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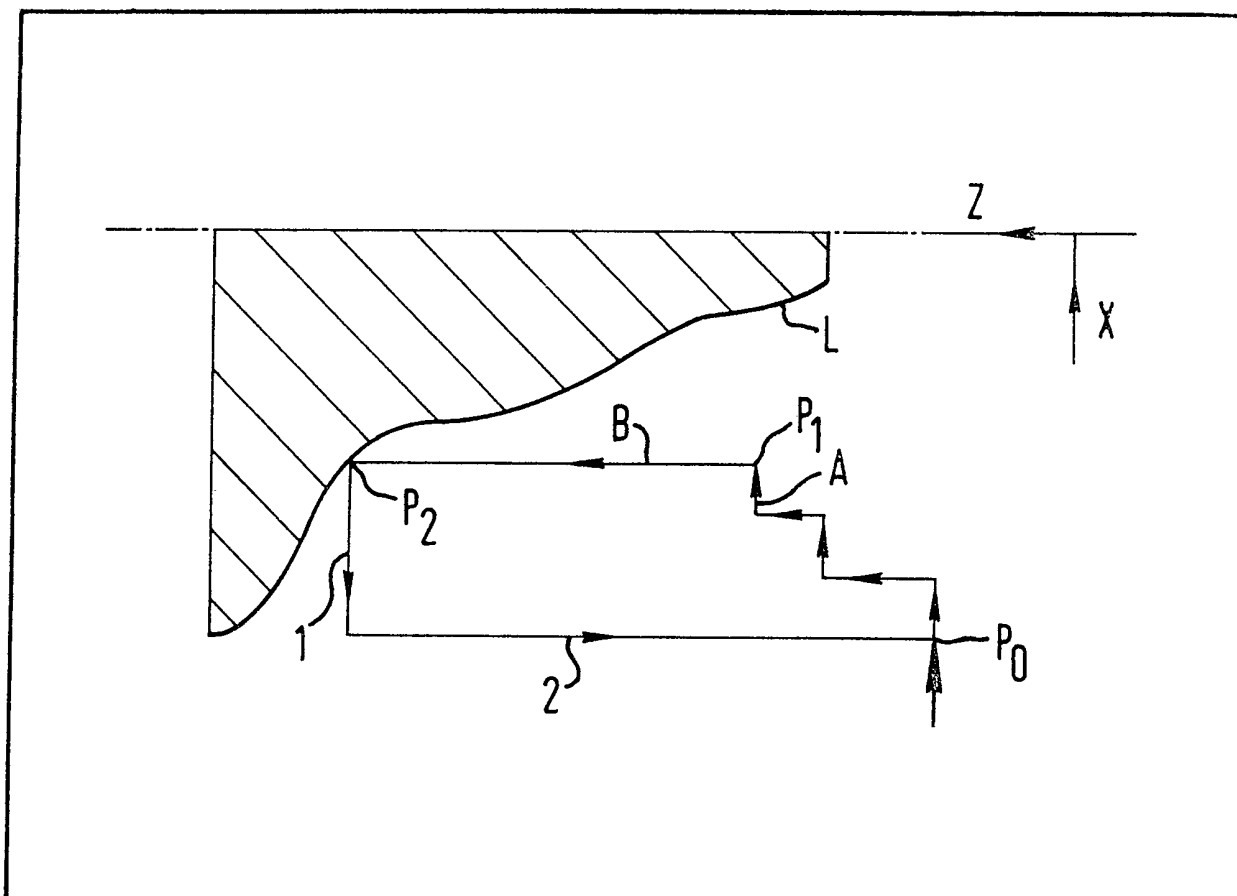
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(54) Programming production
equipment

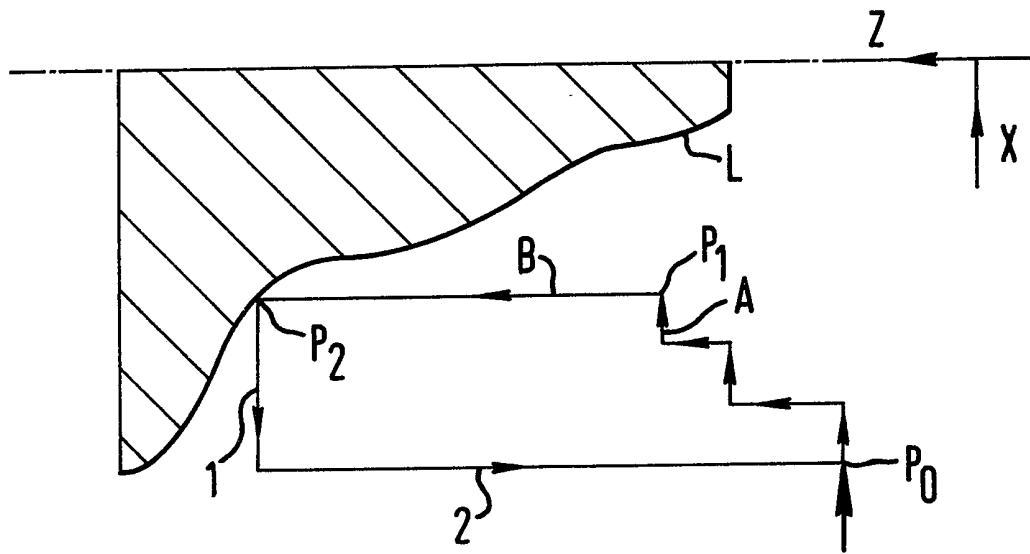
(57) In production equipment
having a movable operating element
and manually actuated drives for
effecting movement of the operating

element e.g. a lathe, welder or paint
sprayer, a programming apparatus
with a microprocessor includes
sensing means for detecting
completion or commencement of a
movement of the operating element. It
is effective thereupon to write
numerical data as to the operating
element position into a store in order
to record the operating element
movements. For example in the lathe,
the position of the machining tool is
recorded each time movement along
either axis X or Z is commenced or
completed.



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SPECIFICATION

Programming production equipment

This invention relates to production equipment and is generally applicable to any such equipment having an operating element which in use executes controlled movements relative to a workpiece. Examples of such an element include a welding head, a paint spraying head, or a machining tool such as that of a lathe. This invention relates particularly to the programming of a numerical control system for controlling movement of the operating element.

In such equipment, it is known for the program to include instructions for the precise movements of the operating element throughout its production cycle and for these instructions to be produced initially by an operator manually actuating drives which effect the desired movements of the operating element. For example in machining equipment (e.g. lathes), the operator manually controls the machining tool to machine a first part to the required profile, with the tool movements being monitored and recorded in a digital store to provide a part program according to which subsequent parts may be machined automatically. In known systems, it is necessary for the operator to actuate a key each time the co-ordinates of the tool position are to be written into the store.

In accordance with this invention there is provided, in or for a production equipment having a movable operating element and manually actuated drives for effecting movement of the operating element, a programming apparatus including sensing means for detecting completion or commencement of a movement of the operating element and effective thereupon to write numerical data as to the operating element position into a store in order for the store to record the operating element movements. Accordingly, there is no requirement for the operator to ensure that he actuates a "write" key each time operating element position co-ordinates are to be stored.

An embodiment of this invention will now be described, by way of example only, with reference to the accompanying drawing, which is a diagrammatic longitudinal section of a part being turned on a lathe, to explain the nature of the part programming apparatus associated with the lathe.

By way of example, a lathe may include two hand-wheels for controlling drives effecting movement of the tool along the respective radial and axial axes X and Z (the desired profile of a part being shown at L), or it may include a single manual control with facility to select between these two axes. The system may be arranged for recording the tool movements, when this mode is selected, wherein the available movements (X or Z directions) are used one-at-a-time. Thus, if a movement A of the tool is effected along the X axis, eventual stopping of this movement is sensed and the new tool position P_1 is written into

the digital data store: if then the tool is moved along the Z axis, when this movement is sensed to have stopped the new tool position P_2 is again written into the store. The system may instead or additionally be capable of recording movements of the tool when it is moved in both X and Z directions at once, again recording the tool co-ordinates digitally when each X or Z direction movement stops or starts. A key may be provided to energise the tool drives to effect its return to its starting point P_0 (via successive X and Z movements 1, 2, for example, which themselves are sensed and recorded in the store), should this return-to-start be desired at certain times in the program.

Following a movement in a given direction parallel to say the X axis, normally it would not be appropriate to effect a movement in the opposite direction along the same axis prior to some movement parallel to the other axis and normally any such reversals would not be recorded. However, the system need not necessarily preclude the facility for recording such movements.

The system preferably includes facility for inserting blocks of data defining standard tool movement cycles, for example for thread cutting.

The above described system is capable of forming a program giving full instructions of the tool for fully automatic operation of a lathe to machine subsequent parts to the same profile. Alternatively, only a portion or several portions of the part may be fully programmed in this manner, leaving other portions to manual control. In any event, facility may be available for controlling the lathe as described in my patent application 8106195, in which the lathe is controllable fully manually but a limit is placed on the tool movements by means of a stored limit profile representing or close to the final required profile.

In order to sense commencement or completion of a tool movement, preferably the system microprocessor monitors the respective train of pulses generated by the manual controller (e.g. hand wheel) only whilst that movement is in progress (i.e. hand wheel being turned).

The system may be applied to 3-axis machines including milling machines.

It is envisaged that the operator may be required to actuate a key at the start and finish of a mode of operation (to write in the tool position at each of those times), with the individual movements within that mode being automatically recorded in accordance with the above description.

A visual display is preferably provided to display e.g. the intended final form of the part being machined and the current position of the tool.

The system may be arranged to effect automatic recordal, at the completion of each block of movements, of the speed of movement of the tool, calculated via an appropriate algorithm from monitoring the operator's actual manual movements of the tool during that period.

Claims

1. In or for a production equipment having a movable operating element and manually actuated drives for effecting movement of the operating element, a programming apparatus including sensing means for detecting completion or commencement of a movement of the operating element and effective thereupon to write numerical data as to the operating element position into a store in order for the store to record the operating element movements.

2. A programming apparatus as claimed in claim 1, the operating element being movable along more than one axis and the apparatus being arranged to write said position data into the store each time movement along any axis ceases or commences.

3. A programming apparatus as claimed in claim 1 or 2, including a key for energising said drives to return the operating element automatically to a starting point, the sensing means being arranged to record in said store, as aforesaid, operating element movements during such returns to the starting point.

4. A programming apparatus as claimed in any preceding claim, in which the sensing means detects completion or commencement of a movement of the operating element by monitoring the presence or absence of a train of pulses generated by a manual controller which causes such movement.

5. A programming apparatus as claimed in any preceding claim, operable to store numerical data defining a limit contour and effective to provide an over-ride limit on the movement of the operating element which is to be permitted by manual actuation of said drives.

6. A programming apparatus as claimed in claim 5, in or for a machining equipment (for example a lathe), in which the limit contour represents the final required profile of a part to be machined, or is close to the required profile of that part so requiring a finishing machining operation after the part has been machined to the limit contour.

7. A programming apparatus in or for a lathe, substantially as herein described with reference to the accompanying drawing.