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[54] **SURFACE GRINDING MACHINE INCLUDING WORK FEED, DELIVERY, AND MEASUREMENT MEANS**

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[58] **Field of Search** ..... 51/112, 116, 117, 118, 51/215 AR, 215 HM, 215 CP, 215 H, 215 UE, 165.83, 165.88, 165.87, 165.91; 198/31 AC

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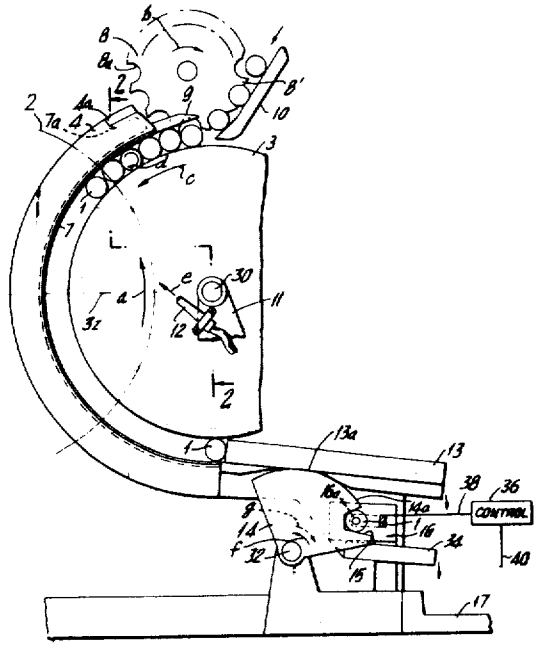
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[57] **ABSTRACT**

A surface grinding machine particularly for grinding workpieces having surfaces of revolution, such as rollers comprises a guide disk having a curved peripheral surface over which the workpieces are moved and a stationary ring overlying the surface which is spaced from the surface by an amount to accommodate the workpieces therebetween. The stationary ring includes an elastic pressure member which permits in a direction toward the curved peripheral surface of the guide disk to engage resiliently against the surfaces of the workpieces to be ground. Workpieces are fed in succession into an inlet defined between one end of the ring and the guide disk and they are removed one at a time from an outlet at the opposite end of the ring. A grinding disk is arranged on each side of the guide disk and its periphery overlaps the periphery of the guide disk and the spacing between the grinding disks is such that they operate on the ends of the workpiece to grind them as they are moved in an operational path between the ring and the surface of the guide disk. The apparatus includes a nozzle mounted adjacent the axis of the guide disk which is oriented to direct a cooling liquid into the operational path. At the outlet end the workpieces are removed one at a time and passed into association with a measuring device for measuring their width and the grind disks are shifted axially in order to ensure that they are positioned at an accurate spacing for the proper grinding of the workpieces. In addition the grind disks are shifted also in response to the wearing of the surface of these grinding disks.

6 Claims, 4 Drawing Figures



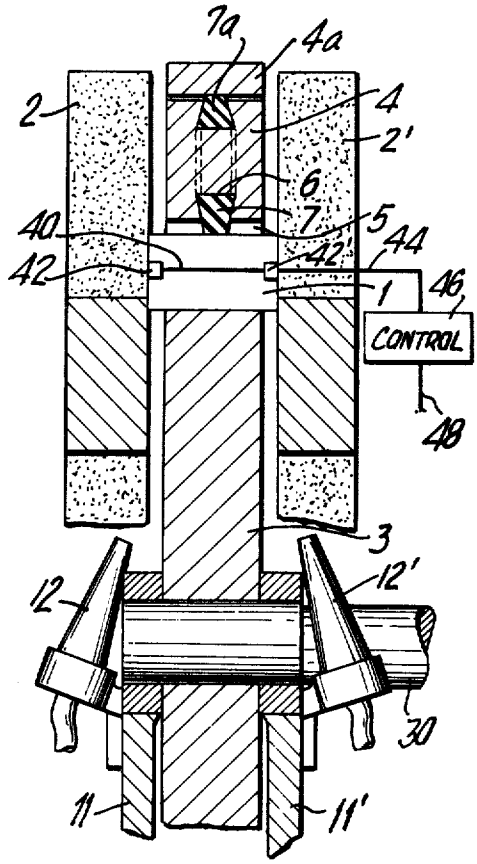

7a
4a
2
4
2'
6
7
5
40
42
42'
44
1
46
CONTROL
48
3
12
12'
30
11
11'

FIG.2

b
8
8a
2
9
8'
10
2
4a
7a
4
3
d
c
1
7
e
30
a
11
32
12
2
13a
13
1
16a
38
36
14a
CONTROL
g
14
16
f
32
34
40
15
17

FIG.1

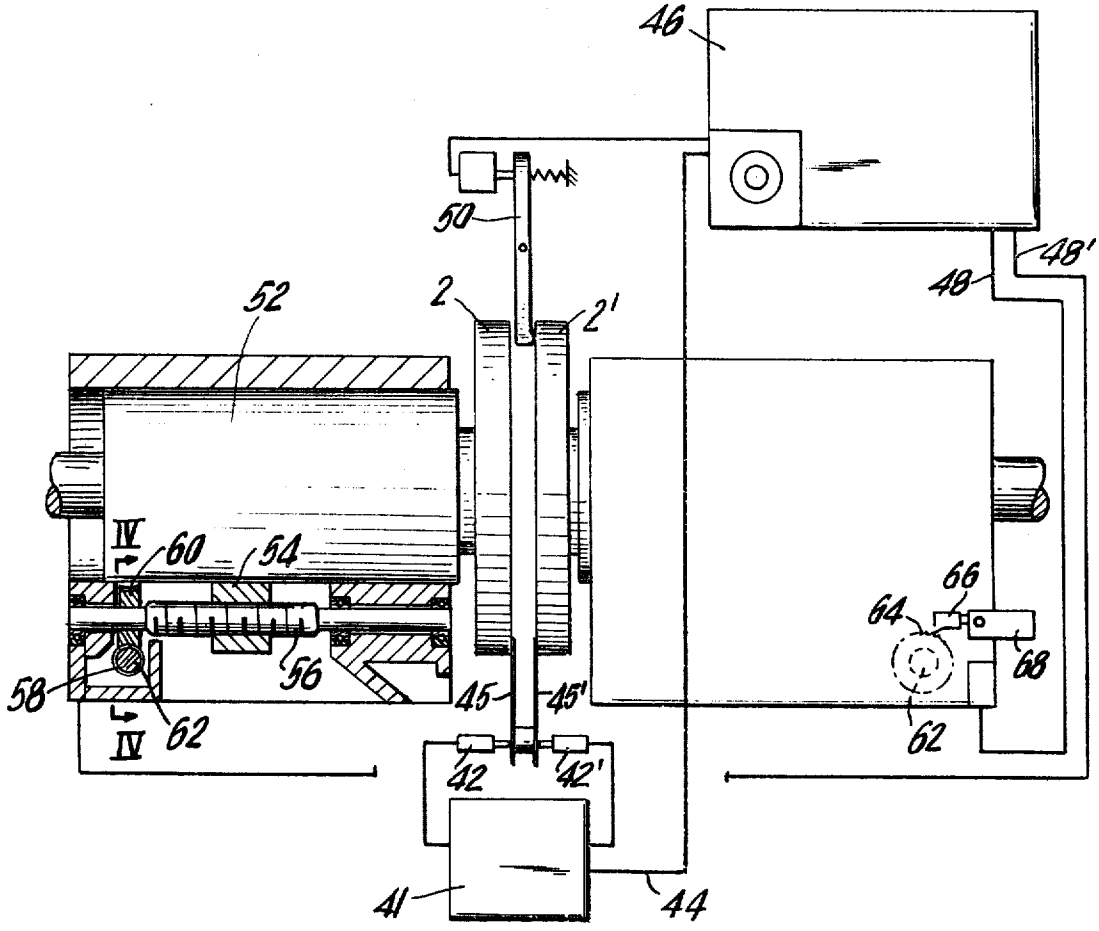

46
50
48'
48
52
2
2'
IV
60
54
66
64
68
58
56
45
45'
62
IV
62
42
42'
41
44

FIG. 3

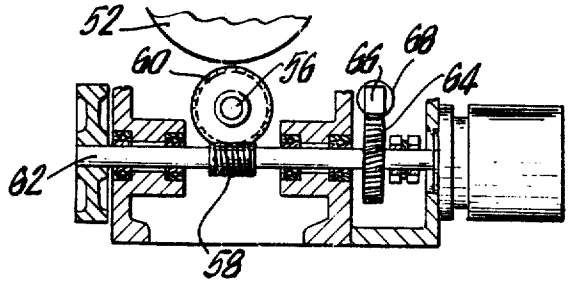

52
60
56
66
68
64
62
58

FIG. 4

SURFACE GRINDING MACHINE INCLUDING WORK FEED, DELIVERY, AND MEASUREMENT MEANS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to the construction of grinding machines and, in particular, to a new and useful grinding machine particularly for grinding workpieces having surfaces of revolution wherein the individual workpieces are moved in an operational path between a fixed partial ring and the periphery of a guide disk and wherein the workpieces are removed at the opposite end of the partial ring after they are passed through an operational path in which they are ground by a grinding disk arranged at each end thereof on each side of the guide disk.

2. Description of the Prior Art

The present invention relates particularly to a grinding machine of the type which is capable of surface grinding the plane-parallel end faces of a workpiece which comprises a body of revolution. For such an operation, it is known to employ a grinding disk on each side of a guide disk which overlaps the periphery of the guide disk and which operates on respective ends of the workpieces which are fed over the surface of the guide disk. In such an arrangement, the workpieces are held by a stationary coaxial ring segment or partial ring which overlies a portion of the guide disk. This type of surface grinding machine is quite satisfactory but for particularly high precision requirements, such as the grinding of rollers or roller bearings, various difficulties are encountered. The stationary ring guide, for example, which includes an elastic pressure element which bears against the workpieces frequently shows a tendency to move in the direction of motion of the workpieces during the feeding of the latter and which they are rotated. When such a pressure element becomes displaced it is no longer suitable for the exact guidance of the body's revolution and for ensuring that they maintain their exact axis parallel position. In addition, during the operation of such machines, the workpieces which are fed in an operational track or path between the stationary ring and the guide disk, tend to resist the grinding action and the forward movement of the workpiece which occurs during the natural feeding motion. This can lead, in conventional constructions, to a loose entrance of the workpieces and thus their canting and when this occurs the grinding will not be absolutely perpendicular to their axes. During the movement of the workpiece through the operational paths in which they are ground by the grinding disks on each side of the guide disk, the workpieces are heated to a very high temperature and this can lead to longitudinal elongation of the workpiece and excessive grinding. In addition, the constant wearing of the grinding disks leads to a change in their dimension and thus results in a grinding of workpieces of unequal length. Thus, then both because of the changes in dimension of the workpiece and also the changes in the profile of the grinding wheels, there are additional inaccuracies introduced into the grinding operation.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a grinding machine which is capable of producing a very accurate grinding of the end faces of a workpiece having a surface of revolution between the end faces. For this purpose, the grinding machine includes a feeding arrangement which assures that the workpieces will be moved through the path of grinding operation and out of the grinding machine while they maintain the axis parallel so that they will always be ground exactly in a right angle to the axis and always ground to the same lengths. For this purpose, the grinding machine, according to the invention, comprises a ring segment which is positioned to overlie a portion of the circularly cylindrical surface of a guide disk and which defines an inlet with the guide disk at one end and an outlet at the opposite end for the workpieces and which includes a grinding disk on each side of the guide disk which operates to grind the end faces of the workpieces as they are moved in the operational path and which also includes means for cooling the workpieces in the operational path and for removing the workpieces one at a time and for determining their length, and wherein the grinding disks are mounted on their associated shafts so that they may be shifted axially in accordance with the changes of dimension of the workpieces which are measured and in accordance with the changes of the grinding profiles or the grinding disks.

Accordingly, it is an object of the invention to provide an improved grinding machine which includes a guide disk and a stationary ring segment defining a feed path for workpieces which comprise bodies of revolution therebetween and which includes a resilient pressure member which bears against the workpieces so that they are rotated as they are progressed through the operational path and which includes grinding disks on each side of the workpieces which overlaps the guide disks at least in the operational path to engage and grind the workpieces and wherein the grinding disks are mounted so that they may be adjusted in accordance with the dimensions of the workpieces after they are ground in the operational path and in accordance with the profile characteristics.

A further object of the invention is to provide a grinding machine which is simple in design, rugged in construction and economical to manufacture.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawing:

FIG. 1 is a partial side elevational view of a grinding machine constructed in accordance with the invention;

FIG. 2 is a section taken along the line II—II of FIG. 1;

FIG. 3 is a schematic elevational view partly in section of the mounting for the grinding disks; and

FIG. 4 is a section taken along line 4—4 of FIG. 3.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, the invention embodied therein comprises a grinding machine which includes a pair of spaced apart parallel grinding disks 2 and 2' which are mounted for axial shiftable movement on a drive shaft (not shown) which is driven by a drive means (not shown) so that it rotates counterclockwise as indicated by the arrow *a*. The guide disk

3 projects with play between the grinding disk 2,2' and it is mounted on a shaft 30 which is driven by the drive means also in a counterclockwise direction as shown by the arrow *c*. An axis 3z of the shaft 30 extends in the same horizontal plane as the axis of the grinding disk. A stationary ring segment 4 overlies a portion of the guide disk and it is mounted so as to be coaxial in respect to the guide disk but spaced from the outer periphery of the guide disk by an amount to accommodate individual workpieces comprising bodies having surfaces of revolution such as rollers 1. The space between the ring segment 4 and the surface of the guide disk 3 defines an operational path of movement for the workpieces which is overlapped on each side by the grinding disks 2,2'. The inner face of the ring segment 4 and the outer surface of the guide disk 3 define a guide channel or operational path 5 for the rollers 1 and the ring includes an elastic pressure element 7 of a rubber elastic material which extends through a dovetail groove 6 of the ring and projects downwardly into the operational path 5 into pressure contact with the individual rollers 1. The inner edges of the pressure element are rounded off to facilitate the insertion into the groove 6 and also to increase the compressibility of the element within the groove.

The grinding disks 2,2' and the guide disk 3 rotate counterclockwise to cause the rollers to rotate themselves in the direction of the arrow *d* which is clockwise as they are moved through the operational path 5. During this movement they move through a zone of the operational path in which they are overlapped by the grinding disk 2 and 2', at which time the pressure element 7 is subject to great pressure. A particularly suitable material to withstand this very great pressure which always acts in the same direction and which is also sufficiently elastic to permit deformation to a limited extent so that the rollers do not move out of their axis parallel position, is a plastic of the type referred to as ADIPRENE. The deformation of the elastic pressure member 7 in the direction of travel of the rollers results in a considerable tension in the pressure element in this direction and this can lead to the displacement of the element in the groove 6. In order to prevent this, however, the inlet end 7*a* of the pressure element 7 is raised upwardly over the end face of the ring segment 4 and is clamped downwardly by an insert 4*a* which is secured to the ring segment 4 by suitable securing elements.

Means are provided for feeding each workpiece 1 in succession into the inlet end of the operational path 5 and this means comprises a conveyor wheel 8 which is rotatably mounted in the plane of the guide disk 3 and which protrudes between two laterally spaced stationary guide fingers 9,9'. The conveyor wheel 8 includes regularly spaced teeth 8' having flank end faces 8b which are inclined to the tangential plane of the teeth. An inclined feed trough 10 in which workpieces 1 are fed such as by gravity, is located directly adjacent the lower end of the conveyor wheel 8 and the workpieces 1 are fed in succession to a position in which they are engaged between adjacent teeth 8' of the wheel. As the wheel 8 rotates in the direction of the arrow *b* the workpieces 1 are moved in succession into the operational path 5, and they are pushed along the path initially by oblique end faces 8*b* of the teeth 8'.

In accordance with a feature of the invention, support members 11 and 11' are secured to the shaft 30 on each side of the guide disk 3 and they carry respective nozzles 12 and 12' for directing a cooling medium in the direction of the arrow *e* into the portion of the operational path 5 in which the path is overlapped by the grinding disks 2,2'.

The nozzles 12 and 12' are connected through suitable conduits to a cooling liquid pump (not shown).

The outlet end of the guide channel 5 at the opposite end of the ring segment 4 from the inlet end 7*a* includes delivery means for the discharge of the individual workpieces 1 which includes a discharge trough 13 for the finished rollers which has a recess 13*a* dimensioned slightly greater than the rollers. A pivotally mounted sector-shaped arm 14 is oscillated on a pivot support 32 and it includes a partially cylindrical outer surface 14*a* which covers the recess 13*a* and the trough bottom in one position. The opposite end of the arm 14 is provided with a recess 15 having a wedge-shaped cross section and having a depth and width so selected that a roller or workpiece 1 can be fully accommodated therein. In the swivel position of the arm 14 represented in FIG. 1, its outer surface 14*a* closes the trough recess 13*a* and the arm recess 15 which carries a workpiece 1 is oriented so that the workpiece is positioned in a measuring device 16. The measuring device is provided with two feelers 16*a* which sense such as by contacting end faces of the workpiece 1 which has already been ground in order to determine the precise length of this finished workpiece. The feelers 16*a* hold the workpiece against removal out of the recess 15 until the measuring is complete and then they relax so as to permit the workpiece to roll down the inclined end faces of the recess and into a trough or delivery chute 34 having an opening at its outer end to permit the finished workpieces to drop into a collecting device 17.

With the machine in operation, the rollers 1 are so pressed by means of a conveyor wheel 8 that they move individually into the operational path 5 and travel without interval along the path after they move out of the gaps 8*a* between teeth 8'. When they enter into the portion of the operational path which extends between the grinding disk 2, the rollers are effectively cooled by the cooling liquid which issues from the nozzles 12, 12' so that undesired elongation of the rollers is prevented. The ground rollers 1 then arrive in thr trough 13 and they move along the trough to the recess 15 over the surface 14*a* of the arm 14 until the arm is moved in the direction indicated by the arrow *f* in solid lines positions the recess 15 below the opening 13 so that the workpiece falls into the recess. Further movement of the arm 14 in the direction of the dotted line arrow *g* will advance the workpiece 1 to the position indicated in FIG. 1.

When the workpiece is positioned in the measuring device 16, its length is measured by the device and this information is fed to a control 36 through a connecting line 38. The control 36 is connected through a line 40 to means for shifting the grinding wheels 2 and 2' along their drive axes (not shown). In this manner the spacing between the grinding disks 2,2' may be changed in order to accommodate a deviation of the measuring result from a nominal value. An additional measuring device or sensor 40' includes feelers 42 and 42' which are placed in association with the grinding edges of the grinding disk 2 and 2' in the area thereof which is contacted by the workpiece and the wearing of the grinding disks is sensed and the condition is transmitted as a signal through a conduit 44 to a control 46 which is

connected through a connecting line **48** which is connected to similar means for shifting the disks **2,2'** to accommodate for the wearing of the disks. The control **46** is such that the disks **2,2'** are maintained at a spacing which will provide for an automatic correction of this spacing due to the wearing of the disks.

Since the workpieces **1** which are pushed by the conveyor wheel into the guide channel or operational path **5** are pressed very heavily against the pressure element **7** when entering the portion of the path which moves between the grinding disks **2,2'**, a direct contact between these rollers with the ring segment **4** can hardly be avoided at least momentarily. In order to avoid an undesired wear at this point, the inner surface of the ring segment **4** is specially hardened or equipped with a specially hard insert. Thus the machine provides many safety features for ensuring that the workpieces are accurately ground to a desired dimension.

As shown in FIGS. **3** and **4**, control **46** is connected to sensors **42** and **42'** of a measuring device **41**, so that positions of the edge extensions **45** and **45'** of the disks **2** and **2'** may be sensed. A position indicator **50** is also connected to the control **46**. The control **46** is connected through lines **48** and **48'** to means for shifting disks **2** and **2'** by shifting its roll support **52** having a nut **54** threaded on a drive spindle **56** which is rotatably supported below roll support **52** and is driven by worm **58** acting through gear **60** on the spindle **56**. Gear **58** is carried on a shaft **62** which carries a ratchet wheel **64** driven by a pawl **66** which is part of an electrically driven solenoid **68'**.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

We claim:

1. A surface grinding machine particularly for grinding workpieces having surfaces of revolution, for example rollers, comprising a guide disk having a curved peripheral surface over which the workpieces are moved, a stationary ring overlying at least a portion of said curved spherical surface and spaced therefrom by an amount to define a workpiece operational path to accommodate the workpieces therebetween, the respective opposite ends of said ring defining an inlet and an outlet with said guide disk at the respective ends, means for feeding workpieces into the space between said ring and said guide disk peripheral surface at said inlet of said ring segment, a cylindrical grinding disk on each side of said guide disk having a periphery overlapping the periphery of said guide disk on respective sides thereof so as to be in a position to contact and grind the end surfaces of the workpieces moving over the peripheral surface of said guide disk along said operational path, delivery means at said outlet end of said ring for feeding said workpieces out of said operational path, an elastic pressure element held by said ring segment and adapted to bear inwardly against the workpieces, said delivery means including a member engaging each workpiece in succession, and measuring means adjacent said delivery means for measuring the width of the workpiece, said grinding disk being movable toward and away from each other to change the spacing therebetween in accordance with the measurement obtained by said measuring means, said delivery means including an oscillatable segment member having an outer curved surface with a recess adjacent one end of a size to accommodate a workpiece, a delivery trough connected to said operational path and having an opening therein for a workpiece overlying the curved surface of said segment, said segment being oscillatable to periodically present the recess therein below the opening in said trough to receive a workpiece and being oscillatable in a reverse direction to present the workpiece at a delivery station, said measuring means being located at said delivery station, said measuring means comprising a feeler arm on each side of the workpiece engageable with said workpiece and holding it in the recess until it is measured.

2. A surface grinding machine, according to claim **1**, including nozzle means for supplying a cooling liquid to the operational path of the workpieces on each side of said guide disks.

3. A surface grinding machine, according to claim **1**, including a sensing device for sensing the amount of wear of the grinding disk at the area bearing against the workpieces and adapted to be connected to the disk for shifting them relative to each other for changing the spacing therebetween in order to accommodate for the wear of said disk.

4. A surface grinding machine, according to claim **1**, wherein said ring segment includes a dovetail groove extending therethrough of a generally trapezoidal cross section, said pressure element being disposed in said groove and having rounded off edges.

5. A surface grinding machine, according to claim **4**, wherein said pressure element extends around said ring segment from end to the other, said pressure element at the inlet end of said ring segment extending outwardly from the outer surface of said ring segment, and an insert clamped to said ring segment overlying said elastic pressure element.

6. A surface grinding machine particularly for grinding workpieces having surfaces of revolution, for example rollers, comprising a guide disk having a curved peripheral surface over which the workpieces are moved, a stationary ring overlying at least a portion of said curved spherical surface and spaced therefrom by an amount to define a workpiece operational path to accommodate the workpieces therebetween, the respective opposite ends of said ring defining an inlet and an outlet with said guide disk at the respective ends, means for feeding workpieces into the space between said ring and said guide disk peripheral surface at said inlet of said ring segment, a cylindrical grinding disk on each side of said guide disk having a periphery overlapping the periphery of said guide disk on respective sides thereof so as to be in a position to contact and grind the end surfaces of the workpieces moving over the peripheral surface of said guide disk along said operational path, delivery means at said outlet end of said ring for feeding said workpieces out of said operational path, an elastic pressure element held by said ring segment and adapted to bear inwardly against the workpieces, said delivery means including a member engaging each workpiece in succession, and measuring means adjacent said delivery means for measuring the width of the workpiece, said grinding disk being movable toward and away from each other to change the spacing therebetween in accordance with the measurement obtained by said measuring means, said means for feeding workpieces comprising a rotatable sprocket wheel having spaced teeth around its periphery, gaps between the

teeth into which the workpieces are engageable, an inclined chute adjacent the lower end of said sprocket wheel for feeding the workpieces into a location in which they may be engaged between the teeth of the sprocket wheel and advanced by rotation thereof into said operational path and a finger guide on each side of said sprocket wheel for engaging the workpieces which are fed and reflecting them downwardly onto the surface of said guide disk, said guide disk and said grinding disks being rotatable in the same rotational direction, said elastic pressure element pressing said workpieces onto said guide disks so that the workpieces rotate in a clockwise direction as they are moved along side operational path, the flanks of said sprocket wheel teeth being oblique so that they form surfaces for pushing the workpieces in succession into the operational path.

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