

The object of the present invention is an auxiliary apparatus for the precision turning of a lateral surface of a workpiece fixed in a spindle of a machine according to the preamble of claim 1.

5 Apparatus of this kind have already been disclosed, especially in Japanese publication No. 50-145, 986 which describes the most recent state of the art. European Patent Application No. 88810239.9 of 14 April 1988 (not published at the priority date of the present application)
10 likewise relates to apparatus of the same kind.

Such apparatus are especially designed for the efficient machining of parts such as the drums which bear recording tapes for VCRs, as well as for digital cassette recorders. A drum of this kind is shown in Figure 1.

15 Prior art apparatus of the type mentioned are generally satisfactory. In most cases they can be used for machining economically and with the requisite precision for the variable-height shoulder which the outer surface of the drum must include. The curve of this shoulder is
20 defined by a cam. In particular, when this shoulder has the curve shown in Figure 1B, i.e., a continuous curve so that the accelerations and decelerations are of limited value, the prior art devices are quite suitable.

However, there are cases where the profile of the
25 shoulders has abrupt modifications which create significant deviations of acceleration and deceleration (see Figure 1C).

The machining of such parts with prior art apparatus requires working at a reduced speed, hence under not very
30 economical conditions.

It is the object of this invention to provide improved apparatus for the precision turning of a lateral surface by means of which workpieces such as those of Figures 1 1C may be machined economically.

To this end, in the auxiliary apparatus according to the present invention, of the type initially mentioned, the cam control comprises several synchronously driven cams, each having a guide surface, and several transmission components mounted on the slide and each intended to co-operate with one of the cams, the guide surface of the cams and the transmission components being arranged so that the transmission components can be brought successively, by displacements of the cross-slide, into bearing positions in which they rest against the guide surface of the cam to which they correspond, against the action of the mentioned elastic means, as as to control displacements of the slide.

A preferred embodiment of the invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 is an elevation of the drum to be machined,

Figure 1A is a detail on a larger scale of zone A of Figure 1,

Figure 1B is a developed view of the profile of a shoulder 1a of an ordinary drum,

Figure 1C is a view similar to that Figure 1B showing the profile of a shoulder having high accelerations and decelerations,

Figure 2 is a diagrammatic top plan view of a turning machine equipped with the preferred embodiment of the apparatus, given by way of example,

Figure 3 is a top plan view of the apparatus,

Figure 4 is a longitudinal section taken on the line A-A of Figure 3,

Figure 5 is a cross-section taken on the line B-B of Figure 4,

Figure 6 is a cross-section taken on the line C-C of Figure 5,

Figure 7 is a longitudinal section taken on the line D-D of Figure 5,

Figure 8 is a view showing the position of the apparatus during turning of a surface 1d, and

5 Figure 9 is a view showing the position of the apparatus during finish turning of the shoulder 1a.

The turning machine illustrated in Figures 2-9 comprises a headstock 2 in which there is disposed a main spindle 3 equipped with a chuck 4 controlled by a pneumatic cylinder 5. A bell-shaped cam 30 is mounted
10 coaxially with chuck 4 and integrally therewith. The profile of its control surface is an exact reproduction of the profile of a shoulder 1a to be machined in a workpiece 1. Spindle 3 is driven by an electric motor (not shown)
15 connected to spindle 3 by belt drive including a belt 6 and a pulley 7 integral with spindle 3. A synchronous belt 9 further connects spindle 3 to an incremental shaft encoder 8 which acts as a transmitter of signals for controlling a driving motor 10 of the auxiliary apparatus.

20 This apparatus is designated as a whole by reference numeral 11. It is fixed on the top plate of a cross-slide support 12 forming part of the machine. It may thus be brought into operating position or into resting position by displacement of device 12. Apparatus 11 includes a
25 base 13 which is fixed to the top plate of device 12. A slide 14 is guided longitudinally in base 13, preferably by hydrostatic means. The oil feed for the hydrostatic support is connected to tapped bores 22, and the oil flows through capillary ducts 24 and bores 23 into oil lodgings
30 25.

One of the end portions of slide 14, which protrudes out of base 13, bears a revolving roller 31 which acts as a feeler and can co-operate with cam 30. This same end portion of slide 14 comprises two toolholder seats 15 in
35 which two turning cutters 16 and 17 are fixed.

In the vicinity of its other end, slide 14 bears a second revolving roller 18 which acts as a feeler co-operating with a second cam 20.

This second cam 20 is integral with a shaft 21 which
5 is mounted pivotingly in base 13 by means of bearings 26. One of the ends of this shaft is designed as a shaft-hub coupling and connected to the drive shaft 27 of an electric motor 10, likewise mounted on the base 13. In this embodiment, the electric motor is a stepping motor, the
10 number of steps per revolution corresponds to the number of pulses transmitted per revolution by the pulse generator 8, and the speed of rotation of which is determined by this pulse generator associated with spindle 32, with the aid of a control unit. The whole is regulated in such a
15 way that cam 20 rotates in exact synchronization with main spindle 3.

For driving cam 20, it would also be possible to use a rotary-field or DC motor equipped with a pulse-generating rotor which would also drive cam 20 synchronously with
20 the main spindle by means of an appropriate control.

A pin 28 fixed in shaft 21 co-operates with a proximity switch 29 to cut off a current upon each revolution for a precisely determined angular position of shaft 21. Thus a reference signal is transmitted which is repeated
25 upon each revolution of cam 20. Pulse generator 8 likewise gives a reference signal upon each revolution for a precisely determined angular position.

Slide 14 finally co-operates with pressing means 19 made up of one or more springs; and it is seen that according to the position of the apparatus governed by
30 cross-slide device 12, it can be held in place, in the direction of its longitudinal displacement, either by roller 18 resting against cam 20 (Figure 8) or by roller 31 resting against cam 30 (Figure 9).

The apparatus described operates in the following manner:

Once coaxial bores 1b and 1c of workpiece 1 have been machined while this workpiece is clamped in chuck 4, apparatus 11 is immediately brought into the active position of Figure 8 by displacement of device 12. Cam 30 then has no effect, and the control of slide 14 is carried out via cam 20. The speed of rotation of main spindle 3 is brought to a low value by braking, while motor 10 or apparatus 11 causes cam 20 to rotate to bring it into its reference orientation. When, in this situation, pulse-generating rotor 8 passes through the orientation which gives the reference signal, motor 10 is switched on and starts to turn synchronously with spindle 3 as regards rpm and angular position. The speed of rotation of spindle 3 is then increased up to the value intended for machining. Motor 10 follows this acceleration. Via support 12, the apparatus carries out a hobbing movement in Z direction, and tool 17 first machines the outside lateral surface 1d of drum 1. During this operation, shoulder 1a is likewise rough-machined, for slide 14 to which tool 17 is fixed follows the profile of cam 20 under the influence of springs 19. It therefore reciprocates axially upon each revolution.

This machining can be carried out at high speed, for the profile of cam 20 is continuous, as shown in Figure 1b, hence does not cause any abrupt jump in acceleration or deceleration. However, the rough-machining precision of shoulder 1a on workpiece 1 is sufficiently precise for it to be able to be subsequently finished by turning in one pass. In addition, during the operation which has just been described, cam 30 is inactive in apparatus 11. Thus, no interfering force liable to disturb the circular turning of the jacket surface 1d of workpiece 1 is exerted upon the bearings of spindle 3.

When machining of surface 1a of workpiece 1 is finished, the rpm of spindle 3 is decreased by braking, and tool 17 is moved away from workpiece 1 by an X displacement of cross-slide 12. Then, this device moves its plate in Z direction and brings auxiliary apparatus 11 into a position corresponding to Figure 9.

In this situation, tool 16 is in an advanced position relative to tool 17. Cam 30 is then in an active position where it acts upon slide 14 via roller 31 and under the action of springs 19. Between roller 18 and cam 20 there now exists a space "X" so that cam 20 has no effect upon the movements of slide 14.

As cam 30 is an exact replica of the profile to be machined, according to Figure 1C, final machining of shoulder 1a and of the neighbouring zone of surface 1d (Figure 1A) is carried out in a single turning pass by displacement of the cross-slide in X direction. As soon as this operation is terminated, cross-slide 12 moves and returns to its starting position, which allows the finished workpiece 1 to be unclamped from chuck 4.

Owing to the use of two cams, one of which has a relatively continuous profile and goes into operation for the machining of surface 1d, and the other, fixed on the spindle, is an exact reproduction of shoulder 1a and goes into operation at the time of the end pass, surface 1d can be machined under economical conditions at high speed. Only the final pass of undercut turning for finishing shoulder 1a, which is not of long duration, necessitates a reduced speed of rotation. As cam 30 fixed on the main spindle is not in action relative to apparatus 11 during machining of surface 1d, no additional force liable to disturb the coaxiality of lateral surface 1d is exerted during this time on the bearings of the spindle. In addition, there is no mechanical connection between apparatus 11 and spindle 3. Hence cross-slide 12 can move

without hindrance throughout its operating area. For finishing bores 1b and 1c, spindle 3 may be accelerated to more than 6000 rpm. All these elements contribute to the fact that the apparatus described makes it possible efficiently to machine tape drums of video and DAT recording apparatus, the shoulder profiles of which present marked jumps in acceleration or deceleration.

Patent Claims.

1. Auxiliary apparatus for the precision turning of a lateral surface (1a, 1d) of a workpiece (1) fixed in a spindle (3) of a machining centre, comprising
5 a base (13) intended to be fixed on a support to a cross-slide (12) of said machining center,
slide means (14) movable in a predetermined direction relative to the base against the action of spring means
10 (19),
holding means (15), integral with said slide means, for a plurality of turning tools (16, 17),
and cam control means (20, 30) comprising at least one cam driven rotatively synchronously with the spindle,
15 said control means ensuring displacement of the tools in the course of which each of them machines a portion of said lateral surface,
characterized in that
said slide means constitute a single slide (14), and
20 in that
said cam control means comprise a plurality of cams for synchronized driving, each having a guide surface, and several transmission elements, mounted on said slide (18, 31), and each intended to co-operate with one of the cams,
25 the guide surfaces of the cams and the transmission elements being arranged so that they can be brought successively by displacements of the cross-slide into bearing positions in which said transmission elements rest against the guide surface of the cam to which it
30 corresponds, against the action of said spring means, in a manner to control displacements of the slide.

2. Auxiliary apparatus as set forth in claim 1, characterized in that the forwarding, positioning and
35 lifting movements of the tools are realized by the



movements of the cross-slide on which auxiliary apparatus is fixed.

3. Auxiliary apparatus as set forth in one of the
5 claims 1 or 2, characterized in that it comprises two
cams.

4. Auxiliary apparatus as set forth in claim 3,
characterized in that the first cam (30) is associated
10 with the spindle (3) of the machining centre bearing a
chuck (4) for the workpiece, and in that second cam (20)
is associated with an auxiliary arbour (21) borne by the
base (13) of said auxiliary apparatus, and is driven in
rotation synchronized in speed and in angular position to
15 the spindle by an electric driving means (8, 10).

5. Auxiliary apparatus as set forth in claim 4,
characterized in that the first cam (30) is a bell-type
cam, integral with the spindle of the machining centre and
20 coaxial therewith.

6. Auxiliary apparatus as set forth in claim 4,
characterized in that the second cam (20) is a flat cam,
and in that the auxiliary arbour (21) is oriented
25 perpendicular in its axis to the direction of displacement
of the slide.

7. Auxiliary apparatus as set forth in the claims 5
and 6, characterized in that the said cams are brought one
30 behind the other in the work position by a displacement of
the cross-slide.

8. Auxiliary apparatus as set forth in one of the
preceding claims, characterized in that the slide is



guided in the base in the said predetermined direction by a hydrostatic bearing means.

