United States Patent

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[54] BELT GRINDING MACHINE

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Related U.S. Application Data

[63] Continuation of Ser. No. 684,867, Nov. 21, 1967, abandoned.

[52] **U.S. Cl.** **51/138,** 51/141

[51] **Int. Cl.** **B24b 21/08**

[58] **Field of Search** ..... 51/135 R, 141, 148, 137–139

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[57] **ABSTRACT**

A belt grinding machine which is equipped with an elastically flexible load beam extending over the entire operative length of an endless grinding belt for applying the necessary grinding pressure to the belt. The effective pressure-applying surface of said beam is suspended for elevational control from support elements distributed at intervals along the length of the beam and attached to an elevationally movable carrier preferably in the form of transverse beams mounted on push rods operable by a pressure medium. The push rods are associated with constant delay mechanism adjustable to the difference in time between the instant of response of a sensing element to the passage of the leading end of a workpiece and the instant the grinding action begins, on the one hand, and between the instant of response of a sensing element to the passage of the trailing end of the workpiece and the instant the grinding action terminates, on the other hand.

13 Claims, 6 Drawing Figures

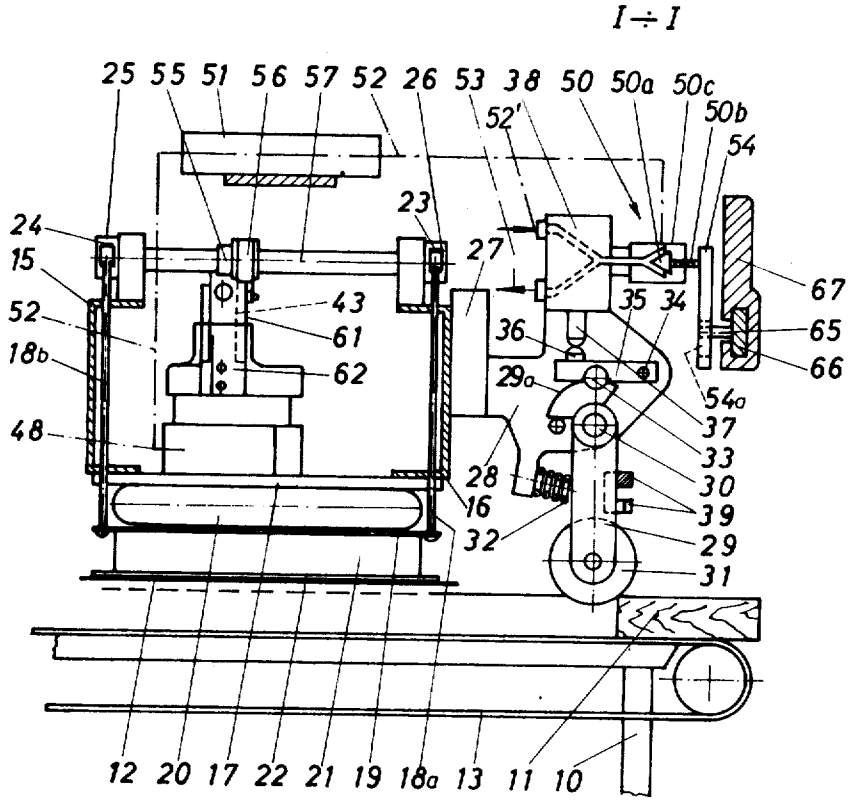

Fig.1

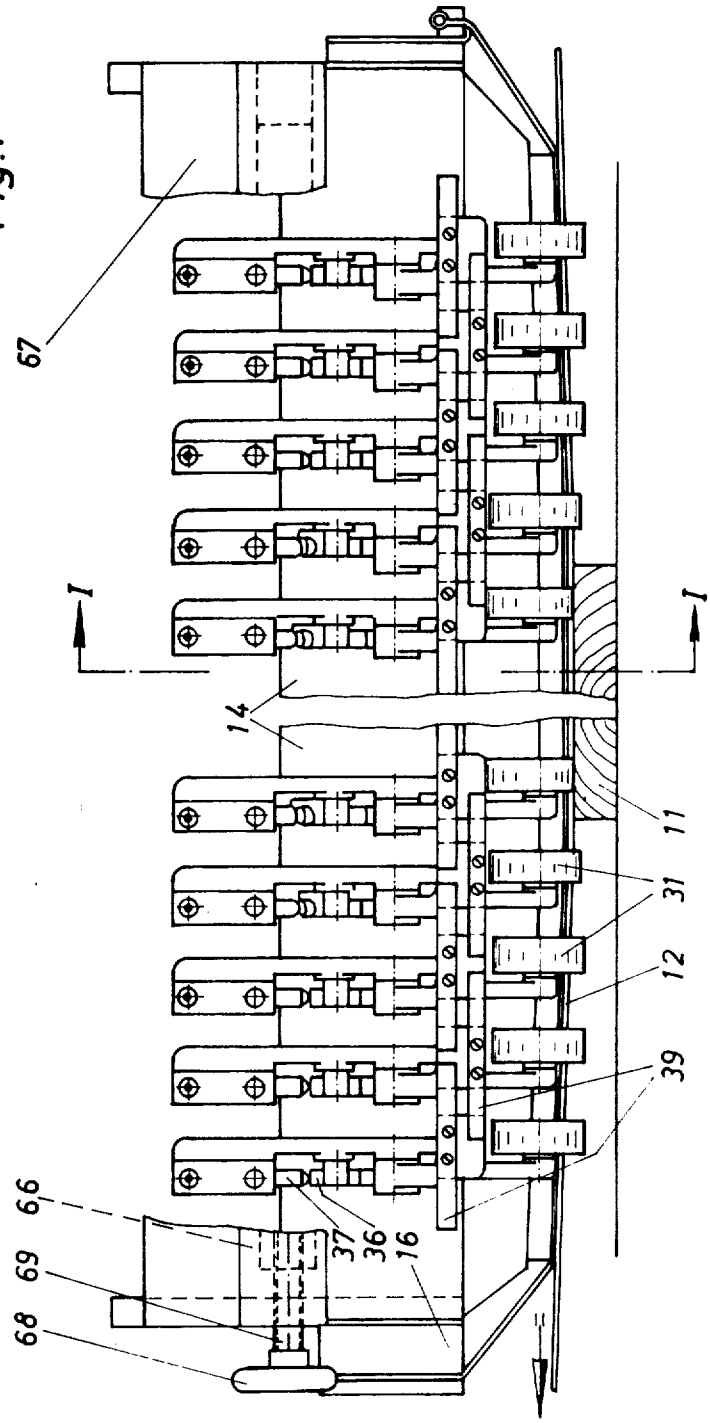

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Fig. 2

I ÷ I

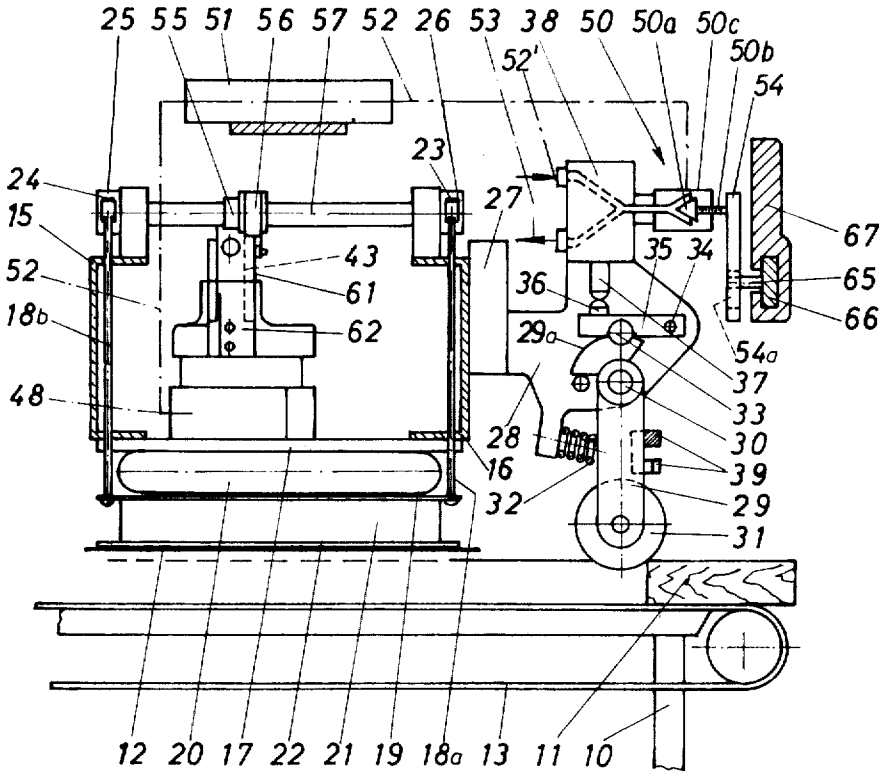

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Fig. 3

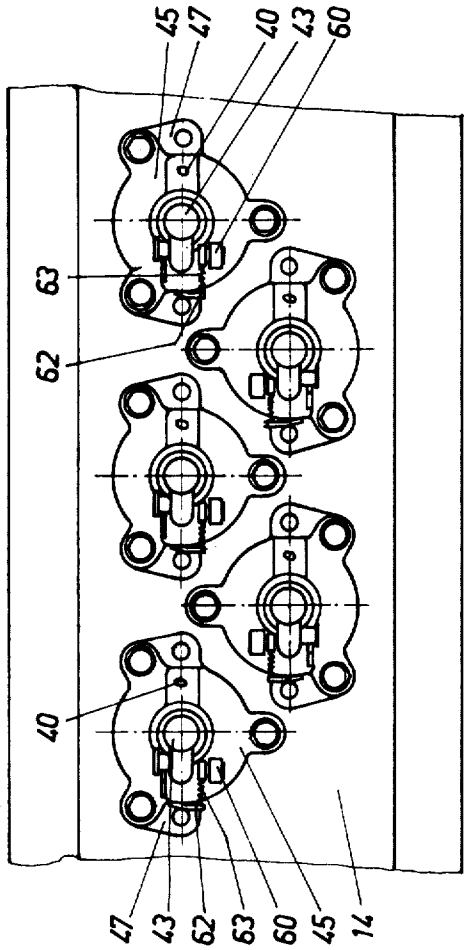

Fig. 4

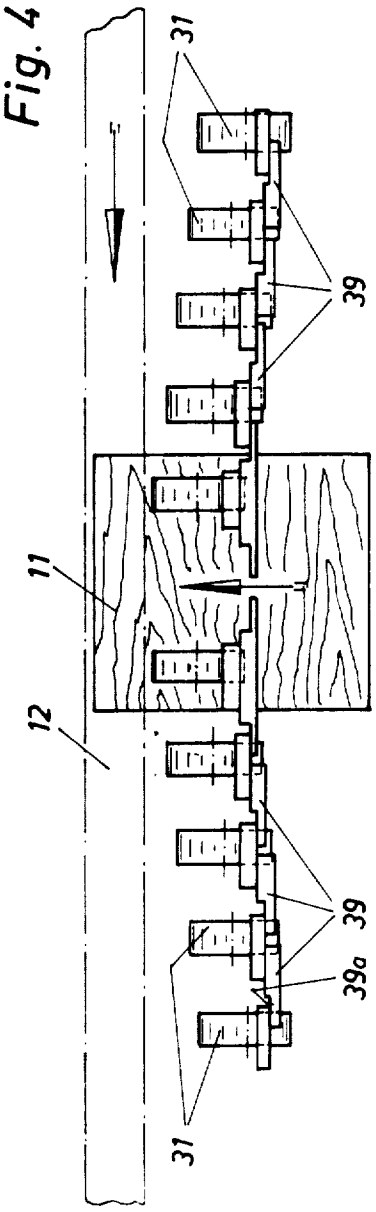

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Fig. 5

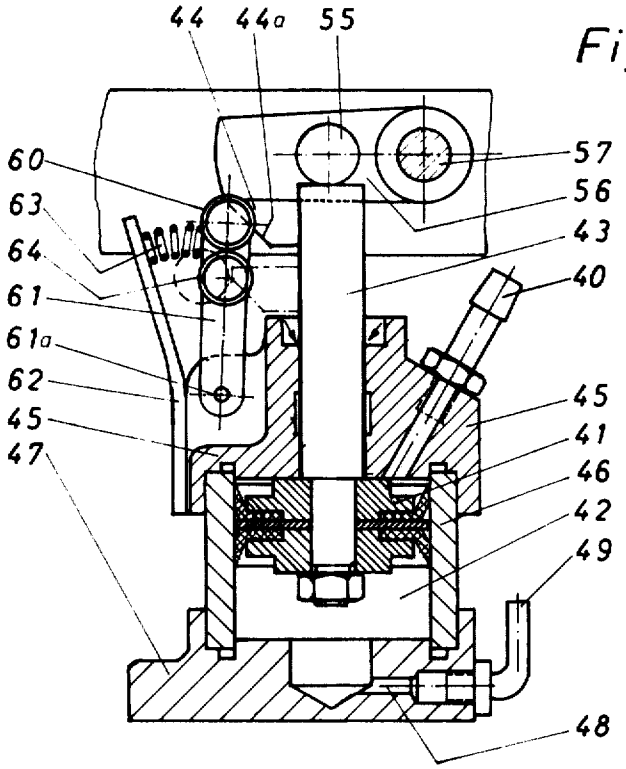
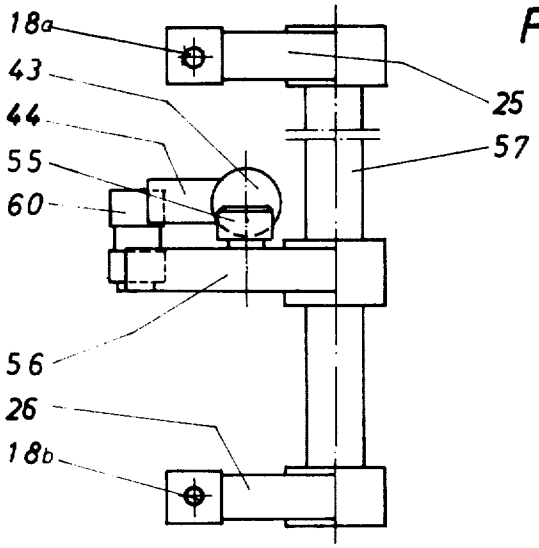


Fig. 6



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BELT GRINDING MACHINE

This is a continuation application of my copending application Ser. No. 684,867 filed Nov. 21, 1967, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a belt grinding machine equipped with an elastically flexible load beam extending over the entire operative length of an endless grinding belt for applying the necessary grinding pressure to the belt, the effective pressure-applying surface of said beam being suspended for elevational control from support elements distributed at intervals along the length of the beam and attached to elevationally movable carrier means preferably in the form of transverse beams mounted on push rod means operable by a pressure medium.

SUMMARY OF THE INVENTION

In such belt grinding machines, particularly for grinding workpieces faced with thin veneers or coated with thin films of lacquer it is an object of the present invention to prevent the facing or coating at the leading and trailing edges as well as at the side edges of the workpiece from being cut through.

Another object of the invention is the provision of a belt grinding machine in which the effective pressure-applying surface is automatically controlled to conform with the contours of the workpiece.

In a belt grinding machine of the specified kind said objects are attained by the present invention in that the push rod means are associated with constant delay means adjustable to the difference in time between the instant of response of a sensing means to the passage of the leading end of a workpiece and the instant the grinding action begins, on the one hand, and between the instant of response of a sensing means to the passage of the trailing end of the workpiece and the instant the grinding action terminates, on the other hand.

In a preferred embodiment of the invention a pawl is associated with the push rod means, for delaying the transmission of the movement of the push rod means or the operation of the actuating means interposed between the push rod means and the effective pressure-applying surface of the load beam after said sensing means have responded. To this end the preferably spring-loaded pawl may be operable by cam means, projections and the like, attached to the push rod means in such a manner that the interposed actuating means remain locked for a given constant period of delay after the response of the sensing means, to be released at the end of said period of delay to activate the flexible pressure-applying surface of the load beam and to lower the effective surface of the load beam into pressure-applying position.

Moreover, for improving the continuous adjustability of the effective pressure-applying surface of the load beam a preferred embodiment of the invention provides for the operational co-operation of neighboring push rods in such a way that push rods not directly controlled by the workpiece are entrained for partial operation by the push rods that are directly controlled by the workpiece.

In a belt grinding machine as proposed by the invention only that part of the pressure-applying surface of the load beam automatically takes effect which in size and shape conforms with the size and shape of the surface of the workpiece that is to be ground.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

FIG. **1** is a front elevational view of a belt grinding machine showing a load beam and control means according to the invention;

FIG. **2** is a cross section of the load beam and of one of the control means, the section being taken on the line I—I of FIG. **1**;

FIG. **3** is a top plan view of the load beam showing the relatively offset disposition of the cylinders operable by a pressure medium for raising and lowering the push rods;

FIG. **4** is a top plan view of the disposition of the sensing and control means on the load beam;

FIG. **5** is an axial section of a piston chamber and push rod associated with the load beam, and

FIG. **6** is a top plan view of the upper portion of the lever mechanism in FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the illustrated belt grinding machine which comprises an underframe **10** through which workpieces **11** that are to be ground are conveyed on a conveyor belt **13** or the like transversely across the direction of travel of a grinding belt **12**, there is provided a flexible load beam **14** extending along the entire working length of the grinding belt. The load beam comprises U-section support members **15** and **16** interconnected by a baseplate **17** of the same length. Interposed between this baseplate **17** and an elastic steel plate **19** suspended from tierods **18***a* and **18***b* is a flexible tube **20** for the reception of a pressure medium, preferably air, for generating resilient pressure.

Adhesively affixed to the underside of the elastic steel plate **19** is a pad **21** made of felt, sponge rubber or the like of which the underface is covered by a loosely applied sliding mat **22**. The sliding mat **22** is fastened to one end of the load beam **14** itself whereas at the other end of the beam **14** it is attached to tensioning means not shown in the drawings. The load beam extends above the endless grinding belt **12** of the belt grinding machine.

The grinding belt **12** which is likewise tensioned travels under the sliding mat **22** in continuous contact therewith. The entire pressure-applying surface of the beam **14** is shown in raised, i.e., in inoperative position.

The tiebolts **18***a* and **18***b* are held at their upper ends by counternuts **23**, **24** in holding levers **25**, **26**.

Affixed to the front of the load beam **14** in the belt grinding machine is an elevationally adjustable supporting rail **27** extending across the entire width of the machine. Attached at equidistant intervals to the supporting rail **27** are angle brackets **28** which carry sensing levers **29** fulcrumed on pivot pins **30**, each sensing lever carrying a roller **31** at its bottom end. Attached to each sensing lever **29** at a point between its pivot pin **30** and the roller **31** is a compression spring **32** which bears against an abutment formed on the angle bracket **28**. Above its pivot pin **30** the sensing

lever **29** is formed with a cam edge **29***a* which co-operates with a ball bearing **33** mounted on a lever arm **35** fulcrumed on a pivot pin **34**. The free end of the lever arm **35** carries a screw stop **36** which operates the actuating rod **37** of a three-way valve **38**.

Moreover, between the roller **31** and the pivot pin **30** each sensing lever **29** is provided with an entraining arm **39** which is screwed to the sensing lever, and which with its free horizontal ends, provided with recesses **39***a*, extends across the two neighboring sensing levers **29**, in front of the sensing levers when viewed in the direction of feed of the workpiece, without actually touching the same. The entraining arms **39** of neighboring sensing levers **29** are elevationally offset to prevent them from obstructing each other. The entraining arms of the outer sensing levers **29** have only an inwardly projecting end (cf. FIGS. **2** and **4**).

In the illustrated embodiment pipe means comprising a pressure reducing valve and an accumulator admit compressed air at constant pressure directly via a connection **40** to the upper face of a piston **41** which is slidable in a chamber **42** formed by a cylinder **46** and a baseplate **47**, the latter containing a passage **48** and fitted with a connection **49** for a flexible tube (cf. FIG. **5**).

Likewise through pipe means comprising a pressure reducing valve, accumulator, three-way valve **38** and a throttle valve **50** and buffering vessel **51** temporary counter-pressure is applied via connection **49** (cf. FIG. **5**) to the underside of the piston **41** through a pipe **52** and released through an exhaust **53**. The throttle valve **50** comprises a tapered body **50***a* including a helically threaded shaft **50***b* rotatably mounted in housing **50***c* to move towards and away from the valve seat. The throttle valve is controllable by a lever **54** attached to the end of shaft **50***b*. The lever **54** has a vertical slot **54***a* or the like at its free end engaged by a pin **65** on a rail **66**. The rail **66** is held in a guide rail **67** which is longitudinally movable by a handwheel **68** and a lead screw **69**, to adjust the angular position of the levers **54** of the throttle valves **50** and thereby centrally to control the rate of air flow through all of the throttle valves.

The piston **41** and its push rod **43** which is fitted with a cam **44** are axially movably guided in a cover **45** (cf. FIGS. **2** and **5**).

The free end of the push rod **43** co-operates with the roller **55** of a control lever **56** which is fast on a rotatably mounted shaft **57**. The same shaft also carries the holding levers **25** and **26** which retain the elastic steel plate **19** by means of the two tiebolts **18***a* and **18***b* (cf. FIG. **2**).

When the pressure-applying face of the load beam **14** is in its raised inoperative position the roller **55** on control lever **56** bears on the projecting upper end of the push rod **43** (cf. FIG. **5**).

Directly below the free end of the control lever **56** is a roller **60** on a pawl **61** fulcrumed on a pivot **61***a* and held in position by a compression spring **63** interposed between the pawl and an abutment arm **62** affixed to the cover **45**. When the piston **41** descends as a result of the counterpressure falling to zero when the control means are actuated and the constant grinding pressure introduced through the tube connection **40** takes effect, a ramp **44***a* on the cam **44** attached to the push rod **43**, after descending a predetermined distance, rides up against a second roller **64** and thereby deflects the pawl **61** together with the roller **60** against the counterpressure of the compression spring **63**. This releases the control lever **56** permitting it to be tilted by the elastic pressure in the tube **20** which is transmitted thereto by the tiebolts **18***a* and **18***b*, the holding levers **25**, **26** and the shaft **57**.

Since the push rod **43** must first descend a given distance before the control lever **56** can yield to the downward pull of the tiebolts **18***a* and **18***b* there is a period of delay between the time of operation of the sensing means by the workpiece **11** and the time the pressure-applying face of the load beam **14** is released for operation.

The machine illustrated in FIGS. **1** to **6** operates as follows:

The workpiece **11** which is fed into the machine for grinding pushes the roller **31**, which is adjusted to project slightly below the top of the workpiece, in the direction toward the load beam **14**. The roller **31** is deflected along an arcuate path about the pivot pin **30** of the sensing lever **29** against the counter-pressure of the spring **32**. The cam edge **29***a* at the upper end of the sensing lever **29** therefore rolls across the bottom of the ball bearing **33**, deflecting the latter and hence the free end of the lever arm **35** upwards about the pivot pin **34**. The adjustable screw stop **36** which, at the free end of the lever can be set to compensate working tolerations, thrusts the actuating rod **37** into the three-way valve **38** which closes the admission pipe **52'** for compressed air and opens the exhaust **53**.

The events triggered by the entering workpiece **11** affect all those pistons **41** which are directly or indirectly controlled by the sensing levers **29** deflected by the infeeding workpiece. The outwardly extending ends of the entraining arms **39** on the outer sensing levers **29** entrain the neighboring sensing levers **29** which are not directly deflected by the workpiece **11** and these levers are therefore likewise deflected about their respective pivot pins **30**. However, the angular deflection of these levers is less than that of the levers **29** which are directly deflected by the workpiece because the entraining arms **39** are formed with the recesses **39***a* at their ends. The angular deflections of neighboring sensing levers **29** by the co-operating entraining arms **39** sequentially lessen towards each side of the workpiece **11** and each lever on either side of the workpiece **11** deflects the outwardly neighboring lever **29** through an angle that is slightly smaller than its own angle of deflection (cf. FIG. **4**). Consequently the pressure-applying face of the load beam **14** will generate grinding pressure at all those points where the workpiece **11** moves underneath the beam **14**. On each side the pressure-applying face of the load beam **14** pressure is not applied to the flexible load beam at points spaced from the edges of the work-piece; therefore, the beam curves upwardly away to a normal position at a level spaced a given distance away from the top of the workpiece.

According to possible differences in the feed speed of the workpiece **11** the delay between the instant of deflection of the sensing lever **29** by the workpiece **11** and the application or relaxation of pressure by the load beam must be increased or reduced. This is done with the aid of the throttle valve **50** which operates in both directions of flow.

The throttle valve **50** is incorporated in that pipe system which supplies the compressed air to the underside of the piston **41**. If according to the feed speed of the work the cross section of flow through the throttle valve is increased or reduced, the resultant delay will vary accordingly and can be adjusted to the required period.

It transpires that the leading edge of the workpiece travels a longer distance from the instant of making contact with the roller **31** to the instant the grinding operation begins than the trailing end of the workpiece from the instant of releasing the roller **31** to the instant the grinding operation terminates. This means that the period of delay at the beginning of the grinding operation must be longer than the period of delay at the termination of the grinding operation. Conveniently allowance can be made for this necessity by providing for additional delay before the beginning of the grinding operation by virtue of the cam **44** on the push rod **43** not deflecting the pawl **61** retaining the control lever **56** until the push rod **43** has already completed part of its descent (embodiment shown in FIGS. **5** and **6**).

When the trailing edge of the workpiece **11** releases the roller **31** the compression spring **32** at once returns the sensing lever **29** into its normal position. This causes the cam edge **29***a* on the sensing lever **29** simultaneously to lower the roller bearing **33** and the free end of the lever arm **35**. The adjustable screw stop **36** releases the actuating rod **37** of the three-way valve **38**. Hence the exhaust **53** is closed and at the same time the admission pipe **52** opened. The compressed air entering the inner chamber **42** below the piston **41** causes the pressure-applying face of the load beam **14** to be raised into inoperative position.

The proposed arrangement of a load beam ensures that workpieces fed into the machine will be evenly and fully ground throughout their surface without risk of the facing at the edges being cut through, irrespective of the size and shape of the workpiece and the particular position in which the workpiece enters the machine.

Control of the pressure-applying surface of the load beam so that it conforms with the workpiece could also be effected by means other than those herein described, for instance by photoelectric sensors or via magnetic valves.

It is also within the scope of the invention to embody the delay means in a variably adjustable device, such as a throttle valve or the like which is adjusted in dependence upon the speed of travel of the workpiece and also to provide a constant device such as a locking pawl or the like which operates in accordance with the difference in time between response to the end of the entering workpiece and the end of the grinding operation.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. A grinding machine for grinding the surfaces of workpieces comprising

a. an endless grinding belt,

b. means for conveying workpieces along a path towards and adjacent to the operative length of said belt, said path being transverse to the direction of movement of said grinding belt,

c. means for releasably applying grinding pressure to the operative length of said belt,

d. workpiece sensing means for detecting the leading and trailing edges of workpieces on said conveying means at a point along said path upstream of said grinding belt and for activating said pressure applying means when a leading edge is detected and deactivating said pressure applying means when a trailing edge is detected, and

e. delay means for delaying the application and release of pressure by said pressure applying means following activation and deactivation respectively of said pressure applying means, said delay means providing a first delay period from the time said sensing means detects the leading edge of said workpiece to the time said leading edge has advanced to a position adjacent said belt before pressure is applied to said belt and providing a second delay period from the time said sensing means detects the trailing edge of said workpieces to the time said trailing edge has advanced to a position adjacent said belt before pressure is released from said belt, said first delay period being longer than said second delay period,

f. whereby the surfaces of the workpieces may be ground without grinding down or damaging the edges of the workpieces.

2. A grinding machine as claimed in claim **1** wherein

a. said pressure applying means comprises an elongated elastic plate arranged adjacent to the operative length of the belt, means biasing said plate towards said belt to apply pressure to said plate, and a plurality of retraction means, each for withdrawing pressure applied by a different portion of the length of said elastic plate,

b. said sensing means comprises a plurality of individual sensing elements arranged across said path upstream from said grinding belt, each for releasing one of said retraction means when detecting a workpiece and for actuating said retraction means when not detecting a workpiece, and

c. said delay means comprises a first and a second delay device operatively associated with each of said retraction means and the sensing element for controlling it, said first delay device being adapted to retard release of said retraction means and the application of pressure to said belt and said second delay device being adapted to retard actuation of said retraction means to withdraw application of pressure to said belt,

d. whereby full pressure will be applied to only substantially that portion of the operative length of the grinding belt corresponding to the width of the workpiece and to the number and location of the sensing devices operated by the workpiece.

3. A grinding machine as claimed in claim **2** wherein each retraction means comprises a piston-cylinder arrangement operable by a pressure medium.

4. A grinding machine as claimed in claim **3** further comprising valve means operatively connected to each sensing element for controlling the application and release of said pressure medium to each piston-cylinder arrangement.

5. A grinding machine as claimed in claim 2 wherein said sensing elements comprise pivotally mounted sensing levers and entraining means for coupling neighboring sensing levers such that sensing levers directly deflected by contact with the workpiece operate to deflect adjacent sensing levers to a lesser extent whereby portions of said elastic plate beyond the sides of the workpiece apply a lesser pressure to the operative length of said belt.

6. A grinding machine as claimed in claim 5 wherein said entraining means comprises a plurality of entraining arms, one arm being attached to each of said sensing levers and extending transversely therefrom a sufficient distance to engage and deflect adjacent entraining arms.

7. A grinding machine as claimed in claim 3 wherein said piston-cylinder arrangement further comprises a push rod connected to said piston and mechanical means releasably connecting said push rod with a portion of said elastic plate and said first delay device comprises means to retard movement of said mechanical means in the direction to cause said portion of said elastic plate to apply pressure to said belt for a predetermined time after said push rod is moved in said direction.

8. A grinding machine as claimed in claim 7 wherein said means to retard movement of said mechanical means comprises a pawl and cam means on said push rod for acting on said pawl as said push rod moves in the direction to cause pressure to be applied to said belt.

9. A grinding machine as claimed in claim 8 further comprising spring means biasing said pawl towards said cam means.

10. A grinding machine as claimed in claim 3 further comprising valve means operatively connected to said sensing means for controlling said pressure medium flowing to and from said piston-cylinder arrangement and wherein said second delay device comprises throttle valve means for controlling the rate of flow of said pressure medium to the piston in said piston-cylinder arrangement to withdraw a portion of said elastic plate whereby said elastic plate may be retained in a position applying pressure to said belt for a predetermined time after the trailing edge of said workpiece has passed said sensing device.

11. A grinding machine as claimed in claim 10 wherein said throttle valve means comprises means for adjusting the cross-section of flow through said throttle valve means whereby the period of delay after the trailing edge of the workpiece passes said sensing means and before the elastic plate is moved away from said belt may be controlled.

12. In a grinding machine for grinding the surfaces of workpieces and including means for conveying workpieces along a path past and in contact with the operative length of an endless grinding belt, the improvement comprising

a. a plurality of sensing means extending transversely across said path upstream from said grinding belt to detect the presence of each workpiece on said conveyor means as it approaches said grinding belt,

b. a plurality of pressure applying means arranged to press said grinding belt against workpieces while being conveyed past said belt,

c. a plurality of means for moving said pressure applying means towards and away from said belt, said moving means being responsive to said sensing means such that detection of the presence of a workpiece by said sensing means causes said pressure applying means to press said belt against said workpiece and detection of no workpiece causes said pressure applying means to be withdrawn, and

d. delay means to delay movement of said pressure applying means towards and away from said belt such that said belt is not pressed by said pressure applying means until grinding action begins on a workpiece, the leading edge of which was previously detected upstream by said sensing means, and pressure on said belt by said pressure applying means is not released until grinding action terminates on said workpiece, the trailing edge of which was previously detected upstream by said sensing means, said delay means comprising pawl means to retain said pressure applying means in withdrawn position and cam means on said moving means to release said pawl means after movement of said moving means a predetermined distance following detection of the leading edge of a workpiece by said sensing means

e. whereby the surface of the workpiece may be ground without grinding down or damaging the edges of the workpieces.

13. In a grinding machine for grinding the surfaces of workpieces and including means for conveying workpieces along a path past and in contact with the operative length of an endless grinding belt, the improvement comprising

a. a plurality of sensing means extending transversely across said path upstream from said grinding belt to detect the presence of each workpiece on said conveyor means as it approaches said grinding belt,

b. a plurality of pressure applying means arranged to press said grinding belt against workpieces while being conveyed past said belt,

c. a plurality of means for moving said pressure applying means towards and away from said belt, said moving means being responsive to said sensing means such that detection of the presence of a workpiece by said sensing means causes said pressure applying means to press said belt against said workpiece and detection of no workpiece causes said pressure applying means to be withdrawn, and

d. delay means to delay movement of said pressure applying means towards and away from said belt such that said belt is not pressed by said pressure applying means until grinding action begins on a workpiece, the leading edge of which was previously detected upstream by said sensing means, and pressure on said belt by said pressure applying means is not released until grinding action terminates on said workpiece, the trailing edge of which was previously detected upstream by said sensing means,

e. said moving means comprising fluid pressure operated means and said delay means comprising throttle valve means responsive to said sensing means for controlling the flow of pressure fluid to and from said fluid pressure operated means such

that said fluid pressure means is not moved and said pressure applying means is retained against said belt until predetermined volumes of fluid to and from said fluid pressure operated means have passed through said throttle valve means following detection of the trailing edge of a workpiece by said sensing means

f. whereby the surface of the workpiece may be ground without grinding down or damaging the edges of the workpieces.

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