United States Patent

[11] 3,548,714

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[21] Appl. No. 819,180
[22] Filed Apr. 25, 1969
[45] Patented Dec. 22, 1970

[54] BINARY DIGITAL TRANSDUCER
10 Claims, 6 Drawing Figs.

[52] U.S. Cl. 91/36, 91/167: 92/151
[51] Int. Cl. F15b 21/02
[50] Field of Search 91/36, 37, 167; 92/109, 150, 151

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ABSTRACT: This disclosure relates to a precision movement mechanism which includes a plurality of transducer elements each particularly constructed to advance an element a predetermined distance, and the relative movements of the transducer elements being so related so as to compositely form a binary digital transducer.

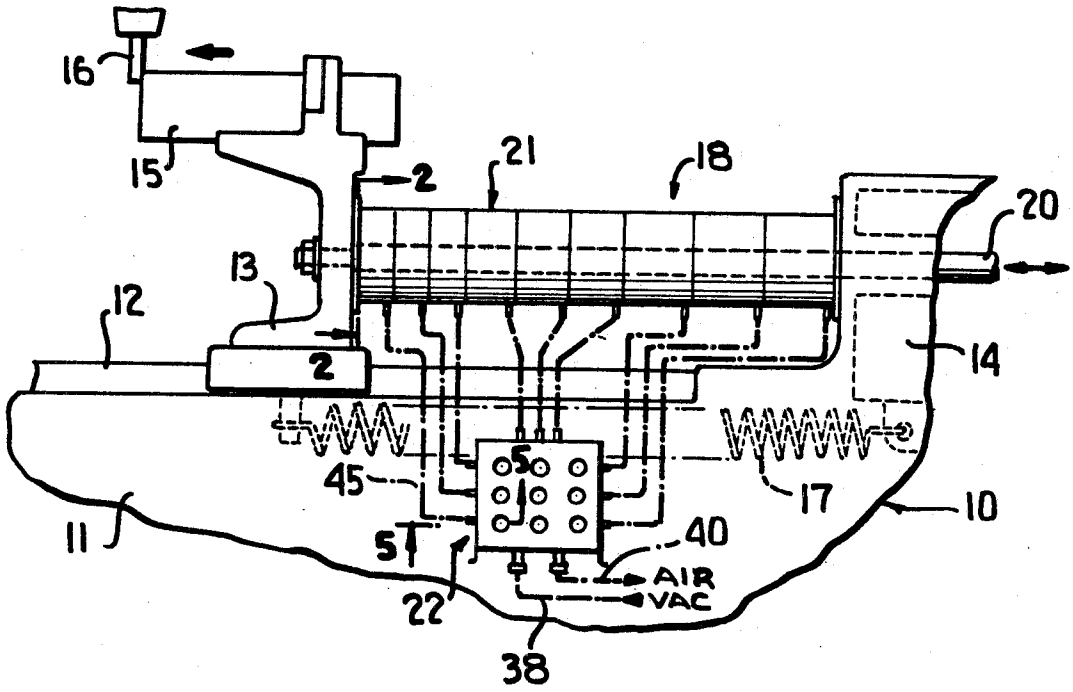


FIG. 1

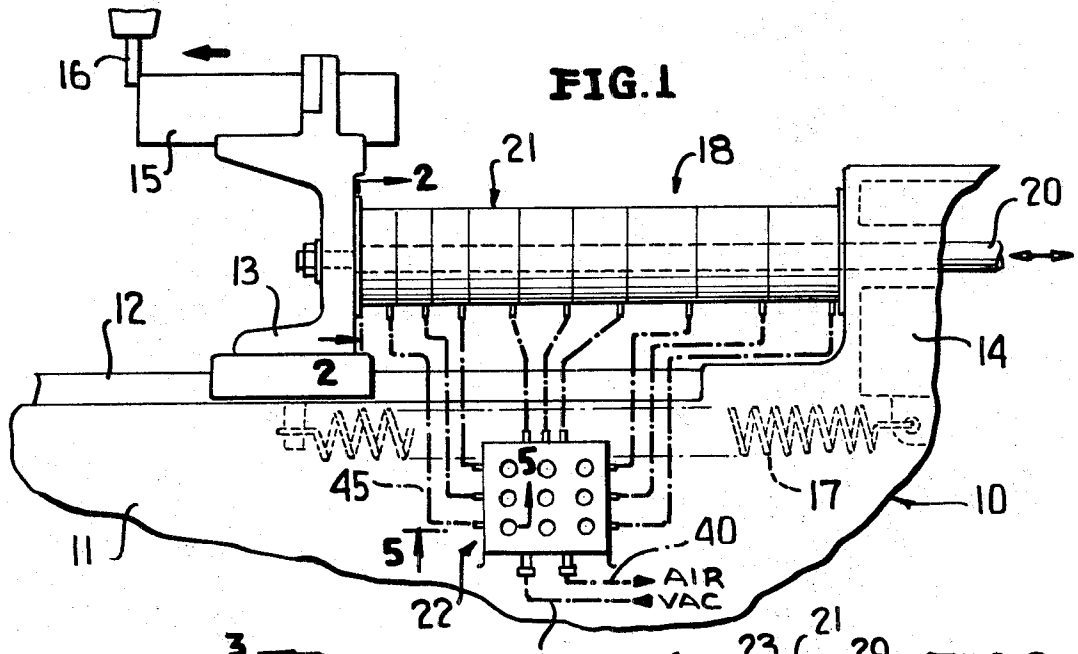


FIG. 2

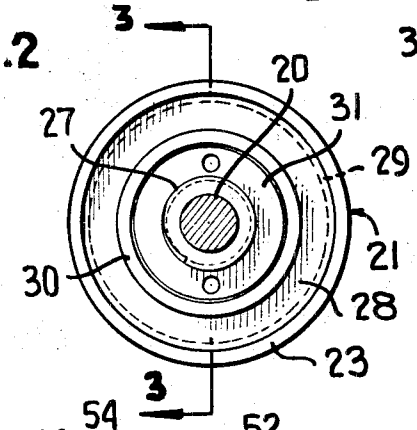


FIG. 3

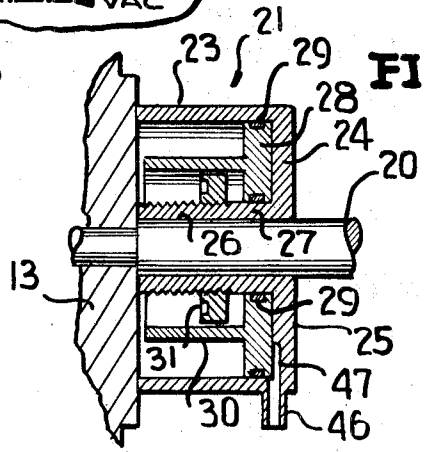


FIG. 5

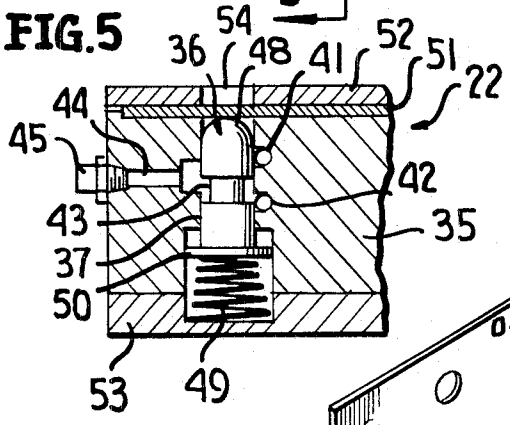


FIG. 4

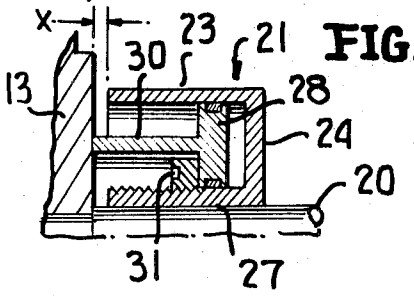
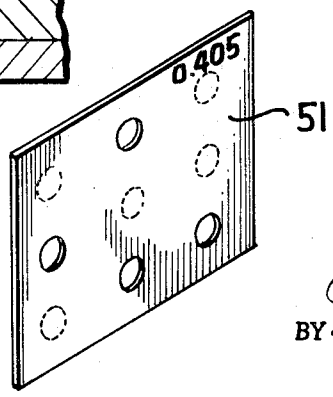


FIG. 6



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BINARY DIGITAL TRANSDUCER

This invention relates to precision movement mechanism for effecting the precision movement of an element a predetermined or preselected distance. The precision movement mechanism is particularly adapted to, but not so limited, use in machine tools.

In accordance with this invention, it is proposed to provide a plurality of transducer elements which are arranged in series. Each of the transducer elements is operable to move an element a predetermined distance. Separate control means are provided for operating each of the transducer elements whereby selected transducer elements may be operated to move a workpiece or like member a predetermined distance. In order that all distances within a range of distances may be effected utilizing the transducer elements, the relationship of relative movements of the transducer elements is a binary one, and the precision movement mechanism may be considered to be a binary digital transducer.

Each transducer element is in the form of a cylinder open at one end and closed at the other with the closed end defining a reference surface. Within each cylinder there is a piston having a projecting part, which projecting part is preferably retracted within the cylinder in the inoperative position of the transducer element and in the operative position projects beyond the cylinder a predetermined distance. For convenience purposes, each cylinder has a central axial opening therethrough so that the transducer elements may be readily mounted on a rod in a series.

In accordance with this invention there is also provided suitable control means for effecting the operation of the binary digital transducer, the control means including a valve block having a plurality of valve elements, one valve element for controlling each of the transducer elements. Each valve element, in its closed position, projects above the valve block and in its open position is flush with the upper surface of the valve block. A punchcard is normally provided for selecting those valve elements which are actuated so as to operate the selected transducer elements.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawing:

In the drawing:

FIG. 1 is a fragmentary elevational view of a machine tool having incorporated therein a precision movement mechanism formed in accordance with this invention.

FIG. 2 is an enlarged fragmentary transverse sectional view showing in elevation the open end of one of the transducer elements.

FIG. 3 is an enlarged fragmentary longitudinal sectional view taken along the line 3–3 of FIG. 2 and shows the specific internal construction of the one transducer element in its inoperative position.

FIG. 4 is an enlarged fragmentary half sectional view similar to FIG. 3 and shows the transducer element in its extended or operative position.

FIG. 5 is an enlarged fragmentary sectional view taken along the line 5–5 of FIG. 1 and shows the internal construction of the control mechanism including the specific details to one of the control valves.

FIG. 6 is a perspective view of a punchcard which may be utilized with the control mechanism to actuate selected ones of the control valves for producing a predetermined combined movement of the binary digital transducer in accordance with the marking of the card.

Referring now to the drawing in detail, it will be seen that there is illustrated in FIG. 1 a conventional type of machine tool which is generally identified by the numeral 10. The machine tool 10 includes a bed 11 having longitudinal rails 12 formed on the upper part thereof. A slide 13 is mounted on the rails 12 for movement longitudinally of the bed 11. The bed is also provided with an abutment member 14 which is generally aligned with the slide and is spaced therefrom.

The slide 13 is particularly constructed in the illustrated machine tool 10 to support a workpiece 15. The machine tool 10 also includes a cutting element or other type of tool element 16.

The slide 13 is constantly urged towards a retracted position towards the right-hand end of the bed 11 by means of suitable retraction means. A simple retraction member in the form of a spring 17 is illustrated. In order to effect the controlled movement of the slide 13 to the left, there is disposed between the slide 13 and the abutment member 14 a precision movement mechanism which is generally identified by the numeral 18. The mechanism specifically provided in accordance with this invention is a binary digital transducer.

The mechanism 18 basically includes a support 20 which is secured at one end to the slide 13 for movement therewith and which is freely slidable through the abutment member 14. There is loosely mounted on the rod 20 a plurality of similar transducer elements, the transducer elements being generally identified by the numeral 21. A control mechanism, which is generally referred to by the numeral 22 is provided for selectively actuating the transducer elements 21.

Referring now to FIGS. 2 and 3 in particular, it will be seen that a typical transducer element 21 includes a cylinder 23 which is open at one end and is provided with a closed end at the other end, the closed end being defined by an end wall 24 which has an exposed reference surface 25. The cylinder 23 has a central opening 26 therethrough through which the rod 20 is freely passable. The opening 26 is defined by an annular internal wall 27 within the cylinder 23.

The cylinder 23 has positioned therein an annular piston 28 which, if desired, may be provided with suitable sealing means 29. The piston 28 is provided with an annular projecting part 30. It is to be noted that when the piston 28 is in its retracted position, the projecting part 30 is fully retracted within the cylinder 23. In order that the outward movement of the projecting part 30 may be limited, the cylinder 23 is provided with an abutment member 31 in the form of an annular ring. The abutment member 31 is threaded onto the internal wall 27 and is extremely accurately positioned so that when the transducer element 21 is actuated, as is shown in FIG. 4, the projecting part 30 of the piston will project beyond the open end of the cylinder 23 a distance X which is a precise predetermined distance.

It will be readily apparent from the foregoing that the accuracy of a transducer element 21 is depended upon the accuracy of the positioning of the abutment member 31. It will, however, be readily apparent that suitable gauges may be provided for measuring the distance X and that while the transducer element 21 is within such a gauge, the abutment member 31 may have the position thereof adjusted to produce the desired projection of the projecting part 30.

Referring once again to FIG. 1 in particular, it will be seen that the precision movement mechanism 18 includes a plurality of the transducer elements 21. Although the transducer elements 21 may be adjusted for any desired movement, it is preferable that the ratio relative movement of respective ones of the transducer elements 21 be a binary relationship. In other words, assuming that the minimum of movement desired utilizing the precision movement mechanism is 0.001 inch, then this would be the effective movement of the transducer element 21 having the least movement. The next smaller movement transducer element would have a movement of 0.002 inch. The next would have a movement of 0.004 inch. This ratio of movement of the transducer elements would be upwardly graded up through and including the transducer element having the maximum movement. It will be readily apparent that with this binary relationship of the movements of the transducer elements, one can produce any movement beginning with the movement of the least movement transducer element up to and including twice the movement of the maximum movement transducer element less the movement of the least movement transducer element.

Reference is now made to the control mechanism 22 which is generally shown in FIG. 1 and wherein specific details

thereof are shown in FIGS. 5 and 6. With particular reference to FIG. 5, it will be seen that the control mechanism 22 includes a valve block or body 35 having a plurality of valve elements 36 mounted therein, there being one valve element 36 for each of the transducer elements 21. The valve block 35 is provided with a bore 37 for each control valve element 36 and the control valve element 36, while it is freely slidable therein, has sufficient frictional engagement with the valve block 35 so as to remain in a last set position.

As is clearly shown in FIG. 1, the valve block 35 has connected thereto a vacuum line 38 and a pressure line 40, the pressure line 40 being an air pressure line, although if desired hydraulic pressure could be utilized.

The valve block 35 is provided with a vacuum port 41 and a pressure port 42 adjacent each bore 37. The valve element 36 is provided with an annular groove 43 in the central portion thereof for communication with one of the ports 41 and 42. In addition, the valve block 35 has an outlet port 44 in communication with each of the bores 37. To each outlet port 44 there is connected a line 45 which extends to the respective transducer element 21 and is connected to a fitting 46 (FIG. 3) of the cylinder thereof. It is to be noted that the fitting 46 opens partially into the wall 24 of the cylinder 23 in the form of a groove 47 so that either a vacuum or a pressure may be always applied behind the piston 28.

The upper end of the valve element 36 may be provided with a rounded nose 48 to facilitate the compressing thereof. The downward movement of the valve element 36 is opposed by a spring 49. As is shown in FIG. 5, when the valve element 36 is depressed, the annular groove 43 is aligned with the port 42 and pressure is delivered through the line 45 to the respective transducer element so as to render the same operative and to project the projecting part 30 thereof. On the other hand, when the valve element 36 is in its elevated position, as effected by the spring 49 and limited by a shoulder 50 on the lower end thereof, the annular groove is aligned with the port 41 and a vacuum is drawn behind the respective piston 28 to hold it in its fully retracted position.

The actuation of the valve elements 36 is effected by means of a punchcard 51. The punchcard 51 is adapted to have openings punched therein in alignment with the valve elements 36 as determined by the dimension of the movement desired for the slide 13. The punchcard 51 of FIG. 6 shows that when it is placed in the control mechanism 22, it will effect a movement of the slide 13 a distance of 0.405 inch. When the punchcard 51 is placed in the control mechanism 51, it will effect the actuation of transducer elements 21 having movements of 0.001 inch, 0.004 inch, 0.016 inch, 0.128 inch and 0.256 inch, the total of which equals the indicated movement 0.405 inch.

Returning once again to FIG. 5, it will be seen that the control mechanism 22 includes an upper plate 52 and a lower plate 53. The plates 52 and 53 are suitably hinged to the valve block 35 in a manner not shown, and are interconnected so that when the plate 52 is moved upwardly to permit a replacement of the punchcard, the plate 53 will move downwardly a slight distance so as to release the spring pressure on the valve elements 36.

It will be readily apparent that when a punchcard 51 is positioned in overlying relation to the valve block 35 and the plate 52 is moved downwardly, any place that the punchcard 51 does not have an opening corresponding to the respective valve element 36, the valve element 36 will be depressed and its respective transducer element 21 will be actuated. On the other hand, when there is an opening in the punchcard 51 aligned with the valve element, the valve element will freely pass through the punchcard 51 and an aligned opening 54 in the plate 52, there being one opening 54 aligned with each of the valve elements 36.

By releasing the spring pressure on the valve element 36 when the card 51 is removed, the valve elements are permitted to remain in their last moved positions during the changing of punchcards. This eliminates the necessity of the transducer elements all being retracted at the end of each operating cycle and then being selectively advanced in accordance with the desired new position of the slide 13.

It will be readily apparent that the punchcards 51 may be formed by any suitable mechanism, including a computer program mechanism so that one could possibly merely punch in the desired dimension, with the computer determining exactly the holes to be punched in the card and simultaneously punching the holes and printing the dimension on the card. For single usage, the punchcard 51 may be formed of paper stock. On the other hand, for repeated usage, the punchcard may be formed of a heavier stock, including paperboard, plastic or even metal. When the punchcards are of a permanent construction, they may be readily stored and the desired punchcard selected from the storage file of figures.

Although only a preferred embodiment of the invention has been specifically illustrated and described herein, it is to be understood that minor variations may be made both in the construction of the transducer element and the construction of the control mechanism without departing from the spirit of the invention.

I claim:

1. A precision movement mechanism including at least one transducer element for effecting a precision movement of an element a predetermined distance, each transducer element comprising a cylinder having an open end and a closed end terminating in a reference surface, means for mounting said cylinder in an operating position with said reference surface abutting a backing member, a piston within said cylinder, said piston including a projecting part retractible relative to said cylinder, and cooperating abutment means between said cylinder and said piston for limiting the projection of said projecting piston part beyond said cylinder at said cylinder open end a predetermined distance.

2. The transducer element of claim 1 wherein said abutment means is in the form of a ringlike member adjustably threadedly engaged with said cylinder.

3. The transducer element of claim 1 wherein said mounting means includes said cylinder being generally of an annular transverse section and having an axial opening therethrough for receiving a mounting rod.

4. The mechanism of claim 1 wherein there are a plurality of said transducer elements arranged in front-to-back relation for cooperation with one another, and control means for selectively actuating said transducer elements to provide a preselected extension thereof.

5. The mechanism of claim 4 wherein said control means includes a separate control valve for each transducer element, and a preformed member for automatically actuating said control valves in accordance with the movement called for by said preformed member.

6. The mechanism of claim 5 wherein said preformed member is in the form of a punched member.

7. The mechanism of claim 5 wherein each control valve is of a construction to remain in a last set position until moved whereby when the effective dimension of said mechanism is being changed only those transducer elements the condition of which is being changed are effected.

8. The mechanism of claim 4 wherein the effective movements of said transducer elements have a binary relationship.

9. The mechanism of claim 4 wherein the effective movements of said transducer elements have a binary relationship, and are combinable to produce all movements between and including the movement of the least effective transducer element to twice the movement of the most effective transducer element less the movement of the least effective transducer element.

10. The mechanism of claim 4 wherein said control means includes vacuum means for holding nonselected transducer elements inoperative, and pressure means for rendering selected transducer elements operative.