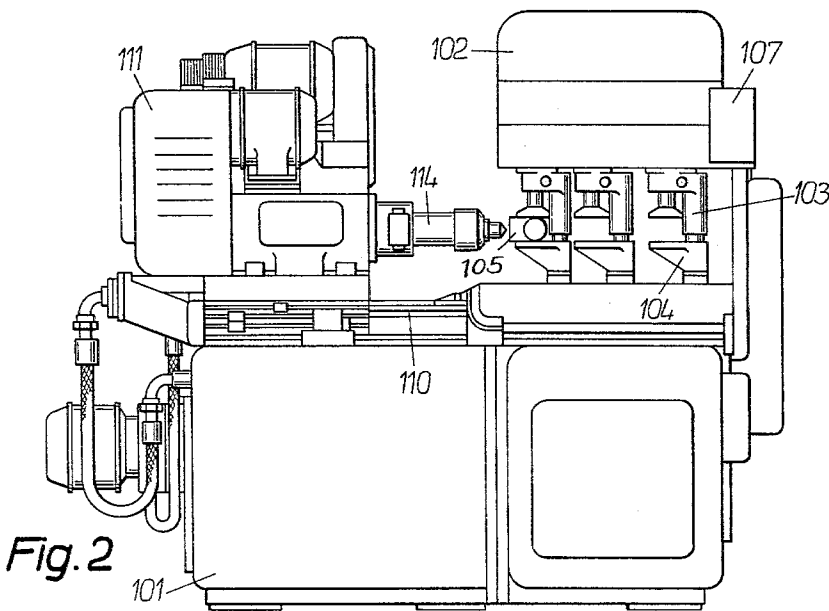
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BY Bailey, Stephens & Guthrie
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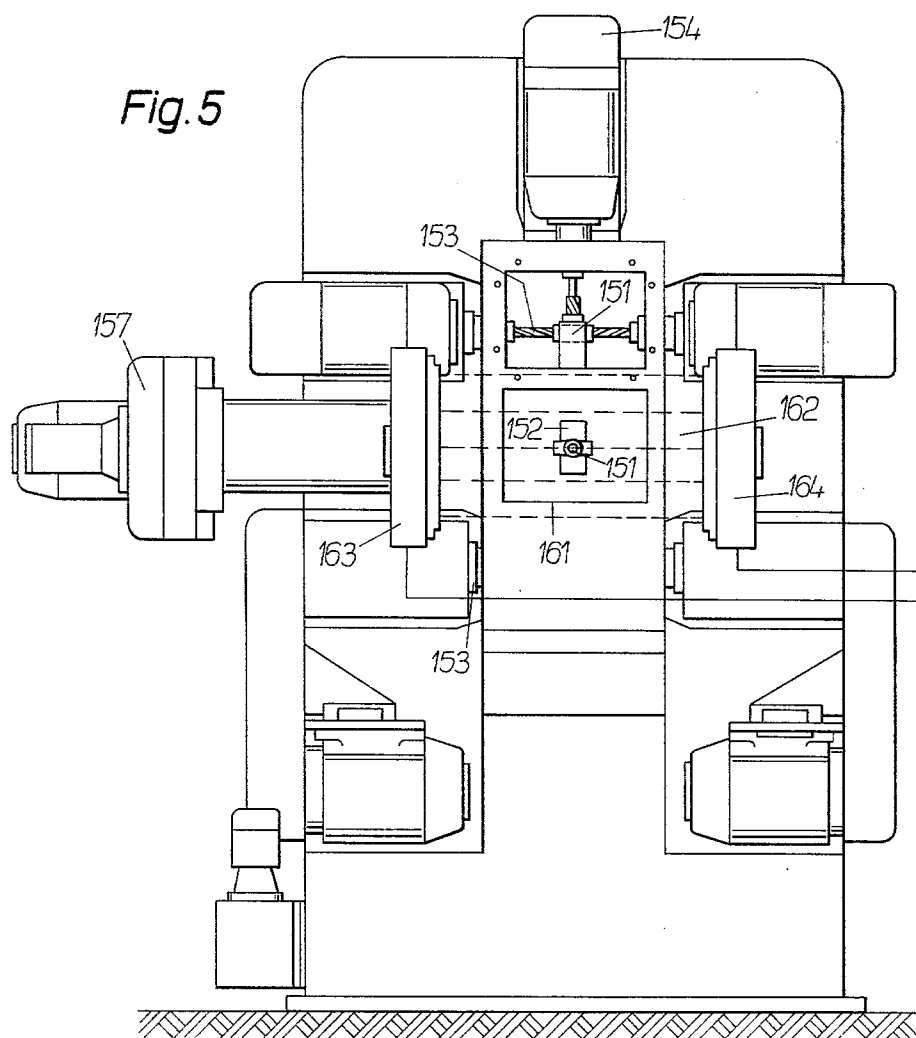
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6 Sheets-Sheet 4



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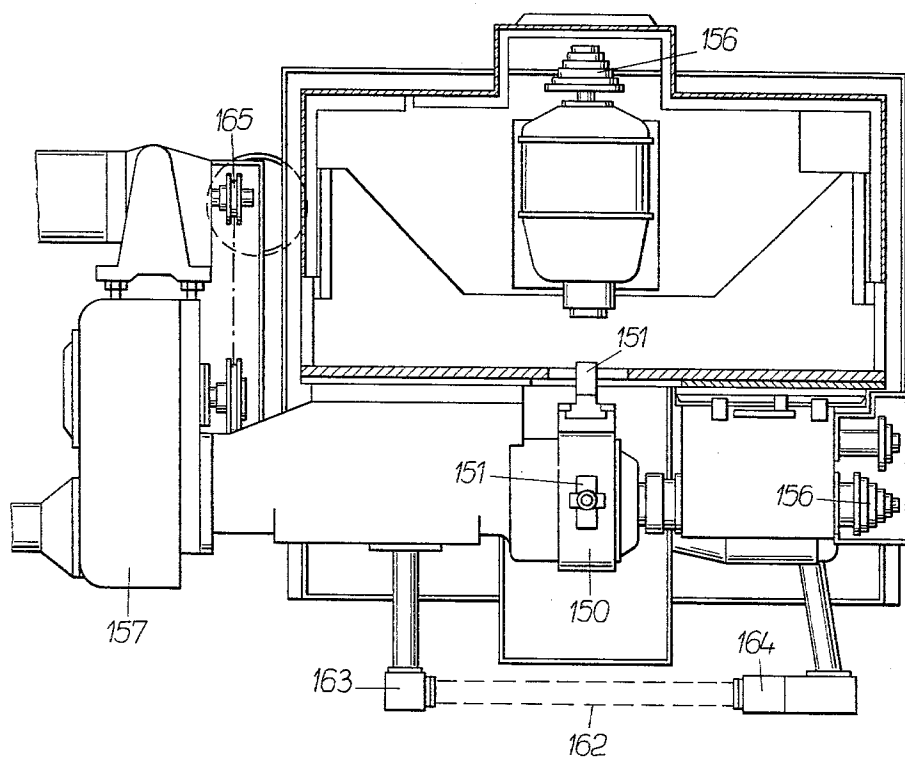
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Fig. 6



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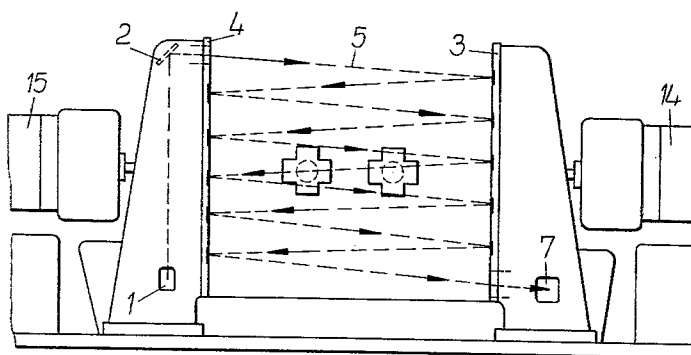


Fig. 8

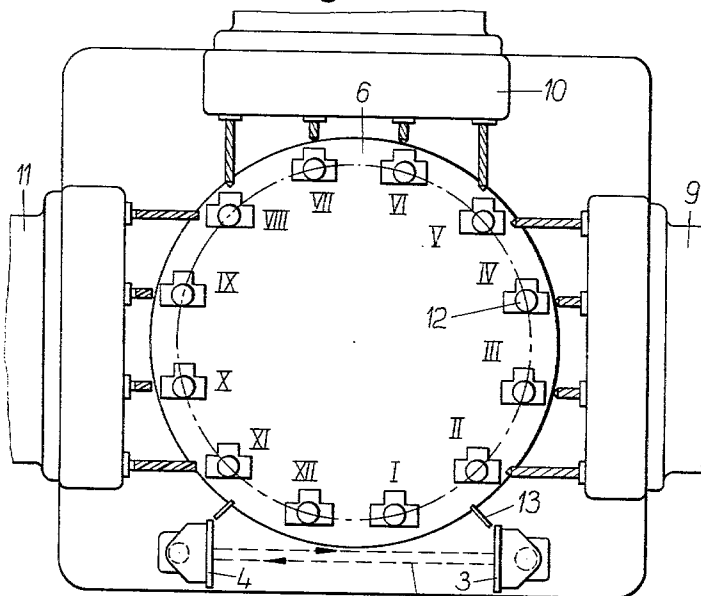


Fig. 9

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3,208,127 TURNTABLE

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Filed Nov. 22, 1961, Ser. No. 154,208
5 Claims. (Cl. 29—38)

This application is a continuation-in-part of application Serial No. 733,299, filed May 6, 1958, now abandoned.

The invention is concerned with a turntable to be used with machine tools and more especially with the kind of turntable having a pre-selection impulse emitting control system. The indexing movement of turntables of machine tools can be produced by hand, for example, by operating a lever, or automatically. With an automatic indexing movement there must be taken into account the time required by the operator for performing the work chucking operation, and further the fact that the intervals in which the turntable can be indexed must be accommodated to the longest time for performing one work machining operation. In this case there must be also taken into account the operator's errors and further that each operator after working for a certain length of time becomes fatigued and then requires more time for the work chucking operations. Therefore, steps must be taken to prevent the turntable from being moved under any circumstances before the work to be machined is securedly clamped thereon. For this purpose it was heretofore necessary to provide very long intervals for the individual steps of the indexed movement of the turntable or to use a device for omitting pre-selection impulses by which the indexing movement is controlled, said device being actuated by the operator by means of a pushbutton after the end of the work chucking operation. In this latter case it is possible to index the table only after the pre-selection impulses emitting device has been actuated so that an automatic continuation of the indexing movement of the turntable is not possible when the work chucking operation for whatever reasons requires more time than that provided initially therefor. When the operator finishes the work chucking operation in due time and actuates immediately thereafter the pushbutton for the pre-selection impulse emitting device, the turntable is indexed immediately after the return of the last working spindle. However, the known arrangement with a pushbutton has the disadvantage that, with machines with which the work-machining operations require a very short time, the time for operating the pre-selection impulse emitting device is too long in comparison with the time necessary for performing the work-machining operations. For example, the time required for operating the pushbutton of the pre-selection impulse emitting device may amount to one second, whereas for performing the work-machining operation there are required three seconds, while for indexing the turntable from one station to the other another second is necessary. Thus, with a total time of five seconds, one second must be spent for operating the pre-selection impulse emitting device, i.e. 20% of the total time. It is evident that this represents a great loss of time in such cases.

It is, therefore, the main object of this invention to provide a turntable of the general character described which is automatically indexed immediately after the end of the work chucking operation and after the longest of the simultaneous work machining operations has been terminated, and which does not require the actuation of a pushbutton for operating the pre-selection impulse emitting device as was hitherto the case.

Another object of this invention is to provide a turntable of the kind above referred to with which the normal operating rhythm is observed punctually if the operator performs the work chucking operation within the

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time provided therefor and which, on the other hand, is indexed only after the work chucking operation has been terminated and does not require the actuation of a pushbutton of the pre-selection impulse emitting device if, because of fatigue or for any other reason, the operator requires more time for the work chucking operation than the time initially provided therefor. In this manner much time can be saved and the operator is also less engaged by this manner of operation.

Yet another object of this invention is to provide a turntable of the character described with which the operator is able to allow the table-operating mechanism to operate in the desired manner by merely remaining inactive, i.e. by not extending his arms forward into the area between his working position and the turntable. As contrasted therewith, with the known devices of this kind, the operator must become active by actuating the pushbutton for the pre-selection impulse emitting device when he wants to release the table-operating mechanism to index the turntable.

Another object of this invention is to facilitate the task of the operator by making the operation of the turntable easier than was hitherto the case. This can be under certain circumstances of great importance with regard to the time necessary for performing the different working operations and to a continuous sequence of operations.

A still further object of this invention is to make provision for the different individual working operations to continue automatically when the operator fails to perform a movement, whereas with the known devices of this kind the operator can start the indexing movement of the turntable after this movement has previously been stopped only by an additional movement which may be performed sooner or later in which case under certain circumstances the operator's liveliness or fatigue may be of great importance.

A still further object of the invention is to provide a turntable of the above described type, the table-operating mechanism of which need not be so adjusted as to be indexed only after expiration of the longest time to be provided for the different working operations and which is operatively connected with a control system emitting pre-selection impulses and controlling the turntable so that it cannot be indexed before the end of the work chucking operations.

With these and other objects in view, which will appear as the description proceeds, the invention consists of certain novel features of construction as will be particularly pointed out in the appended claims.

The manner of carrying the invention into effect is hereinafter described by way of example, reference being had to the accompanying drawings in which:

FIGURE 1 shows a front view of a machine according to the invention which is provided with a horizontal indexed multiple work support;

FIGURE 2 shows a side view of the machine according to FIGURE 1 from which the front work unit is omitted for the sake of clarity of the illustration;

FIGURE 3 shows a plan view of the machine according to FIGURE 1, as seen partly in a cross section taken along line III—III of FIGURE 1;

FIGURE 4 shows a circuit diagram of the machine according to FIGURES 1 to 3;

FIGURE 5 shows a front view of a machine according to a modification of the invention which is provided with a cylindrical indexed multiple work support;

FIGURE 6 shows a plan view of the machine according to FIGURE 5, partly in a section taken approximately along the axis of the cylindrical work support;

FIGURE 7 shows a circuit diagram of the machine according to FIGURES 5 and 6;

FIGURE 8 shows a diagrammatic front view of the

machine according to another modification of the invention;

FIGURE 9 shows a diagrammatic plan view of a machine according to FIGURE 8; while

FIGURE 10 shows a diagrammatic front view of a machine according to a further modification of the invention.

Referring first to FIGURES 1 to 4 of the drawings, the machine tool according to the invention comprises a stationary frame 101 on which an indexing turntable 102 is rotatably mounted which is provided with downwardly suspended work supports 103, the jaws 104 of which are adapted to grip the workpieces 105 from above and below in a centered position. The construction and operation of this turntable is described in detail in our prior United States Patent No. 3,000,273. Underneath the work supports 103 a chip tray 106 is mounted, while at the front side of turntable 102 a switchboard 107 is provided which is mounted on frame 101 by means of brackets 109 and the control knobs 108 of which are indicated in FIGURE 1. Frame 101 carries prismatic guides 110 on which the work units 111 may be moved by hydraulic means from three different sides toward and away from the workpieces 105. The traverse of work units 111 is effected by a piston in a hydraulic cylinder, as indicated at 112, which is supplied with oil under pressure through the lines 113. Each work unit 111 carries work spindles 114 which are driven by electric motors 115. Spindles 114 which are moved together with the work units 111 may be employed for carrying out tapping, boring, turning, and similar operations on the workpieces 105, as illustrated in FIGURE 3.

Chip tray 106 communicates with a collecting tray 1150 in which the chips are collected and which is provided with a sieve for straining off the lubricant or coolant.

The workpieces to be machined which in this particular instance consist of T-shaped fittings are inserted at the loading station 116 into the work supports 103, while the finished workpieces are removed from work supports 103 at the same station.

Within the area adjacent to loading station 116 a photo-electric gate or light screen is provided, the beam of which is indicated at 117 and which consists of a light transmitter 118 and a receiver 119. The operation of this light screen as illustrated in FIGURE 4 is as follows:

As soon as the indexing table as illustrated diagrammatically at 120 on which the work supports 103 are mounted has stopped after one indexing movement in the direction as illustrated by the arrow, it is locked in the machining position by an indexing pin 121 which is moved forwardly by a piston in a hydraulic cylinder 122 which is supplied with pressure oil through the lines 123 from a source of pressure oil 1240. The means for controlling the intermittent movement of turntable 120 and the locking movement of indexing pin 121 are conventional in numerous types of hydraulically controlled machine tools and do not constitute a feature of this invention. When the indexing pin 121 carries out its forward or locking movement, a switch 123 is closed with the result that a timing relay 124 is energized, while at the same time a solenoid valve 125 is supplied with current through a line 1260 with the result that the respective work support 103 which is then located at the loading station 116 as indicated in FIGURE 1, and as indicated diagrammatically in FIGURE 4 at 126, is supplied with pressure oil so that the gripping jaws 127 will open and release the workpiece 105. The diagrammatic illustration of the work support 126 which is only intended to indicate the principle of the operation thereof is believed to be sufficient since its actual construction is described and illustrated in detail in our U.S. Patent No. 3,000,273, as previously mentioned. The timing relay 124 which is energized when switch 123 is engaged acts upon an amplifier 1270 which is connected to lines 128 of the transmitter 118 and the receiver 119 of the light beam 117 so that, during the time of opera-

tion of relay 124, light beam 117 will be inoperative. If relay 124 has run off and light beam 117 is not interrupted, amplifier 127 will send an impulse through line 129 to a solenoid valve 130 whereby this valve will be controlled so as to supply the necessary pressure oil to close jaws 127 of the work support 126. At the same time, by means of a relay, not particularly shown, which is energized by amplifier 127, a switch 131 in line 1260 is opened so that valve 125 will be changed accordingly.

Line 129 through which amplifier 127 sends the impulse for closing the jaws 127 is connected to a further line 132 which through limit switches 133 leads to a solenoid valve 134. Limit switches 133 are actuated by the work units 111 when the latter are in their basic position, that is, when their spindles are disengaged from workpieces 105. Limit switches 133 which are indicated in FIGURE 1 by small circles are actuated by cams 135 which are moved together with the work units.

If the limit switches 133 are closed, a current impulse is transmitted through line 132 to valve 134 and through a line 136 to a valve 137 which is likewise a solenoid valve. By this impulse, the positions of valves 134 and 137 are changed so that index pin 121 is retracted by the piston in cylinder 122, whereupon the driving mechanism of turntable 120, which is illustrated diagrammatically at 138 and consists of a gear and a rack 140 which is guided in cylinders 139, is supplied with pressure oil so that turntable 120 which in its actual construction corresponds to turntable 102 as shown in FIGURE 1, is advanced to the next work station. At the same time, when index pin 121 is retracted, switch 123 is opened so that the entire control system is returned to its basic position. As soon as turntable 120 is moved to the next work station, indexing pin 121 is again moved by a reversal of valve 137 to the locking position, as shown in the drawing, whereby the timing relay 124 is again started and work support 126 is opened in the same manner as already described. The means, for example, limit switches, for controlling the operation of indexing pin 121 when the turntable has been advanced by one step and is then stopped are not illustrated in detail since such control means are of a conventional design.

The actual operation of the machine is as follows:

As soon as turntable 120 has come to a stop and is locked by indexing pin 121, work spindles 114 move forwardly and start the operation of machining the respective workpieces 105 which they are facing. At the same time, timing relay 124 is started, while the work support 103 of the respective workpiece 105 which is located at the loading station is opened. During the period of operation of timing relay 124 which is adjustable, the light screen which is formed by beam 117 is inoperative and the operator of the machine can remove the workpiece 105 which is held in the opened work support 103 at the loading station 116 and exchange it for another workpiece. After the length of time to which the timing relay 124 has been adjusted has expired, light screen 117 will become operative and send a current impulse through the amplifier 127 to effect the closing of the open work support 103 and at the same time preset the indexing mechanism of turntable 120 so that the latter will be advanced by one step after the operation of those spindles 114 which require the longest time has been completed. This is due to the fact that as soon as the last work unit 111 has returned to its basic position, the end switches 133 are actuated so that the impulse which is sent by amplifier 127 can then be transmitted to valves 134 and 137 and thus to the indexing mechanism of turntable 120. In order to effect the mentioned operation of the machine it is presumed that light screen 117 is not interrupted when the period of operation of timing relay 124 has expired, that is, that the operator has been able to complete the exchange of the workpiece 105 at the loading station 116 before timing relay 124 has run off. If,

however, the operator carries out this periodic exchange operation too slowly and requires for it a greater length of time than that allowed by timing relay 124, light screen 117 will be interrupted by the hands or arms of the operator who is still employed in exchanging the workpieces when the timing relay 124 has already run off. Amplifier 1270 will therefore not transmit any impulse and the clamping jaws 127 or 104 will remain open. If light screen 117 remains interrupted until those work spindles 114, the operation of which requires the longest time, have completed their movement, that is, when all work units have been retracted to their basic positions, limit switches 133 will also be closed when light screen 117 again becomes operative. The current impulse which is then sent by the amplifier 1270 may now pass directly from the latter via valve 130 and the closed limit switches 133 to valves 137 and 134 so that there will be no delay until the next indexing movement of turntable 102 or 120 will occur.

FIGURES 5 to 7 illustrate a machine tool according to a modification of the invention in which in place of a horizontal work support in the form of an indexing turntable rotating intermittently about a vertical axis as previously described with reference to FIGURES 1 to 4, a cylindrical drum 150 is employed which intermittently rotates about a horizontal axis and carries a plurality of clamping jaws 152 for mounting workpieces 151. These workpieces 151 are to be machined at the different work stations by spindles 153 which are driven by electric motors 154 and are adapted to move in the axial direction toward and away from the workpieces 151. Between each spindle 153 and its associated motor 154 a pulley gear 156 is interposed to permit the speed of the spindles to be varied in accordance with the respective machining operations to be carried out.

The indexing movement of drum 150 from one station to the next is produced by a Maltese-cross transmission of a conventional type which is mounted in a housing 157 and is illustrated diagrammatically without the housing at 158 in FIGURE 7. The Maltese cross 159 is mounted on a horizontal shaft 160 which also carries and is connected to drum 150 which forms the work support.

At the loading station of the machine which is indicated in FIGURE 5 by an opening 161 in a protective housing which encloses drum 150, a light screen 162 is provided, the light beams of which are sent from an emitter 163 and a receiver 164. This light screen 162 is arranged in such a position that the beam or beams of light will be interrupted by the operator of the machine when he exchanges the workpieces at the loading station 161.

The driving means of the Maltese-cross transmission 158 are indicated diagrammatically in FIGURE 6 at 165. They do not need to be described in detail since they may be of a conventional type. The principle of operation of this transmission as illustrated in FIGURE 7 is as follows.

When motor 166 is started, it turns a lever 167 which carries a pin 168 which is slidable in a groove 169 of the Maltese cross 159 and thereby turns the latter about its axis at an angle of 90° before it emerges from the adjacent groove 169. The manner of operation of the light screen 162 substantially corresponds to that of the light screen 117 as already described with reference to FIGURES 1 to 4 and therefore does not need to be again described.

When drum 150 and Maltese cross 159 are stopped, the work spindles 153 at the different work stations of the machine move toward the workpieces 151, while at the same time a cam 170 on lever 167 engages with a switch 171 to close the same, whereby a timing relay 172 is started and at the same time a solenoid valve 173 is energized so that the clamping jaws 152 are hydraulically

operated to open and to release the respective workpiece 151 which is located at the loading station. After the period to which the timing relay 172 have been preset has expired, the amplifier 1730 which is connected to the emitter 163 and the receiver 164 of light screen 162 sends a current impulse in the same manner as previously described to a solenoid valve 174 whereby the position of this valve is changed so that pressure oil will now be supplied from the source 175 to the work cylinder 176 of clamping jaws 152 so that the latter will clamp the workpiece 151. At the same time, switch 177 is opened so that valve 173 will also be reversed. As soon as the work spindles 153 have arrived in their basic position, they close the switch 178 with the result that the impulse which is sent by the amplifier 1730 is now transmitted to motor 166 so that the Maltese cross 159 and thus also drum 150 are moved to the next work station. It will thus be seen that the control cooperations of the machine insofar as they are effected by the light screen 162 are the same as those which have been described with reference to FIGURES 1 to 4 and therefore do not need to be further described.

The electric circuit of the light screen itself is conventional since such screens are frequently employed as safety devices in presses, sewing machines, and the like, although in a manner entirely different from that in which it is employed according to the present invention. Thus, for example, while a light screen on a press is employed for immediately stopping the operation of the press as soon as the operator reaches into the press and thereby interrupts the light beam or beams, or while in an escalator the movement of the stairs is started when a person interrupts the light beam, the light screen is employed according to the invention for the purpose of emitting a preselection impulse. As already described at the beginning, it has so far been necessary in machine tools of a similar type that the operator of the machine after exchanging the workpieces at the loading station had to operate a preselection pushbutton, whereby a current impulse was emitted to close the clamping jaws and to advance the indexing table to the next step as soon as the longest machining operation was completed. If the machining operation requires only a very short time, for example, less than 15 seconds, the length of time which the operator requires to depress the pushbutton may be of considerable importance. Furthermore, with such pushbutton controls it is left entirely to the operator to depress the pushbutton whenever he wants to. The output of the machine therefore depends considerably upon the operator's willingness to work. The control of the preselection impulse according to the invention by means of a light screen, on the other hand, not only fully replaces such a preselection pushbutton and allows the same to be omitted, but in addition it saves the time which is required for reaching for such a pushbutton and for depressing it. Actual comparative tests which have been carried out with such machines which are pushbutton-controlled and with those according to the invention have shown that the output of the machine which is controlled by a light screen may be increased by 15 to 20% over the old type of control. This is partly also due to the fact that the operator can no longer control the indexing movements and stops as he pleases simply by not depressing the pushbutton when he is supposed to do so. Unless he interrupts the light beam intentionally, for example, by holding his hand in the path of the beam which is a rather tiring manipulation, he will be compelled to work as prescribed by the preset intermittent movement of the machine or he will risk that the machine will run idle. Such an idle run of the machine may by simple signal means of a conventional type be brought immediately to the attention of his supervisor.

An electric circuit of a light screen similar to that as may be employed according to the invention although for an entirely different purpose is described, for exam-

ple, in the U.S. Patent No. 2,418,356 with reference to FIGURE 6 of its drawings in which, if applied in the control system according to the invention, the relay 86 of this patent might be employed to emit the preselection impulse and to actuate the switches 131 and 127 of the apparatus according to the invention, while the time relay of the new apparatus would have to be connected into the exciter circuit of this relay.

It is obviously also possible and therefore not particularly shown in the drawings to employ the light screen not only for controlling the preselection impulse of a machine tool according to the invention, but also in the conventional manner as a safety device, for example, for stopping the work-supporting drum when the operator accidentally or carelessly reaches into the running machine. The circuit as illustrated in FIGURES 4 and 7 may also be easily modified, for example, by installing a suitable kind of amplifier 1270 or 1730 and a suitable kind of valve for the operation of the clamping jaws, so that, when the light screen is interrupted while the work support, i.e. the turntable or the drum, is standing still, the clamping jaws will immediately reopen to permit the operator—in the event that he has accidentally clamped the workpiece improperly—to reclamp it accurately simply after interrupting the light screen.

By means of the timing relay which is connected in series with the amplifier 1270 or 1730 the advantage is attained that immediately after the turntable or work-supporting drum has stopped, the light screen will be inoperative so that the clamping jaws will not be closed while the operator removes the finished workpiece from the opened jaws and then removes his hands from the light screen. The clamping jaws will therefore not be closed until the operator has inserted the new workpiece at the loading station and has thereby formed the light screen for the second time since the preset running period of the timing relay has in the meantime expired.

The embodiment of the invention, as illustrated in FIGURES 8 and 9 differs from that as described with reference to FIGURES 1 to 4 merely by the specific construction of the light screen. In this case, the light beam is emitted from a light source 1 and is deflected and reflected several times by a suitable mirror 2, 3, and 4 until it is received by the light-sensitive element 7 in the form of a photoelectric cell. The light screen 5, that is, the zigzag path of the light beam, is designed so that it is impossible for the operator at the loading station 8 to exchange the work pieces 12 without interrupting the light beam. While clamping the next new work piece 12 or while carrying out a similar operation, the operator must bend over the turntable 6 or insert his hand into the area above this turntable. As indicated in FIGURES 8 and 9, the light source 1 and the photoelectric cell 7 are mounted in a frame which is connected to the machine frame between and at both sides of turntable 6 and the operator's position 8. The machining of the work pieces 12, the individual stations of which are indicated at I to XII, is carried out by the work units 9 to 11 which are driven by suitable means 9 to 11. Deflecting plates 13 prevent the light beam which is emitted from the light source 1 from being weakened by scattering or straying.

FIGURE 10 finally illustrates still another possibility of arranging the light screen. In this machine, several light sources 51 to 55 and corresponding photoelectric cells 56 to 60 are provided at several opposite points of the machine. This type of arrangement will be necessary, for example, if polarized light is used, since the employment of reflecting mirrors would result in the extinction of the light.

Since the operation of the light screens according to FIGURES 8 to 10 is otherwise exactly the same as that which has been described with reference to FIGURES 1 to 7, a detailed description thereof would be superfluous.

Although our invention has been illustrated and described with reference to the preferred embodiments

thereof, we wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed our invention, what we claim is:

1. In a machine tool having an automatically indexed work support, an indexing mechanism for rotating and stopping said work support step-by-step at several work stations and at a loading station, tools movable toward and from at least one workpiece on said work support for machining said workpiece while said work support is stopped at said work stations, control means for automatically controlling said mechanism comprising means for emitting at least one beam of light near said loading station along a path disposed in a position so as to be bound to be interrupted by the operator of the machine while mounting a workpiece on said work support at said loading station and while removing it therefrom, time-responsive means effective to keep said work support stopped for the time necessary for the completion of the longest operation of said tools on said workpiece, said indexing mechanism thereafter normally advancing said work support by one step, said control means including a circuit of which said time-responsive means forms a part and which further includes light-sensitive means in the path of said light beam for normally maintaining said indexing mechanism operative, said circuit further including means rendering the indexing means inoperative to rotate the work support when the beam is interrupted, said circuit rendering the indexing means operative to move the work support when said beam is restored at a time when said time-responsive means is ineffective.

2. In a machine as claimed in claim 1, said beam-emitting means being mounted on said machine at one side of said operator's position, reflecting means mounted on said machine at least at the other side of said operator's position and adapted to reflect said light beam toward said light-sensitive means.

3. In a machine as claimed in claim 1, said beam-emitting means being mounted on said machine at one side of said operator's position, reflecting means mounted on said machine at both sides of said operator's position and offset relative to each other and adapted to reflect said light beam in a zigzag path from one side to the other of said operator's position and finally to said light-sensitive means.

4. In a machine tool having an automatically indexed work support, an indexing mechanism for rotating and stopping said work support step-by-step at several work stations and at a loading station, tools movable toward and from at least one workpiece on said work support for machining said workpiece while said work support is stopped at said work stations, control means for automatically controlling said mechanism comprising means for emitting a plurality of light beams near said loading station along certain paths disposed in a position between said work support and the position of the operator of said machine adjacent to said machine, at least one of said paths being bound to be interrupted by said operator while mounting a workpiece on said work support at said loading station and while removing it therefrom, time-responsive means effective to keep said work support stopped for the time necessary for the completion of the longest operation of said tools on said workpiece, said indexing mechanism thereafter normally advancing said work support by one step, said control means including a circuit of which said time-responsive means forms a part and which further includes a plurality of light-sensitive means in the paths of said beams for normally maintaining said indexing mechanism operative, said circuit further including means rendering the indexing means inoperative to rotate the work support when any of the beams is interrupted, said circuit rendering the indexing means operative to move the work support when said

beam is restored at a time when said time-responsive means is ineffective.

5. In a machine tool having an automatically indexed work support, an indexing mechanism for rotating and stopping said work support step-by-step at several work stations and at a loading station, work-clamping means on said work support, tools movable toward and from said work support for machining a workpiece held by said work-clamping means while said work support is stopped at said work stations, control means for automatically controlling said mechanism comprising means for emitting at least one beam of light near said loading station along a path disposed in a position so as to be bound to be interrupted by the operator of the machine while mounting a workpiece at said loading station in said clamping means and while removing it therefrom, time-responsive means effective to keep said work support stopped for the time necessary for the completion of the longest operation of said tools on said workpiece and during such stop to hold the clamping means open, said indexing mechanism thereafter normally closing the

clamping means and advancing said work support by one step, said control means including a circuit of which said time-responsive means forms a part and which further includes light-sensitive means in the path of said light beam for normally maintaining said indexing mechanism operative, said circuit further including means rendering the indexing means inoperative to close the clamping means and rotate the work support when the beam is interrupted, said circuit rendering the indexing means operative to close the clamping means and move the work support when said beam is restored at a time when said time-responsive means is ineffective.

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