

Dec. 29, 1964

W. C. GLEISNER, JR

3,163,291

TWIN READER TOOL IDENTIFYING APPARATUS

Filed Oct. 1, 1962

4 Sheets-Sheet 1

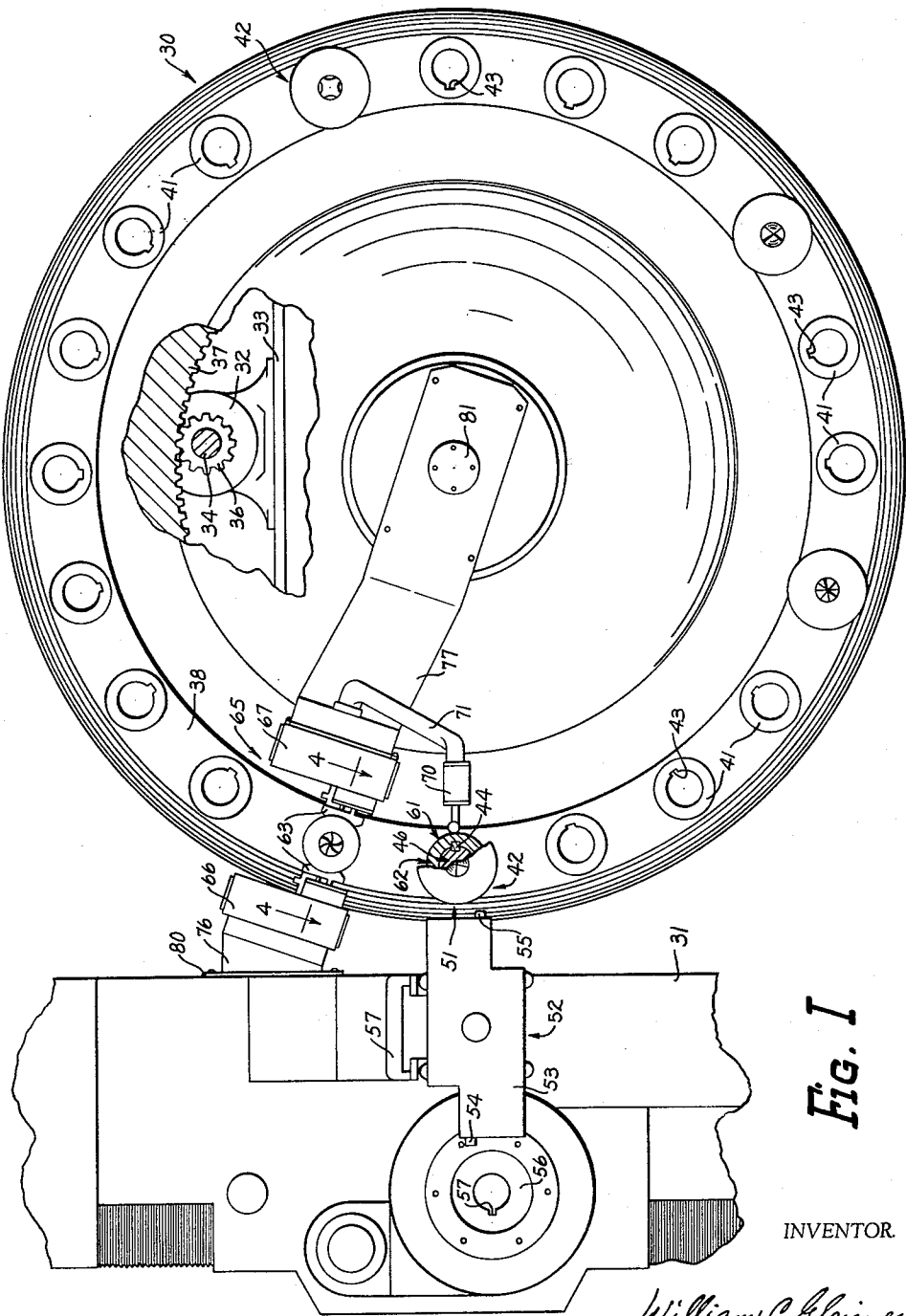


Fig. 1

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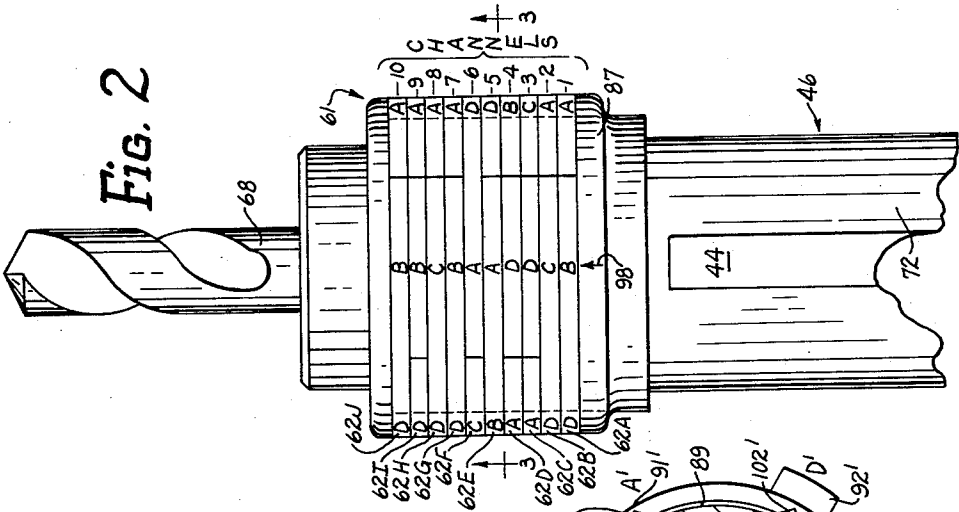
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TWIN READER TOOL IDENTIFYING APPARATUS

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4 Sheets-Sheet 2



TOOL NO. 732,302												
DEACTUATED		0		0	0				0			
ACTUATED	1	1		1		1			1			
SWITCH	110-11	110-12	110-13	110-14	110-15	110-16	110-17	110-18	110-19	110-20		
CODE PORTION	C	C	B	C	A	A	D	D	B	C		
IDENTIFIER	62J	62I	62H	62G	62F	62E	62D	62C	62B	62A		
CHANNEL	10	9	8	7	6	5	4	3	2	1		
CODE PORTION	B	B	C	B	A	A	D	D	C	B		
SWITCH	110-10	110-9	110-8	110-7	110-6	110-5	110-4	110-3	110-2	110-1		
ACTUATED			1				1	1	1			
DEACTUATED	0	0		0	0	0				0		
										READING HEAD 66		
										OPPOSITE CODE PORTION		
										CHANNEL		
										READING POSITION		
										READING HEAD 67		

Fig. 6

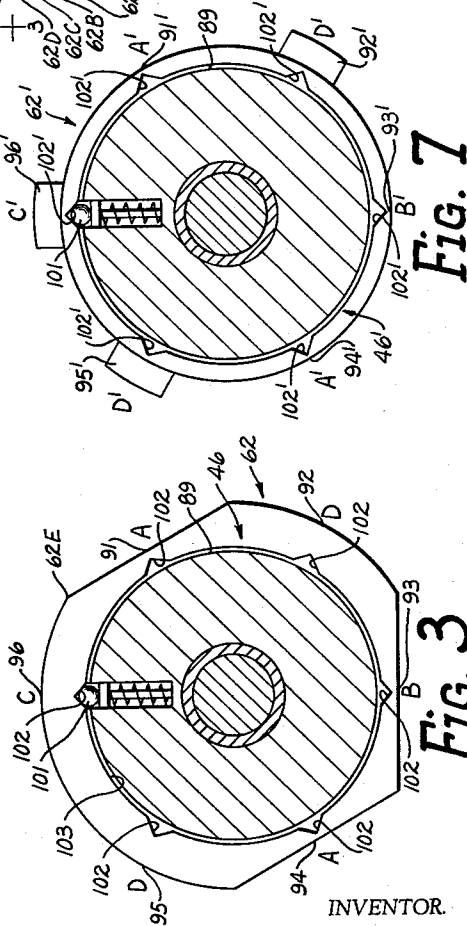


Fig. 7

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TWIN READER TOOL IDENTIFYING APPARATUS

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4 Sheets-Sheet 4

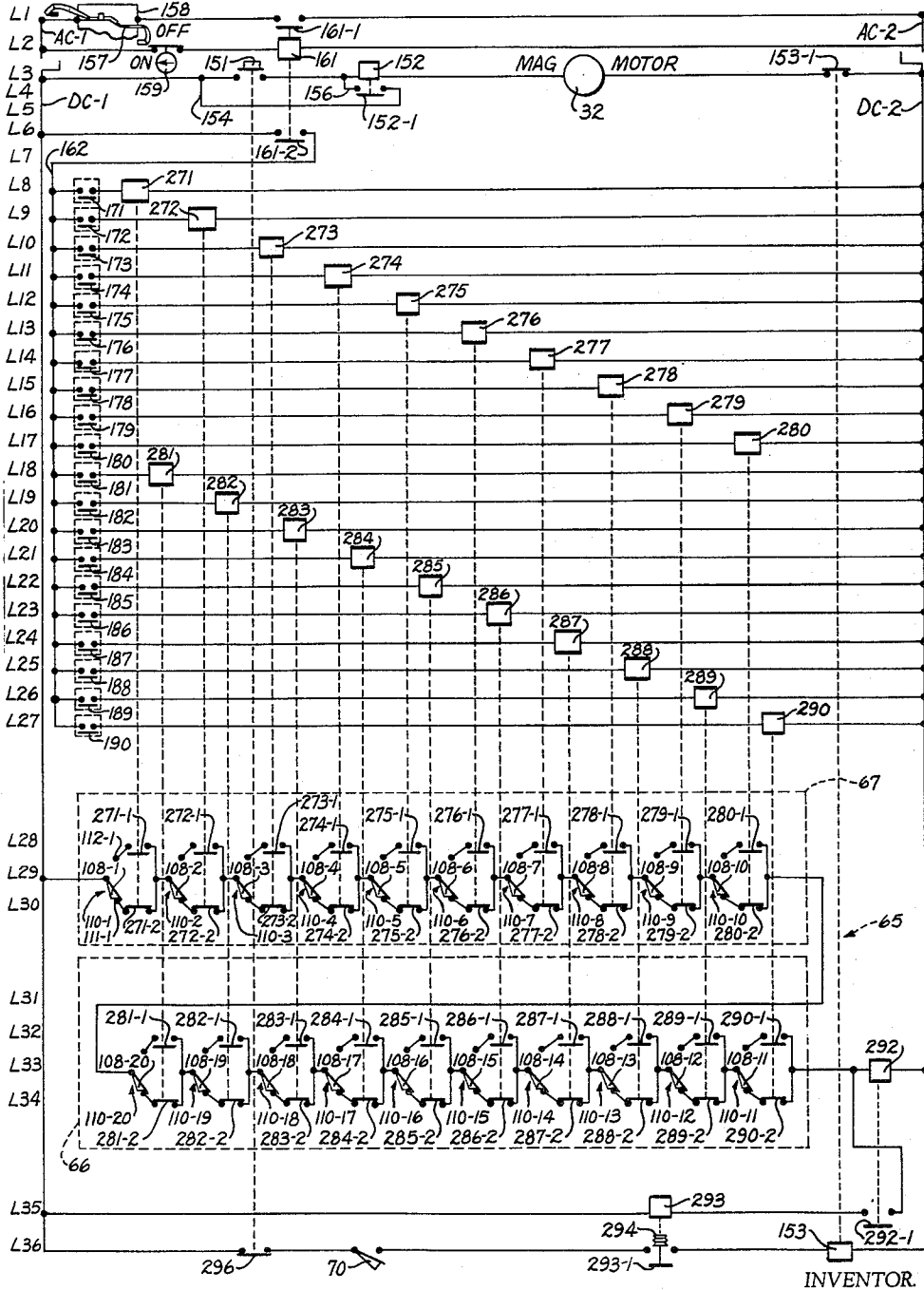


Fig. 8

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3,163,291
TWIN READER TOOL IDENTIFYING APPARATUS
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 a corporation of Wisconsin
 Filed Oct. 1, 1962, Ser. No. 227,464
 25 Claims. (Cl. 211-1.5)

The present invention relates to an improved apparatus for identifying a desired tool from a plurality of tools and effecting the positioning of the identified desired tool at a tool ready station remotely located relative to the position at which the tool is identified.

A general object of the present invention is to provide an improved tool selection apparatus with improved tool identification means.

Another object of the present invention is to provide an improved apparatus for effecting selectively indexing movement of a movable member to a predetermined position.

Still another object of the present invention is to provide an improved tool selector mechanism capable of individually identifying the individual tools of a great number of tools.

Yet another object of the present invention is to provide an improved tool selector mechanism which is remotely positioned relative to the position in which it is desired that the selected tool will be located.

Another object of the present invention is to provide a toolholder having coded identifying members which are adjustable thereon for effecting a predetermined coded setting of the identifying members for identifying any particular tool of a large number of different tools.

A further object of the present invention is to provide a tool retaining holder having permanently mounted coded tool identifying members thereon which are all of the same structural configuration and arranged to be selectively adjustable for establishing a great number of coded configuration settings so as to identify any tool of a large number of different tools.

A still further object of the present invention is to provide an improved tool selector apparatus having a tool identifying mechanism which is remotely positioned relative to a tool ready station in which a selected desired tool is to be located so as to simplify the construction and operation of the tool identifying mechanism.

Other objects and advantages of the present invention will become apparent from the following description of the invention and illustrated in the accompanying drawings, in which:

FIGURE 1 is a view in front elevation of a portion of a machine tool having a rotatable tool storage magazine, a tool change mechanism and a rotatably driven tool receiving spindle together with a tool selector apparatus which is operative to identify each tool removably carried in the magazine for indicating a desired tool which is to be located at a tool ready station adjacent the tool change mechanism;

FIG. 2 is a plan view of a toolholder showing a plurality of coded actuators associated with the tool, with the actuators being adjusted to a particular setting for identifying the particular tool carried in the toolholder;

FIG. 3 is a view in transverse section through the toolholder, taken along the plane represented by the line 3-3 in FIG. 2, illustrating the structural configuration of an identifier;

FIG. 4 is an enlarged detail view in transverse section through the tool selector apparatus and a toolholder, taken along the plane represented by the line 4-4 in FIG. 1;

FIG. 5 is a view in front elevation of one of the twin selector mechanisms shown in FIG. 4 with parts broken

away to reveal the operating mechanism and a portion of the selector control means;

FIG. 6 is a chart showing the particular settings of each coded identifier and the condition of the binary code representation for the particular setting of the individual identifiers with the binary code representation indicating the "off" or "on" condition of the associated switches of each unit of the selector apparatus;

FIG. 7 is a view similar to FIG. 3 showing a modified form of the actuating identifier shown in FIG. 3; and,

FIG. 8 is a diagrammatic view of the electrical control circuit for selecting the desired tool for location at the tool ready station.

In accordance with present production methods, it is the practice to effect a number of changes of different types and sizes of tools in a single machine tool to cut the cost of manufacture and expedite production. Prior apparatus is known which effects such changes automatically and in which a plurality of different tools are carried in a magazine that is rotated to move each tool successively to a tool ready position. In the prior apparatus, the tool which is desired to be positioned at the tool ready station is identified at the tool ready station by a selector mechanism located thereat. With the identified desired tool located at the ready station, the tool or the selector mechanism must be moved to effect disengagement therebetween for the subsequent withdrawal of the tool from the magazine. This requires complex mechanism which is located adjacent to the tool ready station at which a tool change will be effected and restricts and encumbers a vital area of the machine. Also, in the prior apparatus, in identifying each tool, a plurality of coded identifiers are used and are associated with the tool. To change the coding it is necessary to disassemble the coding and reassemble a new coding arrangement, all of which is time consuming and somewhat complicated.

According to this invention, a twin reader selector mechanism is provided and located remotely of a tool ready station in a fixed position to identify each of a plurality of coded tool structures stored in a relatively movable magazine. Identification of a tool structure involves an intermeshing engagement between a code structure carried by each tool structure and code actuating means carried by the selector mechanism precluding axial withdrawal of the selected tool structure. When a desired tool structure has been selected by the remotely positioned selector mechanism, movement of the magazine is continued until the selected tool structure is located at the ready station. At this time, a signal is produced to stop magazine rotation. Thus, there is no need to effect relative movement between the selector mechanism and the selected tool structure to effect disengagement therebetween as disengagement is accomplished in the course of moving the identified selected tool structure into the ready station. Thus, the ready station is not encumbered with additional mechanism and the selector mechanism itself is simplified thereby materially reducing the cost of manufacturing and simplifying the operation. In conjunction with the improved tool selection apparatus, an improved coding structure for identifying the individual tool structures is provided. Such improvement includes a plurality of coded identifier members of the same structural configuration having a plurality of coded portions of different numerical values. The identifiers are adjustably affixed to the tool structure for selective adjustment without removal to transpose positions relative to each other and to the tool structure in a code reading position to constitute an identifying structural configuration for identifying the associated tool structure. As a result of the selective adjustment of the identifiers, each present two angularly spaced, axially extending code configured portions, respectively operative to actuate spaced apart twin readers,

When a tool structure is altered, the identifying members need only be adjusted to a new setting relative to each other and to the tool structure to effect a different structural configuration for identifying the new tool structure. The term tool structure is a generic expression which applies to a tool with coding or a coded toolholder carrying a tool. However, hereinafter, either the word toolholder or tool will be used interchangeably for descriptive purposes.

Referring now to the drawings and particularly to FIG. 1 thereof, the present invention is illustrated in conjunction with a power driven tool storage magazine 30 having a rotatable member 38 that is supported for rotation on a frame portion 31 of a machine tool. Rotation of the magazine member 38 is accomplished by the operation of a motor 32 located behind the magazine and fixedly supported on a bracket 33 that is securely fastened to a portion of the machine frame. Power is transmitted from the motor 32 via a motor drive shaft 34 and a pinion 36 to an internal ring gear 37 which is secured to the rotatable member 38 of the magazine 30 in a well-known manner.

The rotatable member 38 of the magazine 30 is provided with a plurality of spaced apart tool storage sockets 41, the axes of which are disposed in parallelism with the axis of rotation of the rotatable member 38 of the magazine. Each socket 41 is adapted to removably support a tool 42 and is provided with a keyway 43 adapted to be engaged by a key 44 secured to a toolholder, such as the holder 46. It is noted that the keyway is always positioned in like angular relationship to the bore of the socket and in a plane extending radially from the axis of magazine rotation.

The magazine 30 is movable to position the selected tool at a tool ready station 51 at which a selected tool 42 is adapted to be located for a tool change operation. Operatively disposed adjacent the tool change ready station 51 is a tool change mechanism 52 having a tool change arm 53 provided with oppositely disposed extensible tool grips 54 and 55. The change arm 53 is supported in a forwardly extending support member 57 for rotational and translational movements. The tool change arm is operative to engage a preselected tool 42 located in the tool ready station 51 and a tool [not shown] adapted to be carried by an operating spindle 56 of the machine. Thereafter, the tool change mechanism is operable to effect an interchange of the two tools to place the previously used tool extracted from the spindle into the socket of the magazine located at the tool change ready station while simultaneously placing the new tool removed from the socket at the ready station into operative engagement in the spindle. The method and structure utilized to operate the tool change mechanism for effecting a tool change is fully disclosed in a patent application to Sedgwick et al., entitled "Machine Tool With Tool Changer," Serial No. 181,226, filed March 13, 1962.

As previously mentioned, each tool 42 in the magazine 30 is provided with a key 44 which is engageable with the keyways of the storage sockets 41. When a tool interchange is effected, the grips 54 and 55 of the tool change arm 53 are extensibly operable to grip the tools with sufficient force to preclude angular displacement of the tools therein. Thus, the keys 44 carried by the toolholders are engageable with a keyway 57 provided in the working spindle 56. To this end, the spindle is positioned in the proper angular position prior to initiating a tool change cycle, so that the keyway 57 presented thereby is angularly orientated in position to receive the cooperating key fixed to the toolholder of the tool about to be inserted therein. The details of the controls for effecting the angular positioning of the spindle in proper angularly orientated position with respect to the keyway carried by the storage socket located at the tool ready station are fully set forth in the aforementioned patent application to Sedgwick et al.

For selecting the desired tool to be located at the tool change ready station, each of the toolholders 46 is provided with a coded collar 61. As will hereinafter be more fully explained, the collar 61 is provided with a plurality of coded identifier members 62 to provide a different binary code signal for each of the toolholders. Thus, the identifier members 62 provide a binary code signal to actuate radially movable switch actuating fingers 63 carried by a selector or tool indicator mechanism 65 comprising two identical readers 66 and 67.

In the even the numerical control system provides an input signal calling for a tool, such as a drill 68, FIGS. 2 and 4, the motor 32 will be caused to operate to drive the member 38 of the magazine 30 in its rotational movement thereby moving the tools successively past the twin reader heads 66 and 67 of the selector mechanism 65. As each tool 42 moves into position between the readers 66 and 67 of the selector mechanism 65, the coded identifier members 62 engage the switch actuating fingers 63 of the readers. During this interval, the switch fingers 63 intermeshingly engage the coded identifiers 62, as shown in FIG. 4, in such a manner as to preclude axial withdrawal of the toolholder either manually or by automatic means.

When the desired tool is moved into engagement with the switch actuating fingers of the selector mechanism 65 to move them in the proper combination to thereby actuate associated switches of the selector mechanism in the proper combination, which represents the same number that has been impressed upon an electrical designation circuit of the electrical control system, coincidence between the designation circuit and the selector circuit of the control is obtained. When coincidence occurs, an electrical circuit in the control system is conditioned so that when the selected tool arrives at the tool ready station 51, the selected tool will effect the stopping of the rotational movement of the magazine member 38 and the selected tool will be located in the tool ready station 51.

After the readers identify the drill 68, to establish coincidence in the control system, the magazine 30 will continue to operate until the identified drill 68 is positioned at the tool ready station 51. The particular selected tool identified by the coincident actuation of the readers 66 and 67 upon arriving at the tool ready station will actuate a switch 70 mounted on a bracket 71 and positioned at the tool ready station 51. The switch 70, upon being actuated by the particular selected tool subsequent to coincidence obtained in the control system, will operate to effect the interruption of the operation of the magazine motor 32 and thereby stop rotation of the magazine member 38 with the selected tool located in the tool ready station 51.

The tool identifying or selector mechanism 65 comprises two identical components or readers 66 and 67, as previously mentioned, which are supported in facing spaced relationship on brackets 76 and 77, respectively. The bracket 76 on which the reader 66 is supported, is rigidly secured to the side of an upstanding column 80 of the machine. On the other hand, the bracket 77 on which the reader 67 is supported, is secured to the stationary shaft 81 on which the magazine member 38 is rotatably supported. Thus, both readers 66 and 67 of the selector mechanism 65 are fixedly supported in operative spaced apart facing relationship on either side of the path of travel of the tools carried by the storage magazine.

As shown in FIG. 4, a toolholder 46, preferably of cylindrical configuration, is adapted to receive and securely hold a tool, such as the drill 68. The rearward portion 72 of the tool holder 46 is of cylindrical form that is receivable in the operating spindle 56 of the machine in predetermined angular relationship so that the key 44, provided on the rear portion of the toolholder, is engaged in the keyway 57 provided in the bore of the spindle 56. As previously mentioned, the holder 46 includes the coded collar 61 which is formed as an enlarged

cylindrical forward portion 84 provided at its forward end with threads 86, as shown in FIG. 4. A circumferential flange 87, having a machined front face 88, is provided on the enlarged portion 84 of the toolholder at the inner end thereof. Forwardly of the flange 87, the enlarged portion 84 of the holder is provided with a machined cylindrical surface 89 providing for ten channels or spaces which receive the several code identifiers 62. The identifiers 62 for each individual tool comprises ten rings which are adjustably disposed on the machined cylindrical surface 89 of the holder and constitute actuators and identifying means. The channeled positioned identifiers on the toolholder 46, as shown in FIG. 2, serve to identify the size and type of the particular tool 42, which in the present instance, is a drill 68 of a particular size.

The exemplary embodiment provides a coding based on the binary numbering system in which each digit of the binary number is either a "0" or "1," as represented by the "off" or deactuated condition of an electrical switch, or the "on" or actuated condition of the switch, respectively, in this description. The illustrated toolholder 46, as previously mentioned, is provided with ten channels on the cylindrical surface 89 when each channel representing two digits of the binary numbering system. That is, the first channel that is farthest from the tool, as viewed in FIGS. 2 and 4, represents the first and twentieth digit of the binary numbering system, while the tenth channel, which is nearest or adjacent the tool, represents the tenth and eleventh digits of the binary numbering system. The remaining channels likewise each represents two digits of the binary numbering system. Thus, the second channel represents the second and nineteenth digits of the binary numbering system; the third channel represents the third and eighteenth digits; the fourth channel represents the fourth and seventeenth digits; the fifth channel represents the fifth and sixteenth digits; the sixth channel represents the sixth and fifteenth digits; the seventh channel represents the seventh and fourteenth digits; the eighth channel represents the eighth and thirteenth digits; and, the ninth channel represents the ninth and twelfth digits. This proper coding for identifying the particular drill 68 in the toolholder 46 is established by rotating each identifier or actuator 62 into a code reading position on the holder 46.

The series of identifiers 62 are retained in abutting face to face relationship on the cylindrical surface 89 by means of an internally threaded clamping ring 90 engaged on the threaded portion 86 of the enlarged portion 84 of the holder. Thus, when the proper coding for identifying the particular tool held in the holder has been established, the clamping ring 90 is tightened on the threaded portion 86 to clamp the identifiers between itself and the face 88 of the flange 87. When a different identification coding is to be selected, the clamp ring 90 is backed off slightly to release the clamping force on the identifiers 62 and the identifiers are then rotated to a different code reading setting to establish the proper coding. Thereafter, the clamp ring 90 is again tightened to clamp the identifiers in their selected settings. With this arrangement, there is never any need to remove the identifiers from the holder for the purpose of establishing different code settings. The twenty digits of the binary numbering system represented by the ten channels on the cylindrical surface 89 provide for all numbers up to 1,048,575 so that 1,048,575 different tools can be identified by 1,048,575 different combinations of code settings. Under this arrangement, the binary number

00000000000000000001

will identify tool No. 1, while the binary number

11111111111111111111

will identify tool No. 1,048,575.

Each identifier 62 is of identical configuration and one of the identifiers is shown in detail in FIG. 3. As shown in FIG. 3, the identifier 62 is generally ring shaped having six coded peripheral portions 91, 92, 93, 94, 95

and 96. The code portions 92, 95 and 96 are arcuate in profile, while the code portions 91, 93 and 94 present flat or straight line profiles. The arcuate portions 92, 95 and 96 extend different radial distances from the toolholder axis than the flat portions 91, 93 and 94. As shown, code portions 92 and 95, which present arcuate profiles, are directly opposite each other and serve respectively to designate the numeral "1" in the binary system. The code portion 96, which also presents an arcuate profile and which is to the right of the code portion 95, as viewed in FIG. 3, also serves to designate the numeral "1" in the binary system. The code portions 91, 93 and 94 serve respectively to designate a "0" in the binary system. As shown, the code portions 91 and 94 are directly opposite each other, while the code portion 93 is directly opposite the code portion 96. Thus, each identifier member 62 is formed so as to present four different pair combinations of binary number representations when the identifier is positioned into a code reading position relative to the holder 46. Such positions are: (1) a double designation of the binary numeral "1"; (2) the double designation of the binary numeral "0"; (3) the representation of the binary numeral "1" and the binary numeral "0"; and, (4) the representation of the binary numeral "0" and the binary numeral "1."

The selective angular adjustment of identifying members 62 into code reading position is made by manually rotating the identifiers relative to the holder to align selective code portion of each identifier with a code reading position indicator mark, such as an arrow 98 formed on the peripheral surface of the flange 87, as shown in FIG. 2. The code reading position indicator arrow 98 is formed on the flange 87 and is aligned with the key 44, hence radial with respect to the axis of the magazine 30, as are the readers 66 and 67, with their respective groups of switch fingers facing radially inward on opposite sides of the circular toolholder path of travel. Thus, when holder 46 is disposed within a tool storage socket of the magazine and that particular socket is located between the readers 66 and 67 of the selector mechanism 65, the code portions of the identifiers that are in alignment with the arrow 98 will be disposed so as to actuate associated fingers 63 of the reader 67, while the opposite code portions of the identifiers will actuate the opposite associated fingers 63 of the reader 66.

To simplify the selective adjustment of the identifiers 62 into code reading position, the code portions 91 to 96, inclusive, of the identifiers are provided with identifying indicia, as shown in FIGS. 2 and 3. To this end, the code portions 91 and 94, each of which represents the numeral "0," are provided with the indicium letter "A" which is impressed upon the peripheral surface of the identifier. Likewise, the code portions 92 and 95, each of which represents the numeral "1," are provided with the indicium letter "D" which is similarly impressed upon the peripheral surface of the identifier. The code portions 93 and 96, which represent the numerals "0" and "1," respectively, are provided with the indicia letters "B" and "C," respectively, and which are also impressed upon the peripheral surface of the identifier. The indicia "A," "B," "C" and "D," which are provided on the peripheral surface of the identifier to simplify the selective adjustment of the identifier into a code reading position, will hereinafter be referred to as identifying the various code portion that these indicia are associated with.

To illustrate the selective adjustment of the identifiers 62 for identifying a tool, such as the drill 68, which is identified by the decimal number 732,302 and represented in the binary system by the binary number

10110010110010001110

the identifiers 62 will be individually adjusted on the toolholder so that the identifiers 62A to 62J, inclusive, as viewed in FIG. 2, present code portions "B," "C," "D," "D," "A," "A," "B," "C," "B" and "B," respectively,

in alignment with the code reading position indicator arrow 98.

With the tool identifying number established, as represented in FIG. 2, the two axially spaced groups of switches respectively carried by the selector mechanism are simultaneously actuated, as illustrated in the chart of FIG. 6, in predetermined coded combination by the present code identifiers 62A to 62J, inclusive. Each of the code identifiers simultaneously coacts with a separate radially spaced apart pair of switches according to their opposed "channel" position relative to the toolholder, as hereinbefore explained.

To simplify reading the binary number obtained by the described preset condition of the ten identifier rings, however, the chart is arranged to be read in accordance with the reverse sequence of switch designations respectively assigned to the groups of ten (10) switches carried by the readers 66 and 67.

The relationship of the bits, and the decimal values attributed to each, are illustrated by the following chart:

	Switch	Channel	Identifier	Bit Value	Channel Value For "On" or Actuated Switch	Bit Value	Channel Value For "Off" or De-actuated Switch
Reader 66	110-20	1	62A	1	524,288	0	0
	110-19	2	62B	1	131,072	0	0
	110-18	3	62C	1	65,536	0	0
	110-17	4	62D	1	8,192	0	0
	110-16	5	62E	1	2,048	0	0
	110-15	6	62F	1	1,024	0	0
	110-14	7	62G	1	128	0	0
	110-13	8	62H	1	8	0	0
	110-12	9	62I	1	4	0	0
	110-11	10	62J	1	2	0	0
Reader 67	110-10	10	62J	1	2	0	0
	110-9	9	62I	1	4	0	0
	110-8	8	62H	1	8	0	0
	110-7	7	62G	1	128	0	0
	110-6	6	62F	1	1,024	0	0
	110-5	5	62E	1	2,048	0	0
	110-4	4	62D	1	8,192	0	0
	110-3	3	62C	1	65,536	0	0
	110-2	2	62B	1	131,072	0	0
	110-1	1	62A	1	524,288	0	0

Thus, reading from the least to the most significant digit, the code portion "B" of identifier 62A in channel 1 represents the numeral "0" in the first digit in the binary tool number; code portion "C" of identifier 62B in channel 2 represents the numeral "1," which is the second digit of the binary tool number; code portion "D" of identifier 62C in channel 3 represents the numeral "1," which is the third digit of the binary tool number; code portions "D," "A," "A," "B," "C," "B" and "B" of identifiers 62D to 62J inclusive, in channels 4 to 10, inclusive, respectively, represent the numerals "1," "0," "0," "0," "1," "0" and "0," respectively, which are the fourth to tenth digits, respectively, of the binary tool number. The numerals "1," "1," "0," "1," "0," "0," "1," "1," "0" and "1," which are the eleventh to twentieth digits, inclusive, of the binary tool number, are represented by the opposite code portions "C," "C," "B," "C," "A," "A," "D," "D," "B" and "C" of the identifiers 62A to 62J, inclusive. It is to be noted that the reference made as to digit place in the binary tool number has been made from the standpoint that digit place is counted in the binary tool number from right to left, or from the least significant digit to the most significant digit. That is, the first digit, counting from right to left, is the least significant digit, while the twentieth digit, or last leftward digit, is the most significant digit.

With the identifiers constructed and arranged as described above, there is no need of disassembling and reassembling the coded identifiers on the toolholder 46 in order to change the coding for identifying a different tool. Thus, if a tool of a different size and type from the drill 68, shown mounted on the toolholder in FIG. 2 is inserted in the holder, the identifiers on the toolholder need only to be rotated so as to align appropriate code por-

tions with the indicator arrow 98. For example, it will be assumed that the drill 68, shown in FIG. 2, is removed from the holder 46 and replaced by a tool which is of a different type and size, and is identified by the decimal number 732,301, which is represented in the binary system by the binary tool number 10110010110010001101.

As previously shown, the identifiers on the toolholder, which identify the drill 68 depicted in FIG. 2, had been adjusted into a code reading position to indicate the binary tool number 10110010110010001110, which represents the decimal number 732,302.

A comparison of the two binary tool numbers shows that the first and second digits, counting from right to left, of the two binary tool numbers are different while the third to twentieth digits of these numbers are the same. Therefore, in order for the identifiers 62 on the holder 46 to identify the new tool, the particular identifiers 62A and 62B, which represents the first and second digits of a binary number, must be selectively adjusted to a different setting. Thus, the identifier 62A will be rotated on the tool holder to align a code portion "D" with the arrow 98 to represent the number "1," which is the first digit of the binary number of the new tool. It will be recalled, that the identifier 62A represents both the first and eleventh digit in a binary number. Therefore, when the code portion "D" of the identifier 62A is aligned with the arrow 98, the opposite code portion "D" will be automatically positioned to represent the number "1," which is the required eleventh digit in the binary number of the new tool.

The identifier 62B will also be rotated on the toolholder 46 so that its code portion "B" is aligned with code reading position indicator arrow 98. With the code portion "B" of identifier 62B aligned with the arrow 98, the second digit of the binary tool number is represented as "0," which is the desired number. In aligning the code portion "B" of the identifier 62B with the arrow 98, the opposite code portion "C" of the identifier, which represents the number "1," is automatically positioned so as to represent the twelfth digit of the binary number of the new tool, and which is "1."

To retain the several identifiers 62 in a selected setting, a plurality of detent mechanisms 101 are provided in the enlarged cylindrical forward portion 84 of the holder 46. The detent mechanisms 101, one for each of the identifiers 62, are disposed in the holder along an axial line which corresponds to the code reading position, as indicated by the arrow 98. As each identifier 62 is rotated to selectively position a code portion thereof in code reading position, the detent mechanism 101 associated with the particular identifier will be resiliently urged into engagement with a detent receiving groove 102 formed in the surface of the axial opening of the associated identifier. As shown in FIG. 3, each identifier is provided with six detent receiving grooves 102 which correspond to the associated coded portions formed on the perimeter of the identifiers. Therefore, when any code portion of an identifier is located in code reading position, the associated detent 101 will engage in an associated detent receiving groove 102 to retain the identifier with its code portion in alignment with the code reading position indicator arrow 98.

As previously stated, the toolholders 46 with their associated tools are each inserted into one of a plurality of sockets 41 mounted in a rotary member 38 of the storage magazine 30. The coding formed by the selective settings of the several identifiers on the tools in the sockets 41 are read by the selector mechanism 65 illustrated in FIGS. 1, 4 and 5. The selector mechanism 65 comprises the readers 66 and 67, which are identical in construction and operation, and therefore, only the reader 67 will be described and such description will also apply to the reader 66.

The reader 67 includes ten movable fingers 63 which are yieldably urged forwardly and are engaged by the

code portions of the several identifiers 62 selectively positioned in the code reading position, as indicated by the arrow 98, FIG. 2, as the several tools are moved past the fixedly positioned readers 66 and 67 during rotational movement of the tool storage member 38. Each of the fingers 63 is carried by a separate rod 106 which is encircled by a spring 107 that serves to urge the fingers 63 towards the identifiers 62 on the several tool holders 46. The inner end of each rod 106 is connected to a movable contact bar 108 of a switch 110, which is a double throw switch provided with stationary contacts 111 and 112 that form a part of an electrical system upon which is impressed the number of the particular tool desired for positioning at the tool ready station 51 for the next successive machining operation. The switches of the readers 66 and 67 are generally identified by the reference number 110, while the individual particular switches are identified by the general reference number 110 followed by a number suffix. Thus, the switch which corresponds to the first digit of the binary tool number is identified by the reference number 110-1, while the switch which corresponds to the twentieth or last digit of the binary tool number is identified by the reference number 110-20.

As each of the tool holders 46, removably supported in the magazine 38, pass the fixedly positioned selector mechanism 65, the code portions of the identifiers 62 in the channel positions on the surface 89 of successive toolholders engage the fingers 63 and force them rearwardly against the pressure of their cooperating springs 107 to actuate the associated switches 110. The code portions marked "A" and "B" of each identifier 62 do not extend radially far enough to engage the fingers 63 for actuating the switches 110. Accordingly, when a channel on the surface 89 is occupied by an identifier having one of its code portions "C" or "D" positioned in code reading position, the corresponding switch 110, which represents the same digit of the binary tool number, is actuated as the tool holder passes by the selector mechanism 65. On the other hand, when the identifier 62 in the same channel position is selectively adjusted to a setting wherein one of its code portions "A" or "B" is in code reading position, the corresponding switch 110 in the selector mechanism 65 is not actuated when the toolholder is moved past the selector mechanism and the switch remains in its normal position.

Since the toolholders 46 are each provided with ten channel positions for receiving ten identifiers 62, each of which simultaneously represent two digits in the binary number system, the readers 66 and 67 are each provided with ten switches 110. The ten individual switches of the reader 67 are identified by the reference numbers 110-1 to 110-10, inclusive, and represent the first to tenth digits, respectively, in the binary number. Likewise, the ten individual switches of the reader 66 are identified by the reference numbers 110-11 to 110-20, inclusive, and represent the eleventh to twentieth digits, respectively, in the binary tool number. The identifiers 62, presenting different axial configurations on both sides of the tool, comprise separate code switch actuators for actuating the twenty switches 110 in different combinations depending upon the selective settings of the code portions thereof. The number of the tool to be selected for location at the tool ready station 51 is first impressed upon the electrical control system, diagrammatically illustrated in FIG. 8. When the switches 110 are actuated in the combinations which represent the same number that was impressed upon the control system, coincidence is obtained in the control system. When coincidence between the tool designation circuit and the tool selector circuit of the control system is obtained, an electrical circuit in the control system is conditioned so that when the selected tool arrives at the tool change station 51, it will actuate the switch 70, FIGS. 1 and 8, and the rotation of the tool storage member 38 is automatically stopped with the

specified tool located in the tool ready station 51 in position to be withdrawn from the storage magazine and transferred to the spindle 56 of the machine by the subsequent operation of the tool change mechanism 52.

Referring more particularly to FIG. 4 and to the chart of FIG. 6, it will be noted that the individual identifiers 62A to 62J, inclusive, have been selectively adjusted so that their respective code portions "B," "C," "D," "D," "A," "A," "B," "C," "B" and "B" are in code reading position in alignment with the indicator arrow 98, as shown in FIG. 2. With this condition established, the code portion "B" of identifier 62A will not actuate the switch 110-1 and it will remain in its normal position to indicate the numeral "0" of the first digit of the binary tool number. The code portion "C" of identifier 62B will actuate switch 110-2 to indicate the numeral "1" of the second digit of the binary tool number. Similarly, the code portions "D" and "D" of the identifiers 62C and 62D, respectively, will actuate switches 110-3 and 110-4, respectively, to indicate the numerals "1" and "1" of the third and fourth digits, respectively, of the binary tool number. The code portions "A," "A" and "B" of the identifiers 62E, 62F and 62G, respectively, will not actuate their associated switches 110-5, 110-6 and 110-7, respectively, and they will remain in their normal positions to indicate the numerals "0," "0" and "0" of the fifth, sixth and seventh digits, respectively, of the binary tool number. The code portion "C" of the identifier 62H will actuate switch 110-8 to indicate the numeral "1" of the eighth digit of the binary tool number, while the code portions "B" and "B" of the identifiers 62I and 62J, respectively, will not actuate their associated switches 110-9 and 110-10, respectively, and they will remain in their normal positions to indicate numerals "0" and "0" of the ninth and tenth digits, respectively, of the binary tool number.

With the identifiers 62A to 62J, inclusive, selectively adjusted as described, their code portions "C," "B," "D," "D," "A," "A," "C," "B," "C" and "C," respectively, which are opposite to the code portions of the identifiers which are aligned in code reading position, are automatically set for indicating the proper code reading for the remaining ten digits, eleven to twenty, inclusive. That is, the opposite code portion "C" and "C" of the identifiers 62J and 62I, respectively, will actuate switches 110-11 and 110-12, respectively, to indicate numerals "1" and "1" of the eleventh and twelfth digits, respectively, of the binary tool number. The opposite code portion "B" of the identifier 62H will not actuate switch 110-13, and it will remain in its normal position to indicate numeral "0" of the thirteenth digit of the binary tool number. On the other hand, the opposite code portion "C" of the identifier 62G will actuate its associated switch 110-14 to indicate numeral "1" of the fourteenth digit of the binary tool number. The opposite code portions "A" and "A" of identifiers 62F and 62E, respectively, do not actuate their associated switches 110-15 and 110-16, respectively, and they remain in their normal positions to indicate the numerals "0" and "0" of the fifteenth and sixteenth digits, respectively, of the binary tool number. On the other hand, the opposite code portions "D" and "D" of the identifiers 62D and 62C, respectively, actuate their associated switches 110-17 and 110-18, respectively, to indicate the numerals "1" and "1" of the seventeenth and eighteenth digits, respectively, of the binary tool number. The opposite code portion "B" of the identifier 62B will not actuate its associated switch 110-19 and it will remain in its normal position to indicate numeral "0" of the nineteenth digit of the binary tool number. Lastly, the opposite code portion "C" of the identifier 62A will actuate its associated switch 110-20 to indicate the numeral "1" of the twentieth digit of the binary tool number.

Thus, the binary tool number for the particular drill 68, shown in FIGS. 2 and 4, in contact with the selector

mechanism 65 is 10110010110010001110, and if this is the same binary number that was impressed upon the electrical control system, coincidence will be obtained and the electrical circuit which includes the switch 70 will be conditioned to stop the movement of the magazine 30 when the identified selected tool arrives at the tool ready station 51. This is a result of the action of engaged fingers 63 producing respective corresponding coded actuation of the switches 110 which they control. When the fingers 63 are engaged by the code portion "C" or "D" of the identifiers 62, the numeral "1" of the binary coding is indicated, and when fingers 63 are engaged by the code portions "A" or "B" of the identifiers 62, the numeral "0" is indicated. Likewise, when the fingers 63 are engaged by the code portions "C" or "D," the movable contact 108 of the associated switch 110 is moved into engagement with the stationary contact 112 of the particular switch 110, as illustrated in FIG. 5. On the other hand, when the fingers 63 are engaged by the code portions "A" or "B" of the identifiers, the movable contact 108 of the associated switch 110 remains in electrical contact with the stationary contact 111 of the particular switch.

From the foregoing description, it will be understood that the rotary member 38 of the tool storage magazine 30 will continue to rotate to successively bring the several toolholders 46 to the stationary selector mechanism 65, which is remotely located relative to the tool ready station 51. As each toolholder reaches the selector mechanism, the several fingers 63 engage the coded portions of the selectively adjusted identifiers 62 disposed on the cylindrical surface 89 of the several toolholders 46 and this operation continues until such time as the coded information contained on the toolholder in which the desired tool is contained matches the coded information impressed upon the electrical control system. When the desired tool has thus been selected the control system is made operable to condition a circuit thereof which includes the switch 70 for subsequent operation by the selected desired tool. With the desired tool selected by the selector mechanism 65, the rotary member 38 continues to rotate until the selected tool actuates the switch 70, which is located at the tool ready station 51. When the switch 70 is actuated by the selected tool, the control circuit operates to shut off the driving power of the rotary member 38 and the selected desired tool is in position at the tool ready station 51 to be transferred to the spindle 56 of the machine tool.

Referring more particularly to FIG. 7 of the drawings, there is shown a modified form of an identifier. As shown, an identifier 62, in the form of a ring, is provided with six equally spaced detent receiving grooves 102' formed in the inner surface 103' thereof. The grooves 102' operate in cooperation with a detent 101' provided in a toolholder 46' which is in all respects identical to the holder 46 previously described. Three radially extending code projections 92' 95' and 96' are provided on the periphery of the identifier opposite associated detent receiving grooves 102'. The projections 92' and 95' are disposed directly opposite each other and each serves to designate the numeral "1" in the binary system. The projection 96', which is to the right of the projection 95', as viewed in FIG. 7, also serves to designate the numeral "1" in the binary system. Thus, the projections 92', 95' and 96' will serve the same purpose as the coded portions 92, 95 and 96 associated with the identifier 62. With the identifier 62', the designation of the numeral "0" in the binary system is effected directly by the peripheral surface of the identifier 62' at positions directly opposite detent grooves 102' that are not associated with radial projections. Thus, the ring identifier 62' is provided with three code surfaces 91', 93' and 94', each of which designate the numeral "0" in the binary system and which serve the same purpose as the code portions 91, 93 and 94 associated with the identifier 62. As pre-

viously mentioned, the code projections 92' and 95' are directly opposite each other so that when the identifier 62' is adjusted into code reading position wherein one or the other of the code projections 92' or 95' is aligned with the indicator arrow 98 on the holder 46, the identifier 62' will serve to designate two binary system digits having the numeral "1." On the other hand, the code projection 96' is disposed directly opposite the code surface 93' of the identifier and thus, when the projection is aligned with the arrow 98, the identifier 62' serves to designate the numeral "1" and, also, the numeral "0." It is apparent that if the code surface 93' is aligned with the indicator arrow 98 of the holder, the identifier will designate the numeral "0" and the numeral "1," but in a reversed order from the previously described setting. Lastly, the code surfaces 91' and 94' are directly opposite each other so that with either of these surfaces aligned with arrow 98, the identifier 62' will operate to designate two binary digits of the numeral "1."

The code projections and surfaces of the modified form of the identifier 62' are also marked with identifying indicia to simplify the selective setting of the identifier into code reading position. Thus, the code projections 92', 95' and 96' are marked with indicia "D'," "D'" and "C'," respectively, while the code surfaces 91', 93' and 94' are marked with indicia "A'," "B'" and "A'," respectively.

The identifiers 62 and the selector mechanism 65 have been described for operation wherein tools are consecutively numbered from 1 to 1,048,575. However, the identifiers 62 and selector mechanism 65 are not restricted for operation, in the manner described. It may be preferable for facilitating tool classification to divide the tool coding into two groups with the first group identifying a particular tool category and the second group identifying the individual tools within the category. For example, with the twenty operational switches 110 of the selector mechanism 65 available it would be convenient to divide the twenty switches into two groups of ten operational switches each. This could be readily accomplished since the selector mechanism 65 includes the two reading heads 66 and 67, each having ten switches. Thus, the ten switches of the reader 67 will serve for the first group to identify tool category, while the ten switches of the reader 66 will serve to identify the individual tools of a category.

If the switches are divided into two groups in this manner, the coding of the identifiers 62 on the toolholder 46, in FIGS. 2 and 4, represents a different tool number. In this respect, the code portions of the identifiers which are in alignment with the code reading position indicator arrow 98 will serve to identify the tool category. On the other hand, the opposite code portions of the identifiers will serve to identify the individual tool in the category. Accordingly, this coding arrangement has the capacity of identifying 1023 different categories of tools and 1023 different tools in each category to provide for identifying 1,046,529 tools.

If the coding is divided into two groups in this manner, the identifiers 62 on the toolholder 46, FIGS. 2 and 4, represent a different tool number, as previously mentioned. Code portions "B," "C," "D," "D," "A," "A," "B," "C," "B" and "B" of identifiers 62A to 62J inclusive, respectively, will produce the binary code expression 0010001110, which represents the decimal number of 142. The opposite code portions "C," "B," "D," "D," "A," "A," "C," "B," "C" and "C" of the identifiers 62A to 62J, inclusive, respectively, will produce the binary code expression 1101001101, which represents the decimal number of 715. The tool identified by the identifiers 62 in the code setting shown in FIGS. 2 and 4, would therefore be tool number 715 in tool category 142.

An electrical tool designation circuit that operates in conjunction with the tool selector 65 for effecting automatic selection of a desired tool is illustrated in FIG. 8. In the diagram of FIG. 8, the direct current components obtain power from a direct current power line DC-1 and are connected to ground represented by the line

DC-2. The alternating current components are connected across a pair of alternating current power lines AC-1 and AC-2, as illustrated in FIG. 8. The power lines are energized from a source [not shown] in a well-known manner.

Each of the electrical components is shown in the wiring diagram in one of a plurality of conductors or lines that are connected across the power lines with each of these lines being identified successively by references L1 to L36, inclusive, so that the components may be readily located in the diagram. The contacts of the various relays are identified by the same reference numeral as their associated relay coils with an additional numeral suffix added for the purpose of distinguishing each individual contact from the other.

To effect movement of the tools 42 contained in the magazine 30 past the selector mechanism 65, the motor 32, shown in FIG. 1 and diagrammatically in line L3 of FIG. 8, is energized to effect rotation of the rotatable member 38 for moving the individual tools past or between the reading heads 66 and 67 of the selector mechanism 65. Energization of the magazine motor 32 is effected by depressing the button of a manually operated start switch 151 in line L3. With the button of the start switch 151 momentarily depressed, a circuit is established and current will flow from the DC-1 power line along the line L3, through the closed contact of the start switch 151, through the coil of a relay 152 and thence to the magazine motor 32. The current will continue to flow from the magazine motor 32 along the line L3 and through a normally closed contact 153-1 of a deenergized motor stop relay 153, the coil of which is shown in line L36, and thence to ground represented by the line DC-2. The relay 152, upon being energized, will operate to close its normally open contact 152-1, in line L4, to establish a holding circuit around the contact of the start switch 151, through a conductor 154, line L5, the closed contact 152-1 of now energized relay 152 and a conductor 156 for maintaining the coil of the relay 152 and also the magazine motor 32 energized upon the release of the button of the start switch 151. With the magazine motor 32 energized, the rotatable member 104 of the magazine 30 will be rotated and the tools contained therein will be moved between the stationary readers 66 and 67 of the selector mechanism 65 in a continuous rotary path of travel until such time as coincidence is obtained between the designation circuit and the selector circuit, and the switch 70 in the stop circuit is actuated by the selected tool. When coincidence is obtained, the stop circuit will be conditioned so that upon subsequent actuation of the stop switch 70, the motor 32 will be deenergized to stop magazine rotation and the indicated or selected desired tool will be located in the tool ready station 51. The designation circuit and selection circuit of the control system are illustrated diagrammatically in FIG. 8 for operation with the binary coding being employed for identifying the tools which are numbered consecutively.

As previously mentioned, the selection of a desired tool is effected automatically from recorded data contained on a record such as magnetic or punched tape 157 which is read by a tape reader 158, shown diagrammatically in line L1 of FIG. 8. Automatic selection of a tool is effected by the closing of a manually operated automatic mode selector switch 159, in line L2, to complete a circuit to the coil of an automatic relay 161, shown in line L2. Energization of the coil of the relay 161 will condition the electrical circuit for operation in response to signals received from the record and the closing of the relay contact 161-1, in line L1, serves to complete a circuit for effecting the operation of the tape reader 158. The tape reader 158 is electrically connected in the circuit and will operate to produce the appropriate electrical signals in response to the information contained on the tape 157 for effecting a tool selection automatically.

Energization of the coil of the relay 161 also operates to close another of its contacts 162-2, in line L6, to complete a circuit from the power line DC-1 so that current will flow along the line L6, through the closed contact 161-2 and line L7 to a vertical conductor 162 to energize the conductor for the subsequent operation of the various electrical components connected thereto.

In a tool selection operation, the initial step is to indicate in the electrical control circuit which one of the tools 42 is to be next selected for location at the tool ready station 51. It will be recalled that each of the tools 42 is identified by a decimal number and is coded in accordance with the binary numbering system having twenty digits. The ten channels of each of the binary coded tools has an identifier provided with coding which in any code reading setting represents two digits in the binary numbering system and are adapted to be moved past the readers 66 and 67 of the selector mechanism 65 so as to actuate the twenty switches in accordance with the binary code system for identifying the tool. Since there are twenty switches and each may have two different values of "1" or "0," 1,048,575 different numerical values are provided for a capacity for identifying 1,048,575 tools, each of which is represented by a binary number. The binary number of the desired tool may be impressed upon the electrical control system automatically in response to signals from recorded data, such as the tape 157.

Automatic indication of the desired tool to be selected for location at the tool change station is accomplished through operation of a plurality of normally open contacts 171 to 190, inclusive, which contacts are closed in response to signals from the record, such as electrical signals produced by the tape reader 158 from the tape 157. The automatic contacts 171 to 190, inclusive, will be closed in response to a signal from the record, the contacts being closed either singly or in any combination, to indicate in the electrical control system the particular tool that is desired to be located at the tool ready station 51. The contact 171 represents the first digit of the tool binary number and each succeeding contact represents a succeeding digit, with the contact 190 representing the twentieth digit.

With the automatic mode selector switch 159 in the "on" position, as previously mentioned and as shown in FIG. 8 line L2, the coil of the automatic tape control relay 161 is energized so that its contact 161-2, in line L6, is closed thereby completing the circuit to the vertical conductor 162 to energize it so that any of the component relays, which are connected to it, may be energized in response to the closing of any of the associated automatic contacts 171 to 190, inclusive, by operation of the tape reader 158. The automatic contacts 171 to 190, inclusive, operate to complete circuits for selectively energizing the coils of a plurality of relays 271 to 290, inclusive, respectively. Thus, if tool No. 1 is desired to be selected for location at the tool ready station 51, the automatic contact 171 will be closed to indicate the numeral "1" for the first digit of the binary tool number, while the remaining automatic contacts 172 to 190, inclusive, will remain in their normal open position to indicate "0" for the remaining nineteen digits of the binary tool number. A circuit will therefore be completed from the energized vertical conductor 162 through the closed automatic contact 171, the coil of relay 271, line L8, and thence to ground represented by the line DC-2. Energization of the coil of the relay 271 will represent the numeral "1" of the first digit of the binary tool number. The remaining automatic contacts 172 to 190, inclusive, will remain open, as previously mentioned, and the coils of their associated relays 272 to 290, inclusive, respectively, will be maintained deenergized. Thus, the binary tool number indicated in the electrical control system will be 000000000000000001 and tool No. 1 will be indicated as the particular tool to be selected for location in the tool ready station 51.

It will be recalled that the reading heads 66 and 67 of the selector mechanism 65 were previously described as having ten movable fingers 63 each, which engaged the binary coding on the tools as they moved in their circular path of travel past the selector. It will also be recalled that each of the fingers is connected to operate an individual switch whenever it was shifted by an identifier 62. The twenty individual switches of the selector 65 are shown diagrammatically in FIG. 8, with the switch 110-1 representing the first digit of the identifying binary tool number while switch 110-20 represents the twentieth digit of the identifying binary tool number.

Each of the switches 110-1 to 110-20, inclusive, operate in conjunction with a normally open contact and a normally closed contact of one of the twenty relays 271-290, inclusive, with each switch functioning with the contacts of the relay which represents the same digit of the binary number that the switch does. Thus, switch 110-1, line L29, operates in conjunction with a normally open contact 271-1, line L28, and a normally closed contact 271-2, line L30, both of which are actuated by the energization of the coil of the relay 271 in line L8. Similarly, switches 110-2 to 110-20, inclusive, lines L29 and L33, operate in conjunction with normally open contacts 272-1 to 290-1, inclusive, respectively, lines L28 and L32, and normally closed contacts 272-2 to 290-2, inclusive, respectively, lines L30 and L34, which are actuated by the energization of the coils of their associated relays 272 to 290, inclusive, respectively. The operation of the switches 110-1 to 110-20, inclusive, in combination with the operation of the associated relays 271 to 290, inclusive, respectively, will indicate in the electrical control circuit when the desired tool has been selected for location in the tool ready station 51.

In the present example, it has been assumed that tool No. 1 is desired for location at the tool ready station. Therefore, only the coil of the relay 271, line L8, has been energized. As a result, its normally open contact 271-1, line L28, is closed and its normally closed contact 271-2, line L30, is open. Since the contact 271-2 is open, a circuit cannot be completed to the coil of a tool selection indicating relay 292, line L33, which, when energized, indicates that the desired tool has been selected. Therefore, with the coil of the relay 292, deenergized, its normally open contact 292-1, line L35, remains open and a circuit cannot be completed to the coil of a stop circuit conditioning relay 293, line L35. The relay 293 is provided with a normally open contact 293-1, line L36, which, upon energization of the relay coil, will close after a time delay, through operation of a timer 294, to partially condition the stop circuit for subsequent energization of the coil of the stop relay 153.

However, when a tool having its identifier number 62A adjusted so that a code portion "C" is in code reading position in alignment with the indicator arm 98, and the remaining identifiers 62B to 62J, inclusive, adjusted so that their code portions "A" are in code reading position, arrives at the tool reading position, the finger 63 associated with the switch 110-1 will be moved to actuate the switch which represents the numeral "1," the first digit of the binary tool number. The remaining fingers 63 of the selector mechanism 65 will not be moved and their associated switches 110-2 to 110-20, inclusive, will remain in their normal positions to indicate "0" for the remaining nineteen digits of the binary tool number. Actuation of the switch 110-1 will move its cooperating contact bar 108-1, line L33, out of engagement with the contact 111-1 and into engagement with its contact 112-1. When this occurs, coincidence is obtained and a circuit will be completed to the coil of the relay 292 and current will flow from the energized power line DC-1 through the contact bar 108-1 of switch 110-1, the closed contact bar 271-1, the contact bar 108-2 of the switch 110-2, and thence through the contact bars of the other tool number switches 110-3 to 110-20, inclusive, in lines L30 and L34,

to the coil of the relay 292 and thence to ground, as represented by the line DC-2. The coil of the relay 292, upon being energized, will operate to close its normally open contact bar 292-1, line L35, to complete a circuit along line L35 to energize the coil of the relay 293. The completion of the circuit along line L35 will do two things. First, it will establish a maintaining circuit to the coil of the relay 292 around the tool number switches to maintain the relay energized after the desired identified tool has moved out of selector engagement by the continued rotation of the magazine member 38, as previously mentioned. Second, the completed circuit along line L35 will effect energization of the coil of the relay 293. The relay 293, upon energization of its coil, will be conditioned so that its normally open contact 293-1, line L36, will move to a closed position after a time delay. This time delay interval, for the closing of the contact 293-1, is just sufficient so that when the desired tool in the tool reading position actuates the proper number switches to establish coincidence between the automatic designation circuit and the tool number selector switches, a different tool is in the tool ready station and has actuated the switch 70 to closed position. However, the tool that is in the tool ready station 51 and actuating the switch 70 is not the particular desired tool. Therefore, with the contact 293-1, line L36, held open for a short interval, the member 38 of the magazine continues to rotate after a tool selection and the unwanted tool will move out of the tool ready station 51 releasing the switch 70. At this time, the contact 293-1 will close and the switch 70, line L36, will be open so that when the identified selected tool is moved into the tool ready station 51, it will actuate the switch 70 to close it and complete the circuit along line L36. When this occurs, current will flow from the energized power line DC-1 along the line L36 through a closed contact bar 296 of the start switch 151, the closed contact bar of the switch 70 and through the now closed contact 293-1 to the coil of the stop relay 153 and thence to ground, as represented by the line DC-2. With the coil of the relay 153 energized, it will operate to open its normally closed contact 153-1, line L3, to interrupt the circuit along line L3 to stop operation of the magazine motor 32 with the desired No. 1 tool located in the tool ready station 51.

Assuming now that the signals produced by the tape reader 158 from the tape 157 are such as to designate tool No. 732,302 as the next tool designated for selection and location at the tool ready station 51. The automatic contact 171 will immediately be opened thereby effecting deenergization of the coil of its associated relay 271 causing the contacts 271-1 and 271-2 of the relay to move to their normal positions. Since previously selected tool No. 1 had moved out of selector mechanism engagement after being identified and selected, the switch 110-1 had been released so that its contact bar 108-1 was returned to its normal position in engagement with the contact 111-1. As a result, the designation automatic contacts and the tool number selector switches are conditioned for a subsequent operation. However, at this time, the coil of the relay 292 is maintained energized through the maintaining circuit established along line L35. Therefore, the coil of the relay 293 is energized and its contact 293-1, line L36, is closed, therefore, the coil of the stop relay 153 is maintained energized and its contact 153-1, line L3, is in open position so that the magazine motor circuit along line L3 is maintained interrupted.

This condition remains whether or not the previously selected No. 1 tool is in the tool ready station 51 or a too linterchange has been effected to interchange the No. 1 tool with the previously used tool in the magazine and placing the previously used tool in the magazine in the tool ready station. For example, if the previously selected No. 1 tool is in the tool ready station, the switch 70 will be actuated so that the coil of relay 153 is energized. This interrupts the magazine motor circuit which

17

also effects deenergization of the coil of the relay 152 in line L3. Thus, the maintaining circuit to the coil of the relay 152 along line L4 is interrupted because the contact 152-1 is opened upon deenergization of the coil of the relay 152. If a tool interchange has been accomplished, the withdrawal of the No. 1 tool from the tool ready station 51 will cause switch 70 to be deactuated. This, of course, would cause the circuit along line L36 to be interrupted to effect deenergization of the coil of the stop relay 153. When this occurred, the contact 153-1 of the relay in line L3 would be returned to its normally closed position. However, the circuit to the magazine motor 32 is still interrupted because the coil of the relay 152 has been previously deenergized. Therefore, the magazine motor 32 will not operate. On the other hand, upon a tool interchange, when the previously used tool withdrawn from the machine spindle 56 is inserted into the tool storage socket of the magazine in the tool ready station 51, the switch 70 will again be actuated. This will once again complete the circuit along line L36 to once again energize the coil of the relay 153 which again operates to open its contact 153-1 in line L3. This is true, because the coil of relay 292 is still maintained energized; as is the coil of the relay 293.

It will now be assumed that the signals produced by the tape reader 158 from the tape 157 are such as to designate tool No. 732,302 as the next tool designated for selection and location at the tool ready station 51. It will also be assumed that the designated tool No. 732,302 is located in a position other than the tool reading position and the tool ready station. Now, the signals produced designating tool No. 732,302, represented by the binary tool number 10110010110010001110, will effect the closing of the automatic tool number designation contacts 172, 173, 174, 178, 181, 182, 184, 187, 188 and 190. With automatic contacts 172, 173, 174, 178, 181, 182, 184, 187, 188 and 190 closed, the coils of their associated relays 272, 273, 274, 278, 281, 282, 284, 287, 288 and 290 are energized. Energization of the coils of these relays will effect the closing of their associated normally open contacts 272-1, 273-1, 274-1, 278-1, 281-1, 282-1, 284-1, 287-1, 288-1 and 290-1, respectively, lines L28 and L32, and the opening of their associated normally closed contacts 272-2, 273-2, 274-2, 278-2, 281-2, 282-2, 284-2, 287-2, 288-2 and 290-2, respectively, lines L30 and L34. However, even though the coils of the relays which are associated with the automatic contacts which represent the particular digits of the binary number of the desired tool No. 732,302 are energized, coincidence between the automatic designation contacts and the reader or selector switches is not obtained because the desired tool No. 732,302 is not in position to be read by the selector mechanism 65, but some other tool, or no tool, is in reading position. Thus, the particular switch combination which represents the desired binary tool number will not be actuated, accordingly, coincidence does not exist.

However, with the binary tool number

10110010110010001110,

representing tool No. 732,302, impressed on the designation circuit as the next desired tool to be selected by the selective actuation of the automatic switch contacts 171 to 190, inclusive, the button of the manual start switch 151, line L3, is depressed. With the button of the start switch depressed, an associated contact 296 in line L36 is moved to open position. The opening of the contact 296 in line L36 operates to interrupt the circuit along line L36 to deenergize the coil of the relay 153. With the coil of the relay 153 deenergized, its associated contact 153-1, line L3, is moved to its normally closed position. As this occurs, the circuit to the magazine motor 32 is completed and the motor will operate to drive the magazine member 38 in its rotational movement. When tool No. 732,302 carried in the member 38 is moved

18

into engagement with the selector mechanism 65, the coded identifiers 62A to 62J, inclusive, having code portions "B," "C," "D," "D," "A," "A," "B," "C," "B" and "B" respectively, adjusted in code reading position in alignment with the indicator arrow 98 on the holder will cause switches 110-2, 110-3, 110-4 and 110-8 to be actuated, while switches 110-1, 110-5, 110-6, 110-7, 110-9 and 110-10 are not actuated and remain in their normal positions. The opposite code portions "C," "B," "D," "D," "A," "A," "C," "B," "C" and "C" of the identifiers 62A to 62J, inclusive, respectively, will actuate switches 110-11, 110-12, 110-14, 110-17, 110-18 and 110-20, while the switches 110-13, 110-15, 110-16 and 110-19 are not actuated and remain in their normal positions. The actuated switches represent the second, third, fourth, eighth, eleventh, twelfth, fourteenth, seventeenth, eighteenth and twentieth digits, respectively, of the binary tool number 10110010110010001110, which represents tool No. 732,302.

Thus, with coincidence obtained between the automatic tool designation contacts and the tool selector switches, the circuit to the coil of the relay 292 is completed to energize the coil and effect the movement of the associated contact 292-1, line L35, to a closed position to indicate the selection of the desired tool.

Closing of the contact 292-1, line L35, will complete the circuit along line L35 to energize the coil of relay 293. With the circuit completed to energize the coil of the relay 293, its contact 293-1, line L36, will be moved to a closed position, after a time delay, so that an undesired tool is moved out of the tool ready station and releases the switch 70. The continued rotation of the member 38 will move the identified desired tool No. 732,302 into the tool ready station 51 which thereupon will actuate the switch 70, line L36, to effect deenergization of the coil of the relay 153 and the resulting deenergization of the magazine motor 32. The rotation of the magazine will stop with the selected desired tool No. 732,302 located in the tool ready station 51.

The preceding description of a tool selection operation has been given with the assumption that the designated desired tool No. 732,302 was located in a position other than the tool reading position and the tool ready station. It will now be assumed that the designated tool is located at the tool reading position. In this assumed position, all switches, relays and circuits will be in a condition as previously described. Therefore, when the button of the start switch 151 is depressed momentarily, coincidence is immediately obtained because the designated desired tool No. 732,302 is in engagement with the tool selector switches and they are actuated in a proper combination to establish coincidence. Upon coincidence being established, this would normally effect the energization of the coil of the relay 153, line L36, to thereby interrupt the circuit along line L3, so that the magazine motor 32 will not operate. This is true, because with the designated tool assumed to be at the tool reading position another different tool would be located at the tool ready station 51 thereby actuating the switch 70 to closed position. With the switch 70 in closed position, a circuit to the coil of the stop relay 153 is normally completed. To insure that this condition does not occur, when the start switch 151 is depressed momentarily to start the magazine motor, the contact 296 thereof, in line L36, is opened, so that even though the switch 70 is closed and the contact 293-1 of relay 293 is closed, the coil of the stop relay 153 cannot be energized. Thus, upon coincidence being immediately established by the designated tool being in the tool reading position, the magazine member 38 will be rotated to move the tool at the tool ready station out of position thereby releasing switch 70. Thereupon, when the button of the start switch 151 is released, the switch 70 will have been released to its open position and it will operate to keep the coil of the stop relay 153 from being energized until such time

19

as the designated tool is moved into the tool ready station 51. The motor 32 will thus operate, as before, moving the selected tool No. 732,302 out of selector engagement and into the tool ready station 51. When the selected desired tool is moved into the tool ready station, the switch 70 will be actuated and rotation of the magazine will stop with tool No. 732,302 located in the tool ready station 51.

It will now be assumed that the designated desired tool No. 732,302 is located in the tool ready station 51. With the condition existing, the button of the start switch will be depressed and the motor 32 will be energized to rotate the magazine moving the designated desired tool out of the tool ready station 51. Magazine rotation will continue until such time as the designated tool has been rotated into engagement with the selector mechanism 65 to establish coincidence between the automatic designation contacts and the tool selector switches and the desired tool No. 732,302 has once again been moved into the tool ready station 51 to again actuate the switch 70 upon the subsequent identification of the tool.

From the foregoing explanation of the arrangement and operation of the illustrative embodiment of the invention, it is apparent that there has been provided an improved system for identifying the individual tools of a large number of different tools. It is also apparent that there has been provided an improved means for coding the tools in which the coding need never be disassembled in order to change the particular tool identifying coding.

Although particular structure has been shown and described in considerable detail as exemplary of the manner in which the invention may be practiced, it will be apparent to those skilled in the art to which this invention relates that various modifications of the structures herein shown may be effected without departing from the spirit and scope of the invention as defined in the subjoined claims.

The principles of this invention having now been fully explained in connection with the foregoing description, I hereby claim as my invention:

1. In a tool identifying and selection mechanism for identifying a desired tool from a group of tools for location at a tool ready station positioned in spaced apart relationship to a tool identifying station;

a tool storage member carrying the group of tools and being movably supported for moving the tools successively through the tool identifying station and the tool ready station;

a source of power connected to drive said storage member in its path of travel;

a plurality of designation elements actuable in different combinations to designate the number of the tool to be located at the tool ready station;

a plurality of electrical control elements positioned at the identifying station for actuation in different combinations, said designation elements and said control elements being connected to indicate the desired tool to be located at the ready station when said control elements are actuated in the combination which coincides with the combination of actuated designation elements;

a plurality of coded identifier members arranged in code fashion associated with each tool to identify the individual tools and operable to actuate said control elements as the tools move past said control elements in the identifying station; and,

a stop element positioned at the tool ready station for actuation by the indicated desired tool and conditioned to be operable in combination with the proper predetermined tool identifying operation of said control elements to terminate the movement of said storage member with the desired tool located at the tool ready station.

2. In a machine tool;

an indexable storage member having an index station

20

and provided with a plurality of predetermined spaced apart code receiving means;

a plurality of identical code members having a plurality of different code portions adjustably carried by said code receiving means, said code members being predeterminedly adjusted relative to each other and to the receiving means in a manner that the composite code portions of the code members provide a coded structure representing a specific distinguishing numerical coded value, each of the coded structures being operative to initiate a coded output signal for identifying a position on the storage member that corresponds to the associated code receiving means;

a code indicator remotely positioned relative to the index station and disposed in operative proximity to said storage member, said code indicator being responsive to coded identifying signals originated by said coded structures carried by the storage member;

means for effecting relative movement between said storage member and said code indicator for identifying a position on the storage member which is desired to be located at the index station; and,

a stop device responsive to the coded structure indicated by said code indicator to terminate the relative movement between the storage member and said code indicator with the desired position on the storage member located at the index station.

3. In a tool selection mechanism for selecting a desired tool from a plurality of different tools for location at a tool ready station;

a source of power;

a rotatable tool storage magazine operably connected to be rotated by said source of power relative to a tool ready station;

a plurality of different tools removably carried by said magazine for rotation therewith to be moved individually in succession to the tool ready station; code actuators on each of said tools for identifying the associated tool;

a tool selector device comprising a pair of spaced apart reading heads located remotely from the tool ready station and positioned so as to be actuated simultaneously by the code actuators of each of said tools as said tools move with said magazine for identifying the tools;

control means operably connected to control the movement of said magazine; and,

a stop device connected in series with said tool selector device and operable when actuated in series relationship with said selector device by an identified tool to effect operation of said control means to stop the movement of said magazine with the identified tool located at the tool ready station.

4. In a tool selection mechanism for selecting a desired tool from a group of tools at an identification station for subsequent positioning location of the identified tool at a tool ready station;

a plurality of designation elements actuable in different combinations to designate the number of the tool to be selected;

a plurality of control elements at the identification station for actuation in different combinations in binary code fashion;

a plurality of identifier members having a plurality of binary coded identifying portions associated with each tool, said identifier members being arranged to present a distinctive coded configuration to identify the number of an associated tool and operable to actuate said control elements as said tools move past said control elements;

power means connected to produce relative movement between said tools and said control elements so that said identifier members will actuate said control elements in accordance with the number of the tool; and,

- a stop device at the tool ready station connected to terminate relative movement between said control elements and said tools when said control elements have been actuated in the combination that identifies the tool number designated by the actuated designation elements with the indicated tool located in the tool ready station.
5. In apparatus for identifying the individual tools of a group of tools;
- a source of power;
 - a rotatable tool storage magazine connected to be rotated by said source of power relative to a tool ready station;
 - a plurality of tools carried by said magazine for movement with it to be moved individually in succession to the tool ready station;
 - code identifiers associated with each of the tools to identify each tool individually;
 - a tool identifier located remotely from the tool ready station in position to be actuated by the code identifiers on said tool as the tools move with said magazine and operable when engaged by the code identifiers of a tool to produce a signal to indicate the tool identified;
 - control means operably connected to regulate said source of power for stopping rotation of said magazine; and,
 - a stop device located at the tool ready station in position to be actuated by the tool indicated by said tool identifier and operable upon being actuated by the identified tool to effect operation of said control means to stop rotation of said magazine, with the tool indicated by said tool identifier located at the tool ready station.
6. In a tool selection apparatus for a machine tool having a rotatable tool storage magazine indexable to a tool ready station;
- a plurality of different tools removably carried by the magazine for rotation therewith for successive movement to the tool ready station;
 - a source of power connected to indexably drive the magazine in an indexing movement;
 - a plurality of coded identifying members carried by each of said tools for individually identifying each tool;
 - a twin code reader located remotely from the tool ready station and positioned to simultaneously read the coded identifying members of each tool as the tools move with the magazine, said readers being operable to produce a signal for identifying the tool which actuated it;
 - control means operably connected to stop operation of said source of power to thereby stop the movement of the magazine; and,
 - a stop device located at the tool ready station in position to be actuated by the tool identified by said reader and operable when actuated to effect operation of said control means to stop magazine movement with the identified tool located at the tool ready station.
7. A selectively operable tool identification apparatus having a power driven tool storage magazine provided with a tool ready station;
- a plurality of different sizes and types of tools removably carried by the magazine;
 - a plurality of identifying members having the same structural configuration and provided with a plurality of different code portions adjustably affixed to each of said tools for selective individual positioning relative to each other and to the associated tool for identifying the tool;
 - a tool selector remotely positioned relative to the tool ready station and disposed so as to be activated by the identifying members on each of the tools carried

- by the magazine as the magazine is operated, said tool selector being operable when actuated by a desired tool to produce a signal to identify the tool; and,
 - a control device operable when actuated by the identified desired tool to terminate the operation of the magazine with the desired tool located at the tool ready station.
8. In a tool selection apparatus for a machine having a tool storage magazine indexable to a tool ready station;
- a source of power connected to drive the magazine in an indexing movement;
 - a plurality of different tools removably carried by the magazine for movement therewith;
 - a plurality of coded identifying members carried by each of said tools to individually identify each tool;
 - a code reader located remotely from the tool ready station and positioned to read the coded identifying members on said tools as the tools move with the magazine, said reader being operable to produce a signal to identify the tool which actuated it; and,
 - a stop device connected to control the operation of said source of power spaced apart from said reader and positioned to be actuated by the tool identified by said reader to stop the movement of the magazine with the identified tool positioned at the tool ready station.
9. In a tool selection apparatus for selecting a desired tool from a group of tools and including storage means for removably supporting a group of tools;
- identifying members having a plurality of different code portions associated with each tool, said identifying members being adjustable to present selected code portions in predetermined combinations for identifying the number of an associated tool;
 - a plurality of electrical control elements comprising a tool identity station and being arranged in code fashion to be actuated selectively by the code portions of said identifying members for identifying the tools as they move relative to said control elements;
 - power means connected to effect relative movement between said storage means carrying the identified tools and said control elements; and,
 - an interruptor located at a ready station remote from said identity station and being operable when actuated by a tool identified by said control elements to terminate relative movement between the said storage means and said control elements.
10. In apparatus for selecting a desired tool from a plurality of different tools and locating the selected tool at a predetermined location;
- a movable tool storage member;
 - a source of power connected to drive said storage member;
 - a plurality of different tools removably carried by said storage member;
 - separate signal actuators respectively associated with each of said tools for selective adjustment without removal to transposed positions, said actuators presenting two angularly spaced radially extending code configured portions respectively operative to actuate spaced apart twin readers;
 - a code responsive selector apparatus comprising a pair of spaced apart twin readers mounted in position to be actuated simultaneously by the coded signal actuators associated with the respective tools as said tools pass through said readers with said storage member for producing a signal to indicate the tool which actuated them; and,
 - a control means operative in conjunction with said selector apparatus to control the operation of said source of power for locating the indicated desired tool in the predetermined location.
11. In apparatus for indicating a desired tool from a

23

- plurality of tools and locating the indicated desired tool at a predetermined location;
 a movable tool storage member;
 a source of power connected to drive said storage member;
 a plurality of different tools carried by said storage member;
 separate signal actuators respectively associated with each of said tools in predetermined coded combinations for identifying the related tool;
 a code responsive indicator device comprising a pair of spaced apart readers mounted in position to be actuated simultaneously by the coded signal actuators associated with said respective tools as said tools move with said storage member for producing a signal to indicate the tool which actuated it; and,
 a selector device operative in conjunction with said indicator device to control the operation of said source of power for locating the indicated tool in a desired location.
12. In a machine tool;
 an automatic tool selection apparatus comprising a storage member adapted to removably carry a plurality of tools;
 a plurality of separate coded identifying members associated with the tools and with the storage member, said identifying members being provided with a plurality of pairs of opposite code portions;
 a relatively movable pair of spaced apart twin code readers positioned to be operatively responsive in code fashion to said coded identifying members as said storage magazine and said twin readers are moved relative to each other to pass the tools carried by said storage magazine through said twin readers successively;
 drive means for effecting relative movement between said storage magazine and said twin readers; and,
 a stop device connected in series relationship with said twin readers and operable when actuated by a tool selected by said twin readers to interrupt said drive means for locating the selected tool in a desired position.
13. In a tool selection apparatus;
 an indexable tool storage magazine movable relative to a tool identity station and a spaced apart tool ready station, said magazine being provided with a plurality of positive tool locating means respectively adapted to retain a plurality of tools in predetermined corresponding angular relationship to said magazine;
 a plurality of tools provided with complementary positive locating means and being removably carried by said storage magazine;
 a plurality of presettable code identification means associated with each of said stored tools and being preset in predetermined angular relationship to the positive locating means respectively presented thereby for respectively identifying the location of the individual tools in said storage magazine;
 power drive means connected to indexably drive said storage magazine relative to the identity station and the ready station;
 code control means including a code responsive reader positioned at the identity station to be actuated by said code identification means, said code control means being connected to condition said power drive means for subsequently stopping said storage magazine to locate a desired tool at the tool ready station; and a stop device in the ready station responsive to arrival of a preselected tool for deactuating said power drive means in accordance with the predetermined actuation of said code responsive reader.
14. In a tool retaining holder;
 a plurality of coded identifying members adjustably carried by the holder, said identifying members having the same structural configuration comprising

24

- lateral extending elements of different sizes, certain of said elements being of one size to provide one coded value and certain other of said elements being of a different size to provide another coded value;
 a plurality of retaining devices carried by the holder in position to engage each of said identifying members for maintaining said identifying members in selected adjusted position relative to each other and to said holder; and,
 locking means carried by the holder to secure said identifying members in the selected adjusted positions.
15. In a toolholder provided with code guide means;
 a plurality of individual code elements adjustably carried by said guide means for selective individual positioning movement to a predetermined code reading position with respect to one another and to said holder, each of said code elements being so configured as to present a plurality of different code portions respectively having correspondingly different numerical values; and,
 means for retaining said code elements in selectively adjusted positions on said guide means with predetermined code portions respectively presented thereby at the reading position for providing a coded identification equivalent to the summation of the numerical values of the code element portions positioned at the code reading position.
16. In a toolholder provided with a tool receiving socket and code receiving means;
 a plurality of coded identifying members having the same structural configuration and presenting a plurality of lateral extending elements of different sizes with each different size having a different binary value, said coded identifying members being adjustably affixed to the code receiving means of the toolholder;
 releasable retention means associated with the toolholder and with said coded identifying members to releasably retain said identifying members in adjusted position relative to each other and the toolholder so that said adjusted identifying members present a binary coded structural configuration representing the summation of the values of each of the adjusted lateral extending elements of said identifying members.
17. In a tool retaining holder;
 a plurality of coded identifying members adjustably carried by the holder for individual selective angular setting movement to a predetermined code reading position relative to the holder and to each other, said identifying members being each configured so as to present a plurality of different code portions extending different radial distances and respectively having different numerical values; and,
 retaining means for holding said identifying members in selected angularly adjusted position on the holder with the predetermined radially extending code portion respectively presented by said angularly adjusted identifying members at the reading position for providing a coded identification equivalent to the summation of the numerical values of the radially extending code portion of each identifying member located in code reading position.
18. In a tool retaining holder;
 a plurality of coded identifying members carried by said holder, each of said identifier members having the same structural configuration comprising at least two peripheral surfaces having different radii, one of which represents the binary number "1" and the other of which represents the binary number "0";
 a plurality of detent devices carried by said holder and associated with each of said identifier members for maintaining said identifying members in predetermined selected adjusted setting on said holder; and,
 locking means carried by said holder and operable to

lock said identifier members in a selected adjusted setting.

19. In a tool retaining holder;

a plurality of coded identifying members carried by the holder, said identifying members having the same structural configuration comprising a plurality of different contiguous peripheral surfaces, certain of said peripheral surfaces being of one configuration to provide a binary coded value of zero and certain other of said peripheral surfaces being of another configuration to provide a binary coded value of one; and,

retaining means associated with the holder and said identifying members for maintaining each of said coded identifying members in a selected adjusted position relative to each other and the holder.

20. In a toolholder provided with a tool socket and code receiving means;

a plurality of binary coded members, each being of the same structural configuration presenting a plurality of different code portions having a different binary value, said members being adjustably affixed to said code receiving means for selective setting of the code portions of said members to a code reading position to provide a binary coded structural configuration of an identifying coded value representing the summation of the values of the adjusted portions of each identifying member.

21. In a toolholder provided with positive locating means and spaced apart code receiving means;

a plurality of code elements selectively carried by said receiving means in positions to coact for providing a preselected coded identification at a reading position in axial alignment and in predetermined angular relationship to the locating means presented by said toolholder, said code elements being respectively provided with different length radially extending code element portions having different numerical values; and,

means for maintaining said code elements in selective angularly adjusted positions on said receiving means.

22. In combination with tool storage means;

a plurality of tools removably carried by said storage means;

separate positive locating means operative to retain each of said tools in like angular relationship to said storage means;

tool identifying means associated with each of said tools and comprising a predetermined combination of axially spaced code portions of different radial length, each of said combinations of said code portions being in axial alignment and in corresponding angularly relationship to said positive locating means associated with said tool identified thereby;

a code responsive tool identifier carried in spaced relationship to said storage means for operation by said tools identifying means carried by said stored tools to provide coded output signals;

power drive means connected to move said storage means relative to said identifier and relative to a tool select station positioned remotely therefrom; presettable tool select means operative to provide a

coded output signal for identifying the tool to be positioned at the tool select station; and,

stop means responsive to coincidence between the code signals from said identifying means and said tool select means for controlling said power drive means to stop said storage member for positioning the identified tool in the tool select station.

23. Tool means;

code identifying means movably carried thereby and presenting a plurality of axially and peripherally spaced code portions that individually have distinct numerical values; and,

means for retaining said code identifying means in selected angular adjustment relative to said tool means for presenting a selected combination of said code portions in like angular relationship thereto for providing a selected numerical identification equivalent to the summation of values of said code portions comprising the selected combination.

24. Tool means;

code elements carried by said tool means for selective angular adjustment, said code elements being respectively provided with a plurality of angularly spaced apart code portions of different radial length; and,

releasable retaining means operative to secure said elements in angularly adjusted positions for maintaining selected code portions in predetermined relationship to comprise a distinctive coded identifying configuration.

25. In a tool identification system;

tool storage means;

a plurality of tools removably stored in said storage means;

positive locating means operative to retain each of said stored tools in like angular relationship to said storage means;

tool identifying means carried by each of said stored tools and respectively comprising differentiating combinations of code portions of different radial length, each of said combinations of said code portions being in axial alignment and in corresponding angularly spaced relationship to said positive locating means associated with said tool identified thereby; a code responsive tool identifier carried in operatively spaced relationship to said storage means in a position to be operated in code fashion by each of said combinations of said radial code portions respectively comprising said identifying means for each of said stored tools, said identifier being disposed to produce a corresponding coded output signal when operated; and,

selectively operable power drive means connected to effect relative movement between said tool storage means and said tool identifier,

whereby said identifier is operative to provide coded output signals to indicate the location of said stored tools in said storage means.

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