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Edge et al.

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[54] STRUCTURE FOR AND METHOD OF TOOL SELECTION

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[52] **U.S. Cl.** **198/38**

[51] **Int. Cl.** **B65g 43/00**

[58] **Field of Search** ...198/19, 38, 40, 37; 214/11 AS; 29/568

[56] **References Cited**

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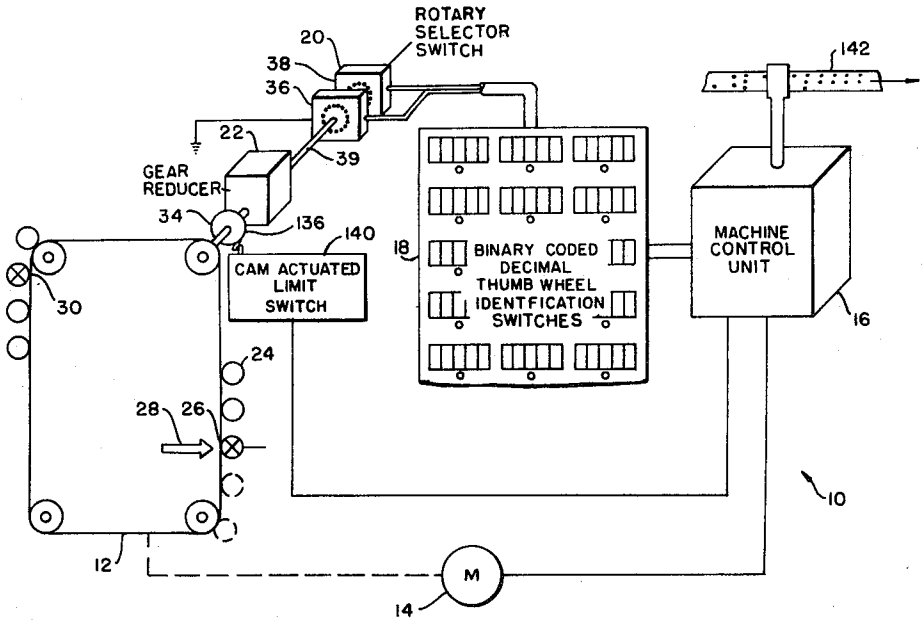
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[57] **ABSTRACT**

Tools having a code number are placed in individual tool positions on an endless conveyor from which they are to be selected. A separate identification switch associated with each tool position on the conveyor is set with a coded number representing the tool in the associated tool position on the conveyor. As the conveyor is moved, selector switch means are closed in accordance with the movement of the conveyor to sequentially qualify identification switches associated with particular tool positions on the conveyor. A light is provided adjacent each identification switch associated with each tool position on the conveyor and the selector switch means includes means for energizing the light adjacent the selector switch qualified thereby. On qualifying the identification switch associated with the position of a desired tool, the conveyor is first slowed and then stopped.

11 Claims, 2 Drawing Figures



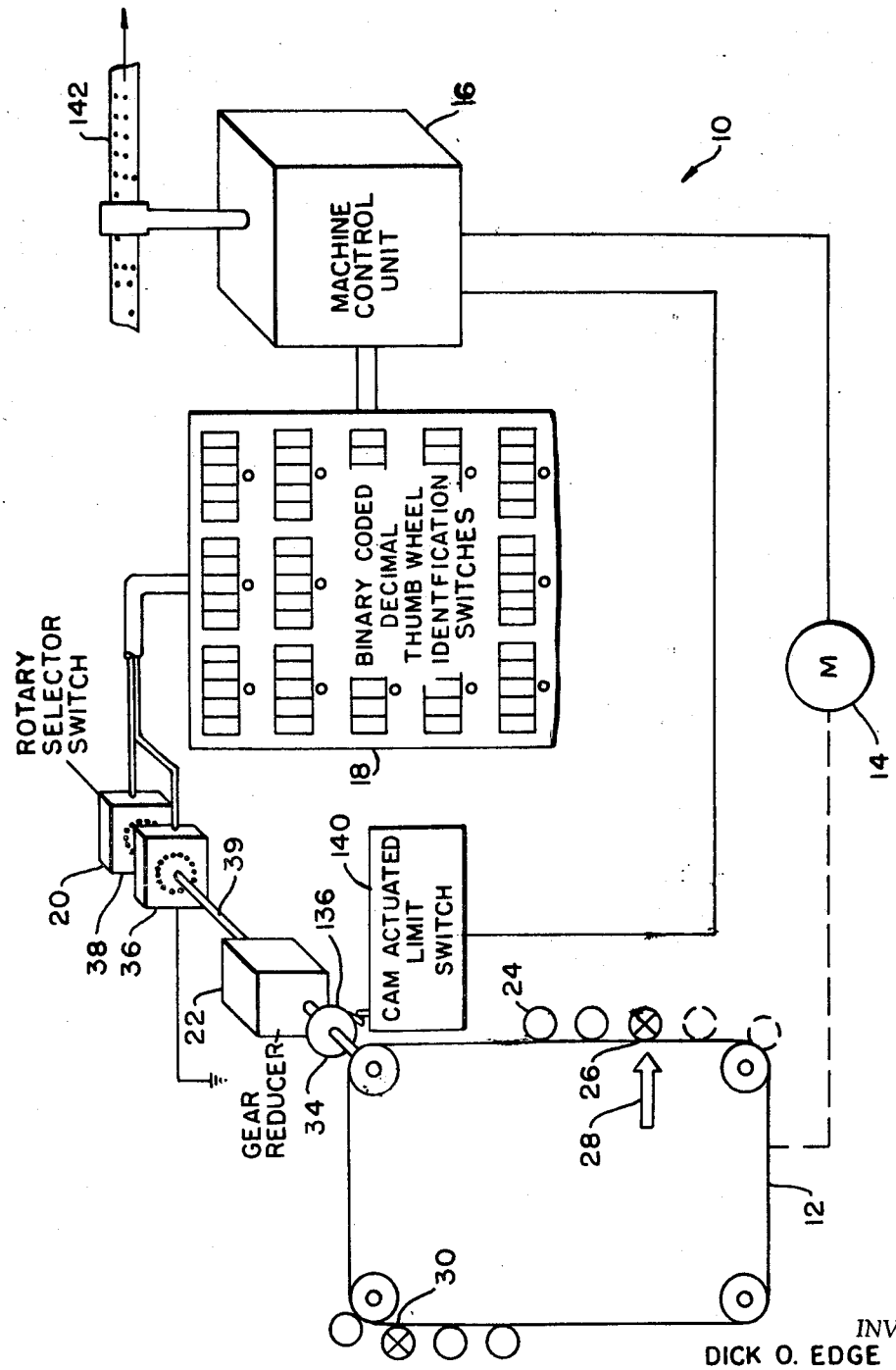


FIG. 1

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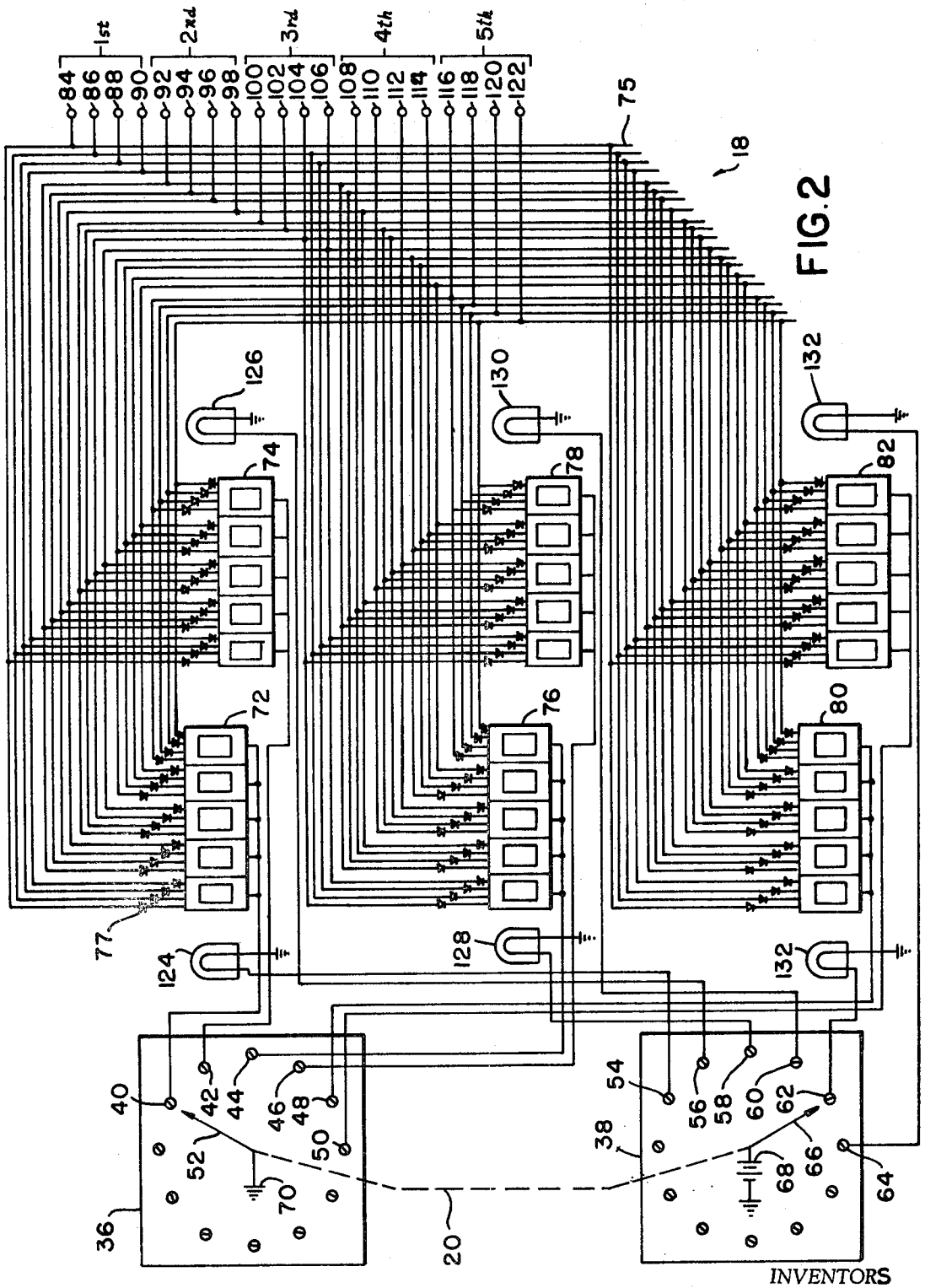


FIG. 2

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STRUCTURE FOR AND METHOD OF TOOL SELECTION

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The invention relates to tool selection and refers more specifically to structure for and a method of automatically selecting a particular tool loaded on an endless conveyor useful in conjunction with tape controlled machine tools and the like.

2. DESCRIPTION OF THE PRIOR ART

In the past automatic tool selection often has been accomplished with the use of tool holders having rings therearound spaced in a coded sequence or individually coded tools. Such structure is disclosed in U.S. Pat. No. 3,052,999 and has been found to be undesirable wherein coded toolholders are used in that on changing a tool in the toolholder, the rings need be changed. Coded tools have different shanks which are difficult to read uniformly and are therefore also undesirable.

A second system of selecting tools for use with automatically controlled machining equipment makes use of a key and a key cartridge. In such systems the key cartridge is coded in accordance with the key placed in the cartridge and the cartridge which is associated with a particular tool pot on a conveyor having tools positioned therein is is read by electronic key cartridge readers. One such system is shown in U.S. Pat. No. 3,173,203. This system has an advantage over the ring system in that the cartridges need not be changed when a tool is changed in a particular tool pot on the conveyor. However, the keys may be lost and particularly accurate alignment which is difficult to obtain in practice is required between the cartridge and readers.

Thus, there has not been available an efficient tool selection method and structure in the past. Further, the structures of the past have been relatively complicated and therefore expensive.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an endless conveyor having a plurality of tool positions thereon which pass in repeated sequence, by a stationary tool load position and a stationary tool pickup position. Tools positioned on the conveyor at the tool load position are provided with an identification number which number is also set in one of a plurality of identification switches associated with the particular tool position on the conveyor at the tool load position.

Light means are provided operably associated with each of the individual identification switches operable to be energized when the associated tool position on the conveyor is in the tool load position to aid setting the tool number positioned on the conveyor in the tool load position on the correct identification switch.

Selector switch means is provided synchronized with the movement of the conveyor and operable to qualify the individual identification switches associated with the tool position on the conveyor moving by the tool pickup position in time to stop the conveyor at the tool pickup position on qualifying the identification switch associated with a tool position having a desired tool thereat.

On qualifying a particular identification switch indicating a tool at the tool pickup position which it is desired to use in a machining operation in accordance with a taped program fed into a machine controller, the machine controller will stop the tool conveyor with the identified tool at the tool pickup position for use.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of tool selection structure constructed in accordance with the invention for performing the method of the invention.

FIG. 2 is a representative schematic diagram of a portion of the tool selection structure illustrated in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the tool selection structure **10** includes an endless tool conveyor **12** which is driven by motor **14** under control of the machine control unit **16**. The tool selection structure **10** further includes the identification switch structure **18**, the rotary selector switch **20** and gear reducer mechanism **22** connected in series between the tool conveyor **12** and machine control unit **16**, as shown best in FIG. 1.

In more detail, the tool conveyor **12** is an endless conveyor having tool positions **24** thereon at which tools (not shown) to be used in a programmed machining operation are positioned. The tool position **26** shown is a load position indicated by the arrow **28** adjacent the conveyor. The tool position **30** is a tool pickup position. The conveyor **12** may be conventional.

Conveyor **12** is driven by motor **14** responsive to the machine control unit **16** at a relatively high rate of speed and may be stopped rapidly to exactly align a tool position **24** on the conveyor in the stationary tool pickup position **30** in response to an electronic command to the motor **14** from the machine control unit **16**.

The gear reducer structure **22** is such that the output shaft **39** therefrom makes one complete revolution for one complete revolution of the continuous conveyor **12**. The gear reducer **22** is actuated in synchronization with the conveyor **12** through the shaft **34** which makes one revolution between each tool position **24** on the conveyor **12**.

The rotary selector switch **20** which is shown better in FIG. 2 has two separate sections **36** and **38**. Each section **36** and **38** of the selector switch **20** has a plurality of individual contacts thereon and a wiper arm rotatable between each of the contacts in break-before-make operation rotated by the shaft **32**.

Thus, the switch section **36** includes the contacts **40**, **42**, **44**, **46**, **48** and **50** and the rotating wiper arm **52**. Similarly, the switch section **38** includes the separate contacts **54**, **56**, **58**, **60**, **62** and **64** and the wiper arm **66**. As illustrated, additional contacts as for example a total of 32 contacts may be provided on both the switch sections **36** and **38**.

The wiper arm **52** of the section **36** of the rotary switch **20** is connected directly to ground **70** as indicated. The wiper arm **66** of switch section **38** is connected through a source of electrical energy as for example 6.3 volts **68** to ground **70**.

In operation, the switch **20** is synchronized with the tool conveyor **12** so that one contact is associated with each tool position on the conveyor **12**. The wiper arms **52** and **66** are rotated together, with the wiper arm **52** always associated with a tool position on the conveyor **12** at the tool pickup position **30** and with the wiper arm **66** always associated with a tool position on the tool conveyor **12** at the tool load position **26**. Consequently, the wiper arms **52** and **66** are always angularly separated by a number of selector switch contacts equal to the number of tool positions on the conveyor from the stationary tool load position **26** to the stationary tool pickup position **30**.

The section **36** of rotary selection switch **20** is provided to qualify the particular identification thumb wheel switch in the identification switch structure **18** associated with a tool position on the conveyor in the tool pickup position. The section **38** of the switch **20** is provided to light the light on the identification switch structure **18** associated with the thumb wheel switch associated with the tool position on the conveyor **12** in the tool load position. The identification switch structure **18** includes a thumb wheel switch associated with each tool position on the conveyor **12**. Six of these switches are particularly illustrated in FIG. **2**, although it will be understood that the invention is not limited to any particular number of positions on the conveyor **12** or any particular number of thumb wheel switches, just as it is not limited in the number of contacts in the rotary selector switch **20**. Thus, additional thumb wheel switches may be connected through conductors **75** to the identification switch structure **18**.

Each of the thumb wheel switches **72, 74, 76, 78, 80,** and **82**, as illustrated in FIG. **2**, are in binary coded decimal configuration and thus have 20 output leads extending therefrom in parallel and connected to the 20 output leads **84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120,** and **122** which connect with the machine control unit **16**. In each thumb wheel switch the first four conductors provide a binary coded ten thousands position or first identification number; the second four conductors provide a second binary coded identification number associated with the thousands digit; and the third, fourth, and fifth grouping of four output conductors provide a binary coded decimal third identification number or hundreds digit, fourth identification number or tens digit and fifth identification number or units digit, respectively.

Similarly, the output signals on the twenty conductors between the identification switch structure **18** and the machine control unit **16** are divided into five groups, each associated with a digit in a tool identification number which is in a binary coded decimal form. Thus, the conductor **84** is provided with a one signal, the conductor **86** is provided with a two signal, the conductor **88** is provided with a four signal and the conductor **90** with an eight signal. Therefore, in accordance with the binary coded decimal system and depending on whether or not there is a signal on the individual conductors **84, 86, 88** and **90**, a number from 0 to 9 may be represented as a first digit. Similarly, a number from 0 to 9 may be represented as a second, third, fourth and fifth digit on the other groupings of four conductors passing between the identification switch structure **18** and the machine control unit **16**.

Each of the thumb wheel switches including the switches **72, 74, 76, 78, 80,** and **82** as indicated above are connected in parallel and are isolated from the other switches by diodes **77** integral with the twenty individual conductors coming from each of the switches. Thus, the output conductors **84** through **122** are used alternatively by the thumb wheel switches on grounding of the particular thumb wheel switches by the wiper arm **52** of the selector switch **20**.

The energizing power for the thumb wheel switches in the identification switch structure **18** is provided from the machine control unit **16** but may be provided in some installations directly from the wiper arm **52** in which case the ground will be provided in the machine control unit **16**.

Thus, in operation as the wiper arm **52** wipes the contact **40**, the identification switch **72** is connected to the machine control unit **16** through the conductors **84** to **122** and the machine control unit **16** can interrogate the switch **72** to determine which tool is in the tool position on the conveyor at the tool pickup position **30**. If the tool is not the tool desired by the machine control unit **16**, the wiper arm **52** continues to the next contact **42** and the identification switch **74** is grounded to permit interrogation of switch **74** by the machine control unit **16**. Interrogation of the individual identification switches is continued by the machine control unit **16** until a desired tool identification number is found in one of the identification switches at which time the machine control unit stops the motor **14** and therefore the tool conveyor **12** with the identified tool in the tool pot at the tool pickup position.

The setting of the identification switches such as **72** through **82** is accomplished by moving the conveyor **12** to position an empty tool position on conveyor **12** adjacent the arrow **28** at the tool load position **26**, placing a desired tool which may have a five-digit identification number etched thereon in the empty tool position and setting the identification switch corresponding to the tool position on conveyor **12** in the position **26** to the number etched on the tool placed in the tool position.

The thumb wheel switches, which are a common article of commerce, are manually set by means of a separate thumb wheel for each decimal digit. Each decimal digit position is connected to four binary coded decimal output conductors and the output conductors for all five digit positions in each thumb wheel switch such as the thumb switches **72** through **82** are connected in parallel to the twenty output conductors **84** through **122**. Each thumb wheel switch is isolated from the others by separate diodes **77** in each of the output conductors thereof as indicated in FIG. **2**.

To aid in selecting the thumb wheel switch associated with a particular tool position on conveyor **12** at the tool load position **26**, a separate light is positioned by each identification thumb wheel switch on the identification switch structure **18** which will be lit only when the particular tool position associated therewith is in the tool load position **26**.

The lights **124, 126, 128, 130, 132,** and **134** associated with the identification switches **72, 74, 76, 78, 80,** and **82**, respectively, are illustrated best in FIG. **2**. As shown, each light is connected to ground at one side and to one of the terminals **54, 56, 58, 60, 62,** and **64** of section **38** of the selector switch **20** on the other side. As the wiper arm **66** of the section **38** of the rotary

switch 20 wipes past each contact, the light connected thereto will be energized with the energy from the power source 68. It is thus substantially impossible for the identification number of a tool placed in a tool position on conveyor 12 at the position 26 to be set in an identification thumb wheel switch which is not associated with the particular tool position in which the tool is placed.

In the present system, when a desired tool is first recognized in a tool position 24 at position 30, the motor is slowed to approximately one-tenth of its original speed after which the cam wheel 136 on shaft 34, driven by the conveyor 12 closes the limit switch 140 when the tool position having the recognized tool therein is exactly located. The proximity detector including the cam wheel 136 and limit switch 140 is arranged to be effective only after the machine control unit 16 has recognized a tool position having a required tool therein at the tool pickup position 30, as will be understood by those in the art.

There is a complete revolution of the cam wheel 136 as the conveyor 12 moves from tool position to tool position. That is to say, if there are 32 tool positions 24 on the conveyor 12, cam wheel 136 will make 32 complete revolutions as the conveyor 12 makes one revolution. Moreover, the shaft 34 will make 32 complete revolutions into the gear reducer 22 as the conveyor 12 makes one revolution. The output shaft 39 will only make one revolution for one complete revolution of the conveyor 12.

In overall operation of the tool selection structure 10, the tools required for a particular machining operation are positioned in the tool positions 24 on conveyor 12 as indicated above by sequencing the positions 24 past the position 26 and placing a separate tool in each tool position at the position 26 and setting the code number etched on the tool in a separate identification thumb switch in the identification switch structure 18 associated with an energized light on the switch structure.

A tape 142 or other structure which may be a numerical control computer, providing a machining program is read by the machine control unit 16 and the motor 14 is started which turns the conveyor 12. From the control tape 142, or other structure, the machine control unit will be provided a code number for a tool which it is desired to select at the station 30 to perform an initial machining operation. As the conveyor is rotated, the wiper 52 wipes past each of the contacts on the rotary switch section 36 to interrogate each of the identification thumb wheel switches in turn.

When an identification switch is found which has a number set therein corresponding to the number of the tool required by the machine control unit and which may be determined by a comparator in the machine control unit into which the number from the tape 142 and the number from the identification switches are fed, the machine control unit will provide an output signal to the motor 14 which will indicate that the tool position or conveyor 12 having the required tool therein is at the position 30. The motor 14 will then be slowed and when the cam wheel 136 indicates exact location of the selected tool position at the position 30 on closing the limit switch 140, the motor 14 will be stopped to stop the conveyor 12.

The tool in the tool position 30 is then used in a machining operation by the machine associated with the tool selection structure 10 and may subsequently be replaced on the conveyor at the position 30. The tape 142 will then move to a new tool selection number and the conveyor will again start to rotate the rotary switch 20 in synchronism therewith one rotation of the switch for one rotation of the conveyor as indicated above and a new tool will be selected for a second machining operation. This procedure will continue until the complete machining program has been accomplished.

The disclosed method of coded tool selection has a number of advantages over previously known structures for and methods of coded tool selection. Thus, no rings or keys are required which need be replaced as different tools are placed in the tool positions 24 and no critical alignment problems are presented with the structure of the invention. Further, since all switches are sealed, there are no problems of contacts becoming contaminated with oil or dirt during operation with the structure disclosed.

While one embodiment of the present invention has been considered in detail, it will be understood that other embodiments and modifications are anticipated by the inventors. For example, any type of signal can be used with the system disclosed herein, and the signal can be applied to the wiper arms of the rotary selector switch directly if desired. In addition, by changing the coding of the thumb wheel switches, a binary, decimal or binary-plus-3 or any other coding scheme can be used in the coding of the identification switch structure. Also it will be understood that a photoelectric proximity device or other light or laser means may be used to signal the position of the conveyor 12 and that other identification devices than the thumb wheel switches indicated may be used to identify the tool positions on conveyor 12. It is the intention to include all such embodiments and modifications as are defined by the appended claims within the scope of the invention.

What we claim as our invention is:

1. Tool selection structure comprising a conveyor having a plurality of tool positions thereon for receiving tools which tools have separate tool code numbers, means for moving the conveyor to pass each of the conveyor tool positions through a tool load and at least one tool pickup position, identification means for identifying each tool position on the conveyor, selector means operably connected between the conveyor and identification means for activating the particular identification means associated with any tool position on the conveyor at the one tool pickup position and means for comparing a desired tool code number and the tool code number of the tool in the tool pickup position from the associated selector means and means for stopping the conveyor with a desired tool at the tool pickup position in response to identity between the code of the tool at the tool pickup position and the desired tool.

2. Structure as set forth in claim 1 wherein the identification means for identifying the tool in each tool position on the conveyor comprises a separate binary coded decimal thumb wheel switch operably associated with each of the tool positions on the conveyor.

3. Structure as set forth in claim 2 and further including means for indicating at the identification means the particular switch associated with each tool position to reduce the possibility of setting an identification switch other than that associated with a particular tool position on the conveyor with the code number of the tool in the particular tool position.

4. Structure as set forth in claim 1 wherein the means for actuating each of the identification means as the tool position associated therewith passes into the tool pickup position on the conveyor comprises a selector switch driven in synchronism with the conveyor.

5. Structure as set forth in claim 1 wherein the means for stopping the conveyor with a desired tool at the tool pickup position includes a cam actuated limit switch and a cam rotated in synchronism with the conveyor for closing the limit switch each time a tool position on the conveyor is in the tool pickup position.

6. The method of tool selection comprising placing a tool having a code number in a tool load position on a conveyor, setting the code number of the tool on an identification switch operably associated with each of the tool positions on the conveyor, moving the conveyor to move the tool positions thereon sequentially through at least one tool pickup position and sequentially activating the identification switches as the tool positions associated therewith are sequenced through the one tool pickup position and stopping movement of the conveyor when the identification switch associated with a desired tool is activated.

7. The method as set forth in claim 6 and further including positively identifying the particular identification switch associated with a tool on the conveyor at the tool load position.

8. The method as set forth in claim 6, wherein the identification switches are thumb wheel switches and wherein each switch is set with a decimal code number etched on the tool placed in the tool position on the conveyor at the tool load position.

9. The method as set forth in claim 6 wherein the means for sequentially qualifying the identification switches is a selector switch and further including driving the selector switch in synchronism with the conveyor one rotation for each rotation of the conveyor.

10. Tool selection structure comprising a conveyor having a plurality of tool positions thereon for receiving tools, means for moving the conveyor to pass each of the conveyor tool positions through a tool load and at least one tool pickup position, identification means for identifying each tool position on the conveyor including a separate binary coded decimal thumb wheel switch operably associated with each of the tool positions on the conveyor and selector means operably connected between the conveyor and identification means for activating the particular identification means associated with any tool position on the conveyor at the one tool pickup position.

11. Tool selection structure comprising a conveyor having a plurality of tool positions thereon for receiving tools, means for moving the conveyor to pass each of the conveyor tool positions through a tool load and at least one tool pickup position, identification means for identifying each tool position on the conveyor and selector means operably connected between the conveyor and the identification means for activating the particular identification means associated with any tool position on the conveyor at the one tool pickup position including a selector switch driven in synchronism with the conveyor.

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