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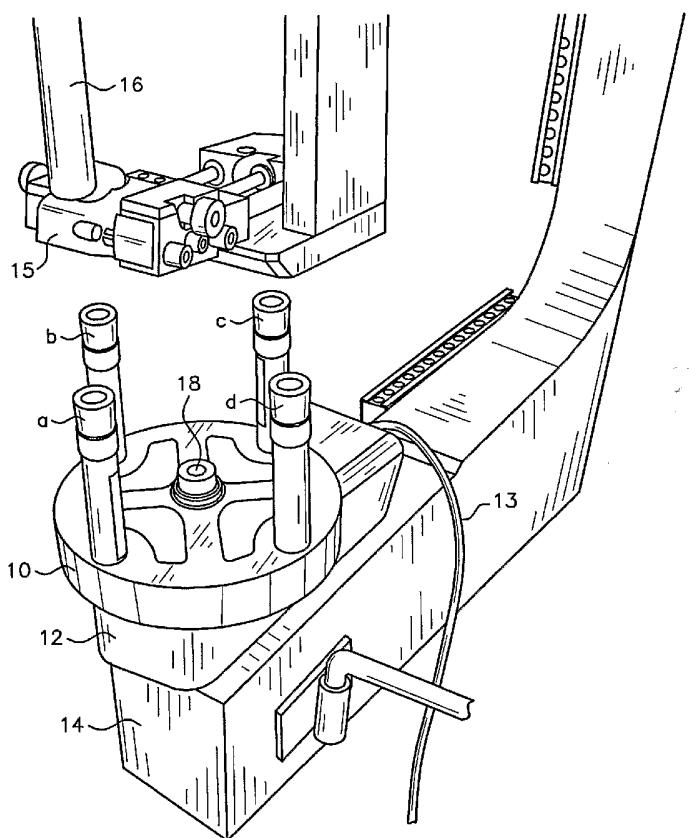
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(54) Title: TURRET TOOL HOLDER FOR A PRESS



(57) Abstract: A tool-changing system for a press utilizes a rotary turret on which different tools are rigidly fixed. The turret includes a circular table base which is rotatably mounted on top of the press anvil. As the turret is turned, a different tool is moved into the work zone in vertical alignment with the upper tool on the press ram. The turret table can either be manually or motor driven in either direction between indexed operative positions. The indexing system which senses the position of the turret and indexes the turret to its next operating position uses only two simple sensors which are located beneath the turret table. Each sensor reads a different circular track on the underside of the turret table.

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## TURRET TOOL HOLDER FOR A PRESS

2

### 3 RELATED APPLICATIONS

4 The present application is related to provisional patent application serial  
5 number 60/572,488 entitled "Turret Tool Holder for a Press" filed on May 20,  
6 2004, priority from which is hereby claimed.

## 7 FIELD OF THE INVENTION

8 The present invention relates to a press used for the insertion of fasteners.

9 More particularly it relates to an apparatus for changing the anvil tooling of an  
10 automated press for installing fasteners into panels such as sheet metal.

## 11 BACKGROUND OF THE INVENTION

12 Hydraulic punch presses as shown in Figure 1 are often used as fastener  
13 insertion machines. These presses include a C-type frame **8** and have upper and  
14 lower tools **3** and **6** held in vertical alignment which come together on opposite  
15 sides of a flat panel workpiece **5** to install a fastener into the workpiece under  
16 pressure. The upper tool is carried by a press ram **2** which extends and retracts  
17 vertically while the lower tool **6** remains stationary, being affixed to an anvil **9**  
18 mounted on the lower jaw of the frame **8** opposite the workpiece **5**. The fasteners  
19 are typically delivered to the insertion site by escapement means **1** which holds  
20 each fastener against the end of the upper tool prior to insertion.

21 Individual tooling is specifically designed to install a particular type of  
22 fastener and since there are fasteners of different types and dimensions, separate  
23 tooling is required for installing each type. This therefore requires tooling changes  
24 when there is a change of fastener to be installed. It can become particularly

1       problematic when one workpiece requires different types of fasteners. This  
2       requires either the tooling to be changed many times for each workpiece or for  
3       workpieces to be batched in lots and then re-run with a tooling change between  
4       each run. In either case, there are great inefficiencies and the increased  
5       opportunity for operator and/or workpiece handling errors.

6           In order to solve this problem, tool-changing devices have been created for  
7       fastener-installing punch presses such as disclosed in U.S. Patent 6,106,446 issued  
8       to Kelly et al. and U.S. Patent 6,135,933 issued to Kelly et al. These patents  
9       describe a tool-changing device in which a plurality of anvil tools may be  
10      interchanged by moving individual tools into and out of a tool clamp on the anvil.  
11      This requires rather complicated robotic handling of the individual tools which are  
12      delivered to the anvil site from a movable belt or other device that holds the  
13      individual tools in separate pockets below the anvil. When a tool is changed, the  
14      robotic device lifts the next tool out of a transfer pocket and into a clamp on the  
15      anvil to hold it in place. This system is very complex and expensive. More  
16      simplified anvil-mounted turret-type tool holders for punch presses are known,  
17      however they have no position-sensing means and cannot be used with monitoring  
18      controller software.

19           There is therefore a need in the art for a control system monitored tool-  
20      changing mechanism for a punch press which contains only a few components and  
21      which is rugged and reliable. Furthermore, there is a need for a rugged and reliable  
22      tool-changing system which is economical to manufacture and which provides  
23      position sensing means to ensure proper operation of the press.

24

1    **SUMMARY OF THE INVENTION**

2            In order to meet the above-stated need in the art, the present tool-changing  
3    system has been devised. The present device utilizes a rotary turret on which  
4    different tools are rigidly fixed. The turret includes a circular table base which is  
5    rotatably mounted on the top of the anvil which in turn is attached to the top of the  
6    bottom jaw of a C-frame punch press. As the turret is turned, a different tool is  
7    moved into the work zone in vertical alignment with the upper tool. The turret  
8    table can either be manually or motor driven in either direction between indexed  
9    operative positions.

10           Novel means have been created for sensing the position of the turret and  
11    indexing the turret to its next operating position. This indexing system utilizes only  
12    two simple sensors which are placed beneath the turret table. The sensors are held  
13    in a modular insert which is located within the anvil housing. Each sensor "reads"  
14    a different circular track on the underside of the turret table. Magnetic induction  
15    sensors are used in combination with grooves on the bottom of the turret table  
16    providing an extremely rugged and reliable position-sensing system. The present  
17    invention accommodates four tools per turret table, and with the possibility of  
18    interchangeable index tables, the invention permits any number of tool choices  
19    desired. The indexing system is preferably used in combination with quality  
20    assurance operating software which controls the operation of the press according  
21    to the selection of the proper tool, the delivery of the appropriate fasteners to the  
22    insertion site, and the number of fasteners to be inserted.

23           More specifically, the applicant has invented a rotary tool holder for a press  
24    comprising a press having an anvil including an assembly with means for rotatably

1       mounting a substantially vertical axle. A rotary turret table is affixed to the axle  
2       and mounted above the anvil housing assembly. A plurality of vertically-extending  
3       tools are rigidly affixed to a top side of the turret table and the turret table is  
4       rotatable to a plurality of working positions defined by the points of rotation of the  
5       turret table where each of the plurality of tools is positioned directly beneath an  
6       upper tool of the press. The anvil assembly includes an index pin engageable with  
7       recesses in the bottom surface of the table when the table is in each working  
8       position. It also includes magnetic induction sensors responsive to position  
9       locating means on a bottom side of the table for indicating a working position of  
10      the table. The position locating means are arcuate grooves located along two  
11      concentric circular tracks in the bottom side surface of the table and integral with  
12      the table. Each of the tools are color-coded by colored panels located on the top  
13      side of the turret table adjacent each of the tools. The anvil assembly includes a  
14      housing secured to a lower jaw of a C-frame punch press. The system further  
15      includes a controller electrically connected to the sensors which pneumatically  
16      actuates the index pin into engagement with the recesses in the table when the  
17      sensors signal the controller that the table is in one of the working positions.

18       Greater detail of the invention will be shown in the following drawings  
19       which will describe the invention in detail. It should be understood however that  
20       there may be modifications and adaptations that will be apparent to those of  
21       ordinary skill in the art which fall within the spirit and scope of the invention.

22       **DESCRIPTION OF THE DRAWINGS**

23       Figure 1 is an overall view of a prior art punch press.

24       Figure 2 is a close-up isometric view of the turret table mounting shown

1 with four tools extending vertically from the top of the table.

2 Figure 3 is a close-up of the anvil with the turret table removed which

3 shows bearing means for receiving an axle which extends below the turret table.

4 The two position-indicating sensors are also shown.

5 Figure 4 shows an exploded isometric view of the turret table sensor insert

6 and anvil housing which comprise the main components of the invention.

7 Figure 5 shows a view of the underside of the turret table and the various

8 grooves along two sensor tracks which provide table position signals.

9 Figure 6 is a table which shows the decoding logic employed by the

10 invention.

11 Figure 7 is a timing chart which shows the output of the sensor signals

12 labeled as A and B.

### 13 DESCRIPTION OF THE PREFERRED EMBODIMENT

14 Referring now to Figure 2, the turret table **10** which carries four different

15 tools **a**, **b**, **c**, and **d** is mounted on top of anvil housing assembly **12**. The housing

16 is in turn secured to the top of the lower jaw **14** of a C-frame type punch press. As

17 the turret table is rotated, the tools (in this Figure tool **a**) move to an outermost

18 point which is directly below and in vertical alignment with the upper tool **16**. The

19 turret table may be either motor-driven or manually rotated in either direction. The

20 press also includes fastener delivery means and an automated fastener holder **15**.

21 The table rotates upon an axis defined by axle **18** which extends below the table

22 and is secured by the anvil housing assembly. Signal wire **13** from the sensors

23 passes from the back of the anvil housing and is connected to appropriate

24 controller software which regulates operation of the machine. The table is

1 preferably composed of a ferro-magnetic material such as steel.

2 Referring now to Figure 3, the anvil housing assembly **12** carries within it  
3 an insert **20** which holds magnetic induction type sensors **21** and **22** and also  
4 supports the axle of the turret table in bore **25**. The sensors which read the  
5 encoding structures on the bottom of the table are covered by the table and  
6 therefore protected from the industrial environment above. In this figure, the table  
7 locking mechanism which includes an index pin **24** is also shown. In the locked  
8 position, the index pin extends upward into one of four circular wells on the  
9 bottom of the turret table as shown in Figure 5. In the preferred embodiment, the  
10 index pin is biased by spring means upwardly into the locking position. Controller  
11 software signals a pneumatic actuator (not shown) that moves the pin downward  
12 and releases the table when the table is ready to be moved to the next indexed  
13 position. Cover plate **26** extends across the top of the anvil housing to cover the  
14 components not covered by the turret table.

15 A more detailed assembly drawing of the various structures previously  
16 discussed is shown in Figure 4. It can be seen from this illustration that the present  
17 invention provides a tool change system with an uncomplicated design that has  
18 very few parts. Only two sensors are used for the index positioning system which  
19 is therefore extremely rugged especially since the sensed features are merely  
20 grooves on the bottom of the turret table. The major components of the invention  
21 are mounted to a modular insert **20** that is secured within the anvil housing. Axle  
22 **18** is fitted to the turret table **10** and extends downward through washer and  
23 bearing assembly **45** being received in bore **25** of the anvil insert **20**. The sensors  
24 are also secured to the anvil insert and the entire assembly is fastened to the anvil

1 housing 12 being protected by cover plate 26. This design permits easy access to  
2 all components of the invention and allows simplified repair and ease of  
3 maintenance. Colored panels 43 adjacent each of the tools may be employed to  
4 color-code each tool position. The table color-coding may correspond to color-  
5 coding of the fastener supply to ensure that the correct fastener gets delivered only  
6 to the proper tool. The appropriate color may also be displayed or referenced on  
7 an operator display screen interface which is generated by the controller software.

8 Referring now to Figure 5, details of the bottom of the turret table are  
9 depicted. Arcuate grooves on the bottom of the table provide features to which  
10 the sensors respond. The grooves are located along two concentric circular tracks  
11 of different diameter. As shown in this drawing, groove 33 lies along a portion of  
12 an inner track and groove 34 lies along a portion of an outer track. Four circular  
13 wells 31 are located directly beneath each tool position and these recesses  
14 cooperate with the index pin 24 on the anvil assembly to properly locate the turret  
15 table in each of its four working positions.

16 The arcuate groove pattern on the bottom of the turret table provides the  
17 timing of the output signals from the sensors. One of the novel features of the  
18 invention is the turret table position-sensing decoding system which is achieved by  
19 the two magnetic induction sensors that “read” these grooves which are cut into  
20 the bottom of the turret table along two concentric circular tracks of different radii.  
21 The sensors detect the proximity of the table, i.e. the absence or presence of a  
22 groove adjacent the sensor. Hence, the signal from each sensor changes as a  
23 transition occurs from the grooved to the non-grooved areas of the table as they  
24 pass closely above it. This change of state is read as either an “on” or an “off”

1 condition in the logic program illustrated in Figure 6. In order to determine the  
2 four absolute positions of the table at each tool position or station 90 degrees  
3 apart, the stations are assigned the combined signal states from the sensors at  
4 points when sensors A and B are either both "off" or both "on". As described in  
5 Figure 6, the decoding logic also relies on recording the state just previous to  
6 reaching these points. Figure 7 is a timing chart which shows the change of state  
7 table positions provided by the two sensors labeled A and B when grooves are  
8 placed and decoded according to the invention. The bars in the chart correspond  
9 to the location of the grooves adjacent each sensor as the turret table is rotated.

10 The present invention operates as follows. The invention is preferably used  
11 on a punch press which includes a touch screen interface that displays menus and  
12 accepts selections from the operator. By way of example, the operating system  
13 preferably used with the invention will have four stations of the turret table which  
14 are numbered and colored as for example number 1 – Green, 2 – Blue, 3 – Yellow,  
15 and 4 – Red. At each station separated by 90 rotational degrees of the turret table,  
16 a different anvil is located appropriate to a particular type of fastener to be  
17 installed.

18 After a "set-up" function is selected, the touch screen initiates a "tooling  
19 selection" that prompts the operator to select the desired tool feed sequence to be  
20 run at, for example, Station 1 – Green. The tooling sequence can be automatic  
21 feed of nuts, studs, stand-offs, or double stroke nuts, or the tooling sequence can  
22 just be manual feed by the operator. The next screen displayed is titled "Size and  
23 Material" and prompts the operator to select the size fastener being installed at  
24 Station 1 – Green and the material of the workpiece. This information is used to

1 suggest a starting installation force for this station. The next screen displayed is  
2 titled "Job Set-Up" which prompts the operator to enter the quantity of fasteners  
3 being installed at each station, the installation force and dwell time for each of the  
4 four stations.

5 When all four stations are programmed, the next screen displayed is entitled  
6 "Locate Table" that prompts the operator to rotate the table to Station 1 – Green if  
7 it is not already in that position. The press controller monitors the state of the two  
8 sensors under the table to determine the rotational location as explained above.

9 When the table has arrived at the target station, the press controller releases the  
10 spring-loaded index pin which then extends upward into the index recess on the  
11 underside of the table into the anvil hole opposite the station. The index pin locks  
12 the table in the precise location for installation and prevents the table from rotating.

13 When the controller senses that the table is at the correct station, the controller  
14 software proceeds to display the next screen, a "Safety Set-Up" screen, which  
15 prompts the operator to operate the foot pedal so the press controller can learn the  
16 safe position of the ramp to perform an install. Next, a "Run Mode" screen is  
17 displayed which includes running information for the selected station including  
18 station status, the fastener installation count for the station, the fastener's  
19 installation count for the workpiece, and other information. Installation of the  
20 fastener then proceeds until the run at the selected station is completed.

21 It should be understood that there may be other modifications and changes  
22 to the present invention that will be obvious to those of skill in the art from the  
23 foregoing description, however, the present invention should be limited only by the  
24 following claims and their legal equivalents.

1

CLAIMS

2       What is claimed is:

3       1.       A rotary tool holder for a press, comprising:

4               a press having an anvil including an assembly with means for

5       rotatably mounting a substantially vertical axle;

6               a rotary turret table affixed to the axle and mounted above said

7       anvil housing assembly; and

8               a plurality of vertically-extending tools rigidly affixed to a top side

9       of said turret table, said turret table rotatable to a plurality of working positions

10       defined by the points of rotation of said turret table where each of said plurality of

11       tools is positioned directly beneath an upper tool of said press.

12       2.       The tool holder of claim 1 wherein said anvil assembly further

13       includes an index pin engageable with recesses in the bottom surface of said table

14       when said table is in each working position.

15       3.       The tool holder of claim 1 wherein said anvil assembly further

16       includes sensors responsive to position locating means on a bottom side of said

17       table for indicating a working position of the table.

18       4.       The tool holder of claim 3 wherein the position locating means is

19       integral with said table.

20       5.       The tool holder of claim 4 wherein said position locating means is

21       arcuate grooves in the bottom side surface of said table.

22       6.       The tool holder of claim 5 wherein said sensors are magnetic

23       induction sensors.

24       7.       The tool holder of claim 6 wherein said grooves are located along

1 two concentric circular tracks.

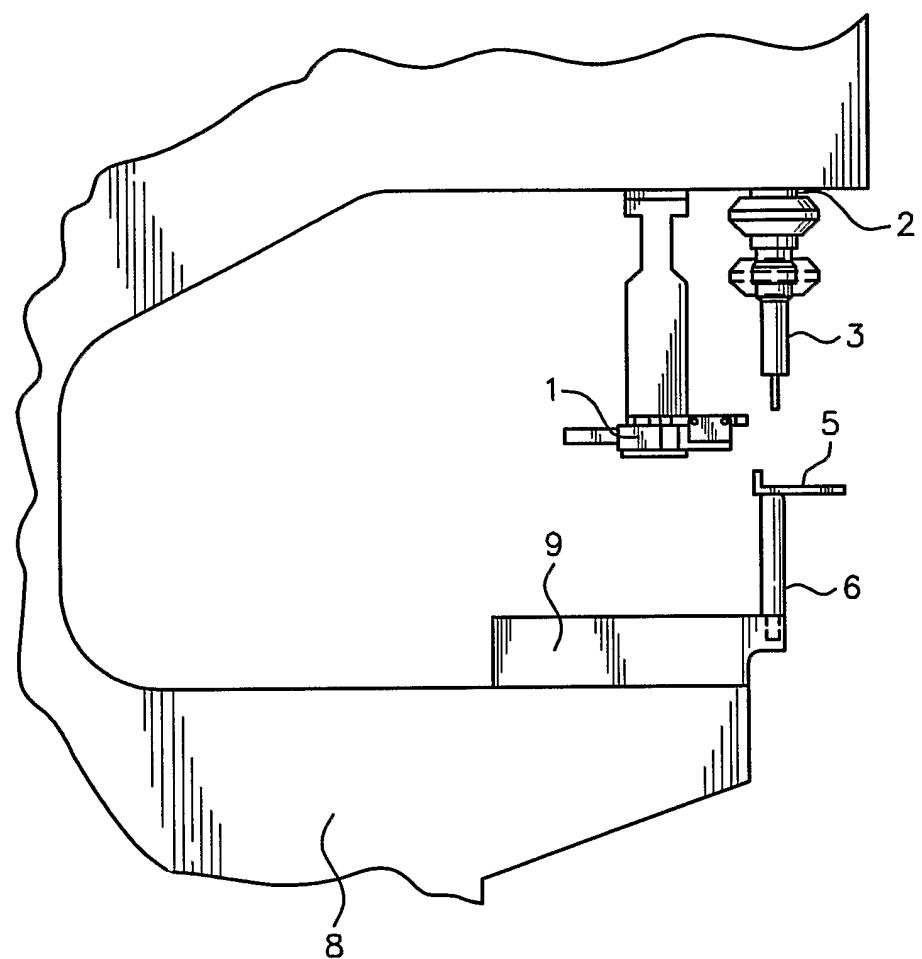
2 8. The tool holder of claim 7 wherein each of said tools are color-coded.

4 9. The tool holder of claim 8 wherein said color coding is provided by colored panels located on the top side of said turret table adjacent each of the tools.

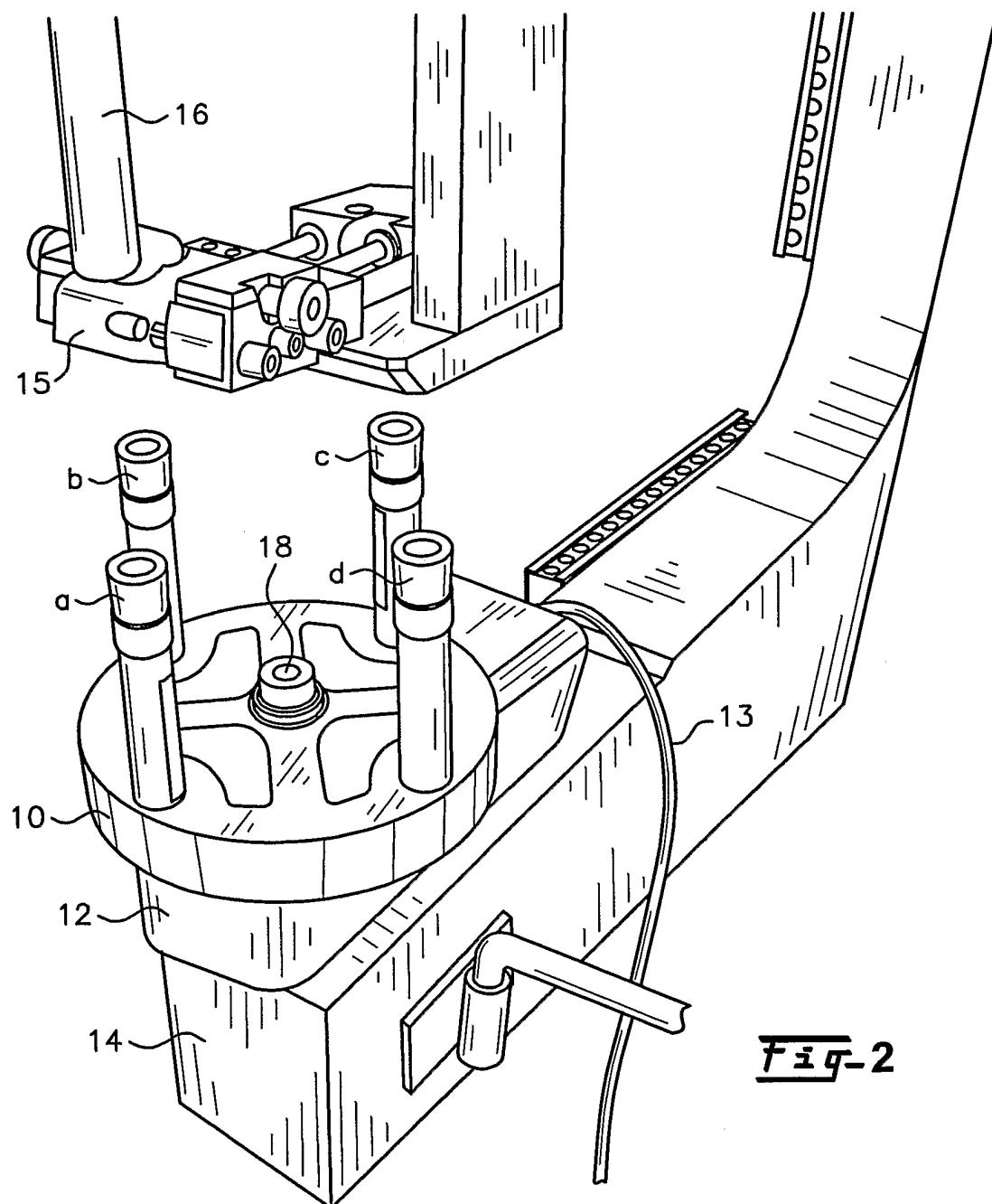
7 10. The tool holder of claim 9 wherein said anvil assembly includes a housing secured to a lower jaw of a C-frame punch press.

9 11. The tool holder of claim 2 further including a controller electrically connected to said sensors for actuating the index pin into engagement with said recesses in said table when said sensors signal said controller that said table is in one of the working positions.

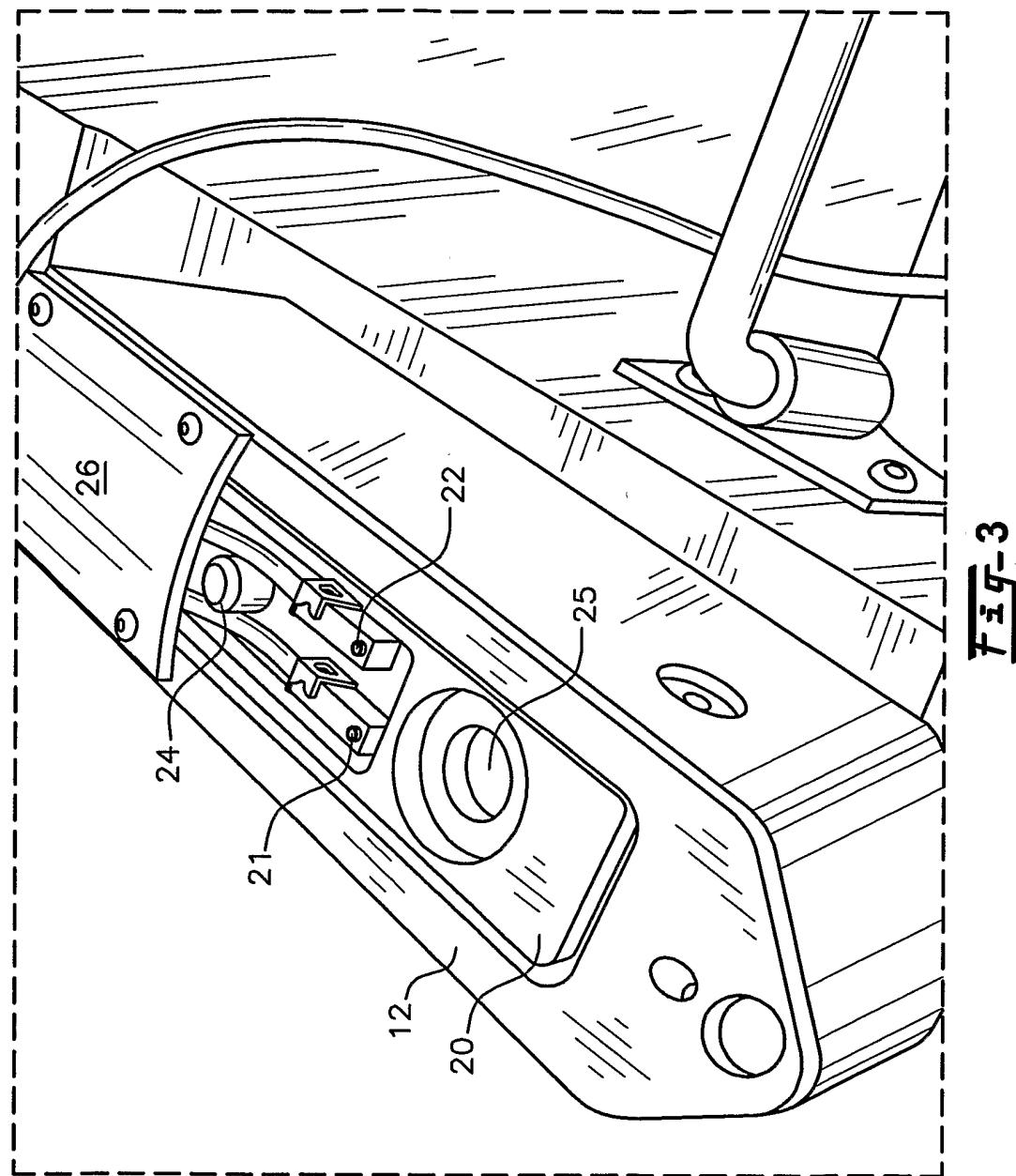
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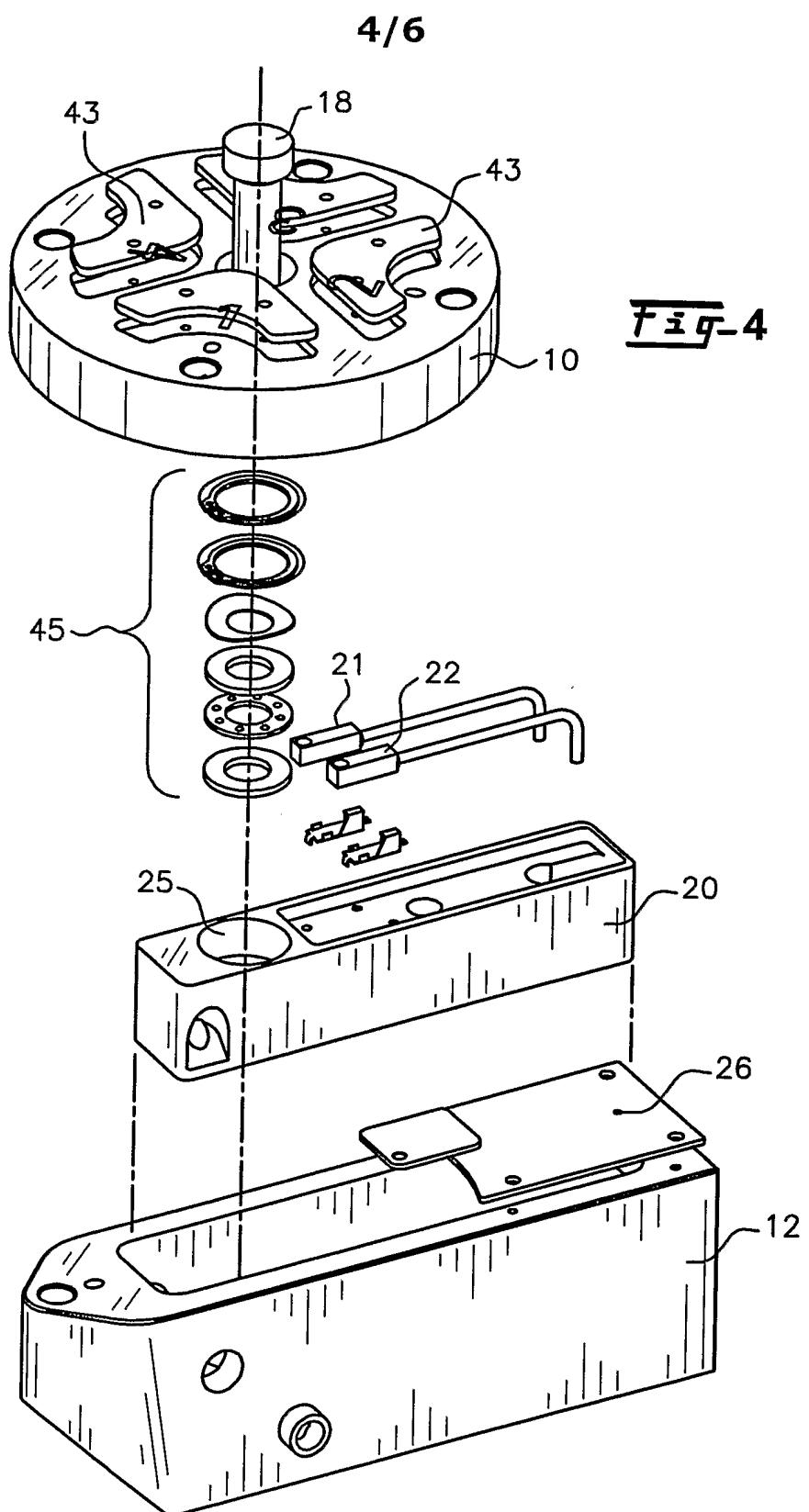
Fig-1

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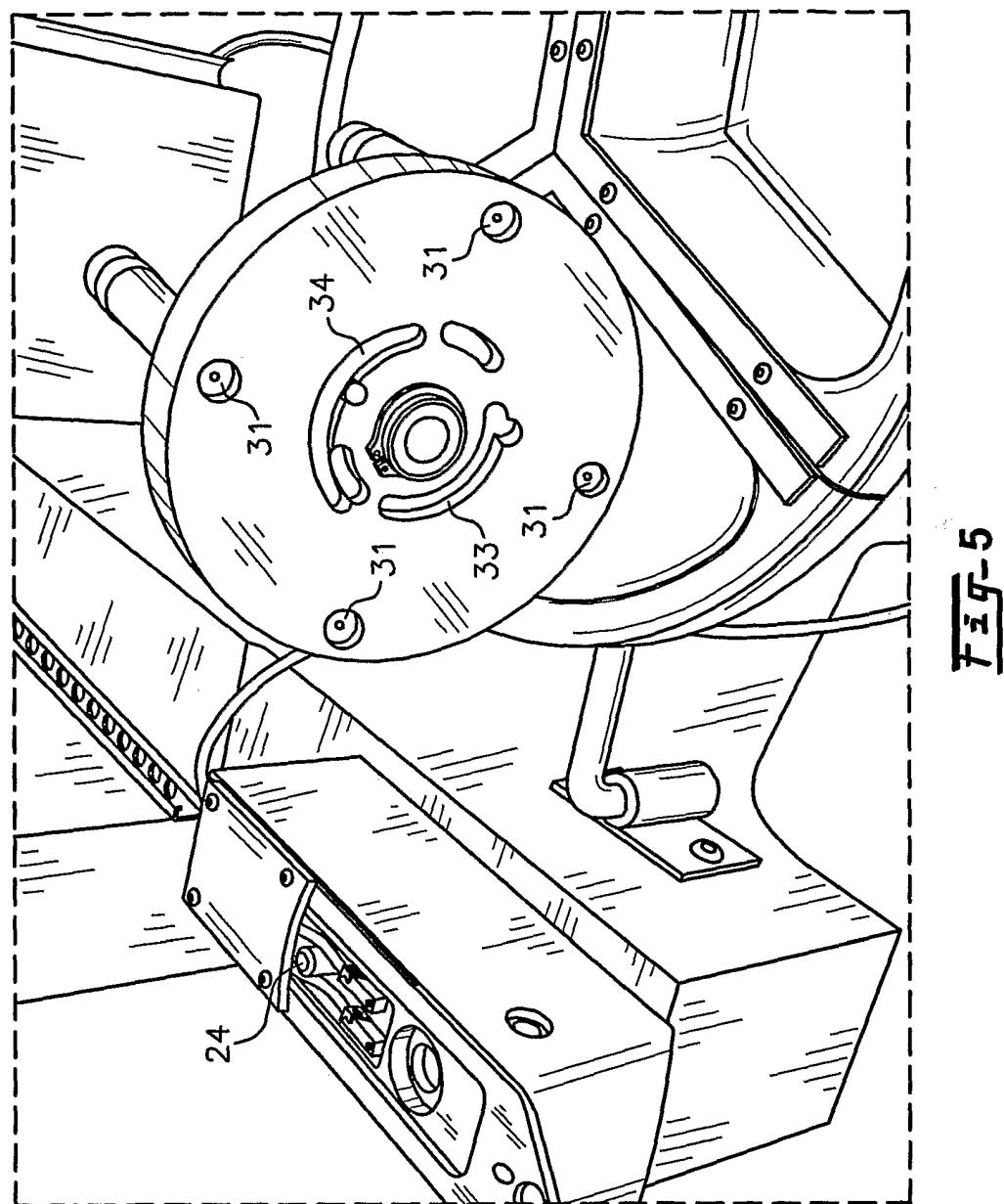


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5/6



**6/6**

Table is at a station if A & B are both ON or both OFF

If both A & B OFF, the table is at Station 1 or 3

If both A & B ON, the table is at Station 2 or 4

A is OFF, B is ON when approaching Station 1 or 2

A is ON, B is OFF when approaching Station 3 or 4

If A-OFF, B-ON becomes A & B-OFF then at Station 1

If A-OFF, B-ON becomes A & B-ON then at Station 2

If A-ON, B-OFF becomes A & B-OFF then at Station 3

If A-ON, B-OFF becomes A & B-ON then at Station 4

Fig-6

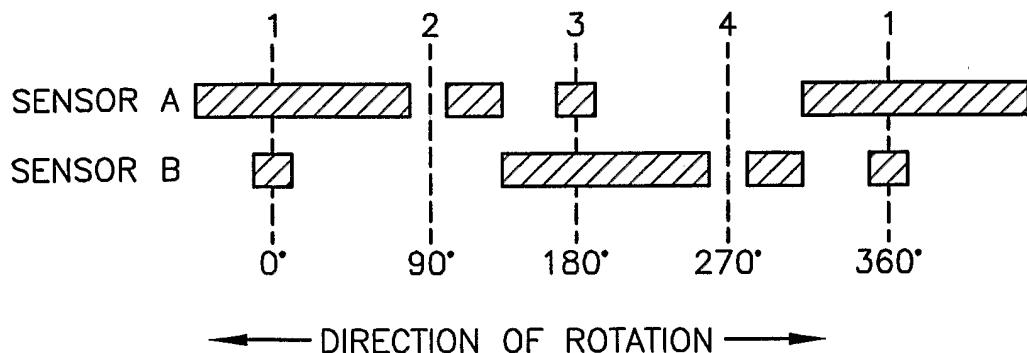


Fig-7