Dec. 1, 1970 K. HEESEMANN 3,543,443

MACHINE FOR GRINDING LARGE-AREA WORKPIECES

Filed Nov. 13, 1967 4 Sheets-Sheet 1

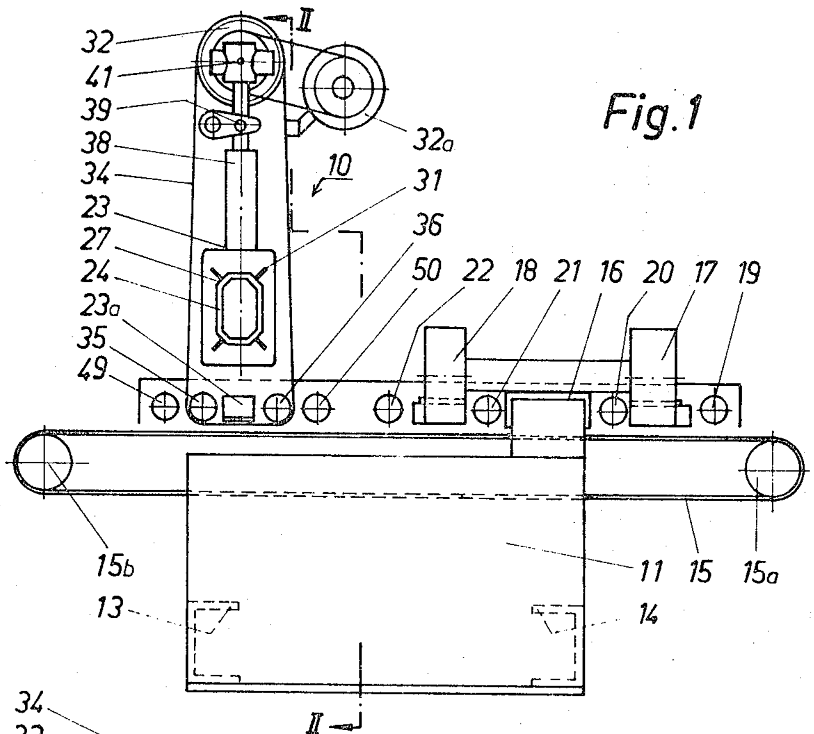

Fig. 1

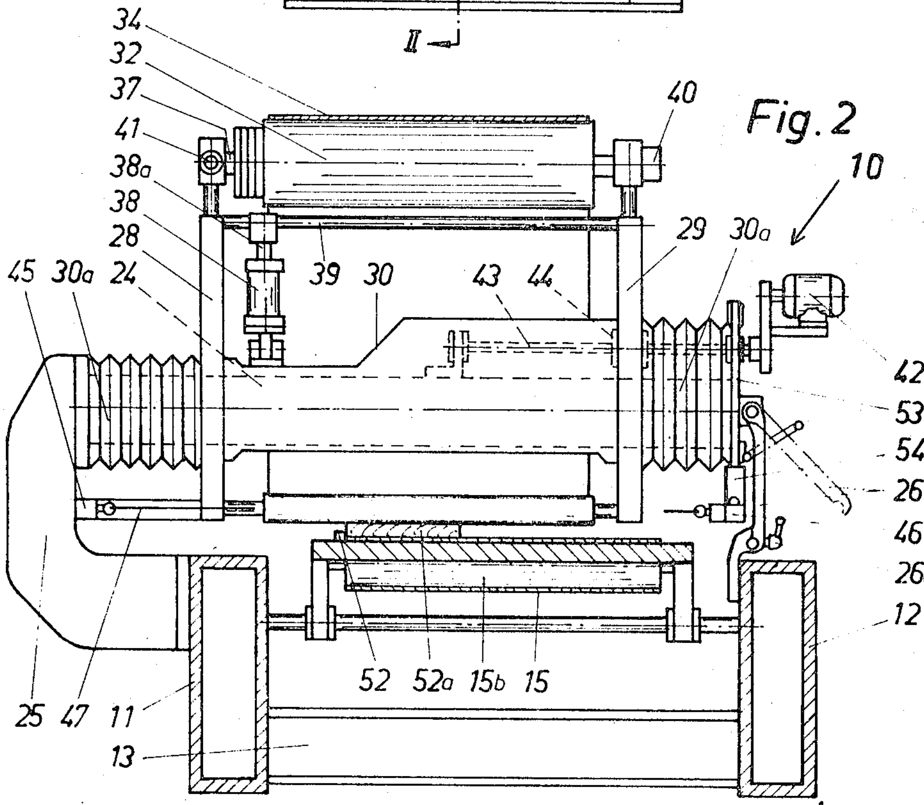

Fig. 2

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MACHINE FOR GRINDING LARGE-AREA WORKPIECES

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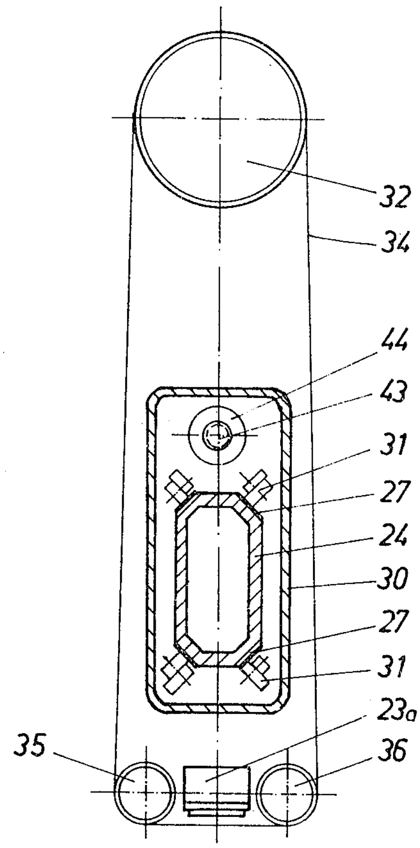
Fig. 3



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MACHINE FOR GRINDING LARGE-AREA WORKPIECES

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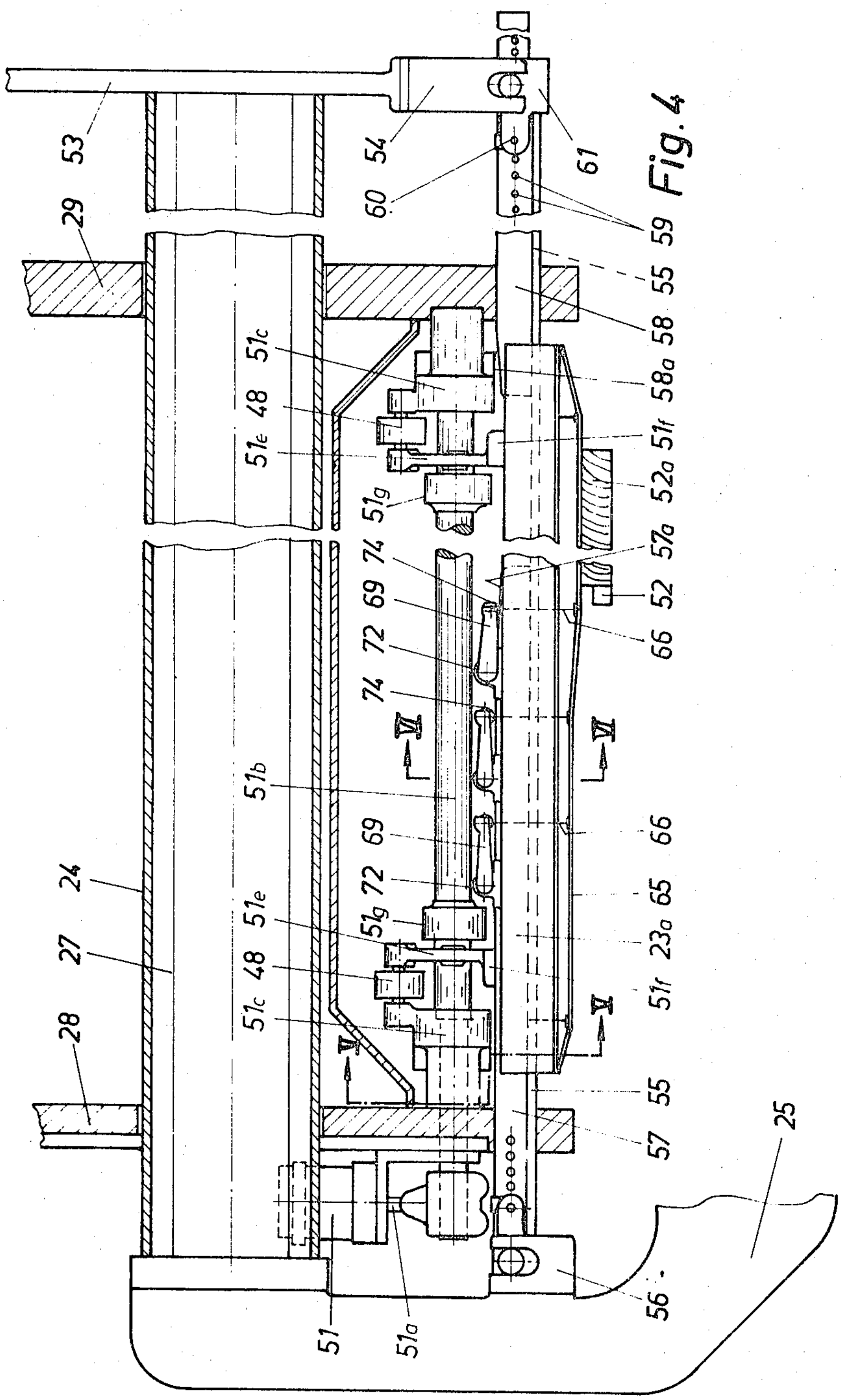

Fig. 4

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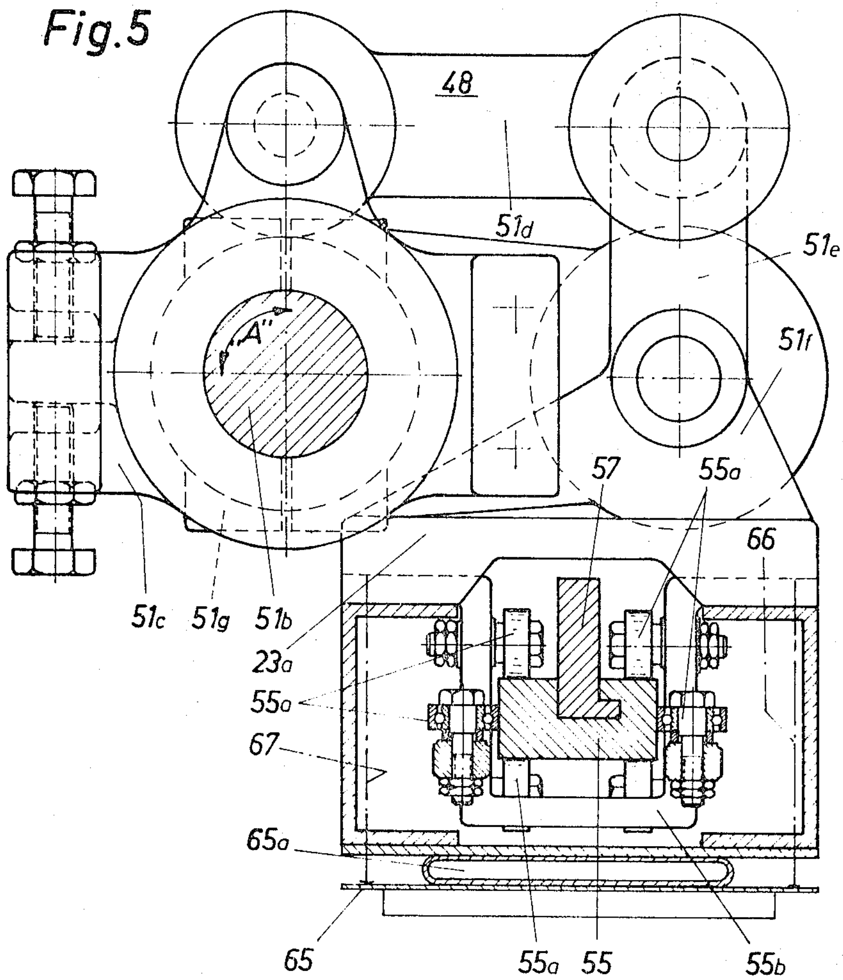
Fig.5



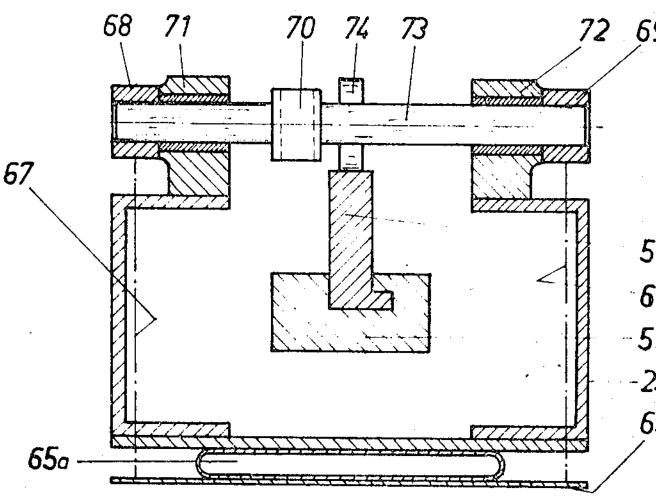


Fig.6

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MACHINE FOR GRINDING LARGE-AREA WORKPIECES

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Int. Cl. B24b *7/00, 9/00, 21/00*
U.S. Cl. 51—3 24 Claims

ABSTRACT OF THE DISCLOSURE

A machine for automatically providing fine and subsequent very fine grinding of large plate-like workpieces is disclosed. A plurality of grinding assemblies are mounted on a frame structure. A conveyor means is provided to transport the workpieces sequentially below the grinding assemblies. At least one of the grinding assemblies provides transverse grinding of the workpiece. At least one of the grinding assemblies provides longitudinal grinding of the workpiece. A means is provided to effect periodic back and forth movement of the longitudinal grinding assembly transversely to the direction of movement of the workpieces.

BACKGROUND OF THE INVENTION

This invention relates to a method of and a machine for automatically fine and subsequently very fine grinding of large-area workpieces.

The fine and very fine grinding of veneered, lacquered or otherwise laminated and also of solid workpieces having large surface areas is executed at present in a known and advantageous manner by cross grinding on two separate automatic belt-grinding machines.

In regard to surface make up, grinding out of the surface and depth of grind, cross grinding yields the best grinding quality. Here the pre-grinding is carried out as a transverse grinding, i.e. across the grain, and the finish-grinding as a longitudinal grinding, i.e. parallel to the grain.

Since in conventional machines the workpieces must be fed longitudinally for the transverse grinding and crosswise for the longitudinal grinding, it is necessary to change the direction of travel of the workpieces by 90° between the longitudinal and the transverse grinding. Thus, for the transverse and the longitudinal grinding separate machines must be used which are to be connected with each other by a so-called angle delivery apparatus so that the direction of travel of the workpieces undergoes the necessary change between the first and the second machines. Such installations call for high investments and require a large area for changing the direction of the workpieces passing through the machines. Moreover, due to the inertia of the workpieces, the speed of passage of the workpieces is limited during the direction change.

So far as the known wide belt grinding machines have been used as the second machine it has shown that these machines are not able to produce a very fine grinding of adequate quality since the feed direction of the workpieces and the running direction of the grinding belt extend parallel to each other. Since thus the grinding is not crosswise and therefore the grinding defects and traces add to each other instead of compensating for one another, the ground surfaces remain rough.

Furthermore, the grinding belt is always only worn out in the area which corresponds to the workpieces being ground. The hard glue joints, for example, which normally reoccur on the same lines on the workpieces always wear the grinding belt along the same longitudinal strips. The grinding belt subsequently clogs on these longitudinal

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strips, leaves grinding traces on the workpieces and becomes prematurely unusable.

SUMMARY OF THE INVENTION

It is the object of the present invention to avoid the disadvantages mentioned above and to provide an efficient method of cross grinding large-area workpieces, and a machine for carrying out that method; which method comprises the steps of first grinding the workpieces transverse to their direction of feed, and subsequently grinding the workpieces substantially parallel to said direction of feed.

An important feature of the invention consists in that transverse grinding motions may be carried out when grinding the workpeces substantially parallel to their direction of feed.

The machine for carrying out the method comprises two supports, rails connecting said supports, a drive roller and an idler roller supported by said supports, a conveyor belt led around said rollers for feeding workpieces to be ground and moving preferably in one and the same direction, at least one transverse grinding mechanism mounted on one of said rails, a longitudinal grinding mechanism arranged downstream of the transverse grinding mechanism, and means for moving said longitudinal grinding mechanism to and fro relative to the workpieces passing through.

In an advantageous form of construction more than one transverse grinding mechanisms are arranged one behind the other and are each provided with a resilient pressure beam and an endless laminated pressure belt inserted between the grinding belt of the transverse grinding mechanism and said pressure beam.

The longitudinal grinding mechanism is preferably provided with a to-and-fro movable, advantageously endless grinding belt pressed against the workpieces to be ground by a pressure beam pressing against its inner side, while the grinding belt is equipped with a device to adjust it to run in the center of its drive and guide roller.

In a particularly advantageous embodiment of the longitudinal grinding mechanism the grinding belt drive and the guiding members as well as, if necessary, the pressure beam with its holding mechanism are mounted on a guide member movable transverse to the direction of travel of the workpieces. For this purpose a device such as a spindle may be provided.

It is further proposed by the invention constantly to change the effective pressing area of the grinding belt corresponding to the width of the workpieces in order to avoid cutting through the edges of the workpieces.

Another embodiment of the invention is possible wherein not the whole longitudinal grinding belt mechanism, but only its grinding belt is moved to and fro transverse to the direction of travel of the workpieces by a special controlling means.

The machine proposed by the invention excels in that the traces of the grinding are in an advantageous manner compensated while the workpiece runs through the machine in one and the same direction.

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 schematic side view of a cross grinding machine according to the invention;

FIG. 2 is a cross section on the line II—II of FIG. 1;

FIG. 3 is a cross section through the guide member of the machine with an enclosing traverse and the grinding belt;

FIG. 4 is a front view, partly in cross section, of the pressure beam of the cross grinding machine;

FIG. 5 is a cross section on the line V—V of FIG. 4 and

FIG. 6 is a cross section on the line VI—VI of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS.1 and 2 show a cross belt grinding machine **10** mounted on two supports **11** and **12** connected by two lower connecting rails **13** and **14**. An endless conveyor belt **15** for feeding workpieces **52*a*** is led around a drive roller **15*b*** and an idler roller **15*a***. A motor (not shown) drives the drive roller **15*b*** and thus the conveyor belt **15** through an infinitely variable gear unit in preferably one and the same direction.

As shown in FIG. 1, two transverse grinding mechanisms **7** and **18** are fixed at a distance from one another on an upper connecting rail **16** extending between the supports **11** and **12** and are provided with two vertically adjustable pressure beams. It is self-evident that instead of two, also one or more than two tranverse grinding mechanisms may be provided which in the latter case are arranged one behind the other. Pressure rollers **19**, **20** and **21**, **22** which may each be composed of many small rollers are arranged on each side of the two pressure beams of the two transverse grinding mechanisms **17** and **18** respectively. A contact roller is arranged in the same plane as the pressure rollers **19** and **21** and is actuated by the passing workpiece **52*a*** to control the vertical movements of the pressure beams. The pressure beams are provided with mechanisms (not shown) with which the working width can be adjusted according to the width of the workpieces **52*a*** passing through the machine. When deemed necessary an endless laminated pressure belt (not shown) may be inserted between the grinding belt and the pressure beam of the transverse grinding mechanisms **17** and **18**. A longitudinal grinding mechanism **23** with a pressure beam **23*a*** is arranged downstream of the two transverse grinding mechanisms **17** and **18**. This longitudinal grinding mechanism **23** is designed as a wide belt grinding machine and comprises a fixed box-shaped guide member **24** which is mounted at one of its ends through the intermediary of a carrier arm **25** on the support **11** and is braced at its other end against the support **12** by a pivotable support **26**. The connection between the pivotable support **26** and the support **12** can be disengaged, for example, when the grinding belt must be replaced, by means of a locking device like a locking lever **26*a***.

Two end plates **28** and **29**, between which a traverse **30** which partly surrounds the guide member **24** is fixed, are guided by means of guide rollers **31** on the box-shaped guide member **24** which for example is provided with four guideways **27** bevelled on the edges of its length, so as to be rollable in a direction transverse to that of the workpieces **52*a***. Lateral sleeves **30*a*** surround the parts of the guide member **24** which are not surrounded by the traverse **30**. A drive roller **32** for a wide endless grinding belt **34** is driven by a motor **32*a*** and rotatably mounted on an arbor **37** extending between the upper ends of the end plates **28** and **29**. This wide endless grinding belt **34** is led around this drive roller **32** and lower guide rollers **35** and **36** located downstream and upstream of the pressure beam **23*a***. The grinding belt **34** is tensioned by means of a compressed air cylinder **38** with a piston rod **38*a*** through parallel rods **39**. This air cylinder **38** is mounted on the traverse **30**. In order to maintain the grinding belt **34** in the middle portion of the drive roller **32**, an electropneumatic control device which comprises for example a compressed air cylinder **40** is provided, through the intermediary of which the arbor **37** of the drive roller **32** is moved about a universal joint **41** or the like when one of the edges of grinding belt **34** touches one of lateral limit switches (not shown) located in the immediate vicinity of the edges of the grinding belt **34**.

The traverse **30** with the end plates **28** and **29** and the further parts of the longitudinal grinding machine **23** connected thereto are movable on the guide member **24** by a reversible motor **42** connected to a spindle **43** passing through a spindle nut **44** built into the end plate **29**. The to-and-fro motions produced by the reversible motor **42** of the above-mentioned parts of the longitudinal grinding mechanism **23** are limited by limit switches **45** and **46** which effect the reversal of the motor **42** whenever these moving parts reach an end position. The extent of the to-and-fro motions is adjustable by displacing the limit switch **45** on a rail **47**.

The pressure beam **23*a*** is vertically adjustable in the end plates **28** and **29** by means of a parallel linkage system **48**. Pressure rollers **49** and **50**, which may consist of a plurality of small rollers, are provided downstream and upstream of the guide rollers **35** and **36** for the grinding belt **34** to guide the workpieces **52*a*** on the conveyor belt **15**. A contact roller (not shown) is arranged in the same plane as the pressure roller or rollers **50** and is activated by the passing workpieces **52*a*** automatically to control the upwards and downwards motions of the pressure beam **23*a*** acted upon by a compressed air cylinder **51**, its piston rod **51*a*** and a shaft **51*b*** (FIG. 5). To achieve this end, clamping collars **51*g*** are fixed on the shaft **51*b*** mounted in mountings **51*c*** which collars **51*g*** carry the pressure beam **23*a*** at its ends through the intermediary of levers **51*d*** and **51*e*** with a carrier foot **51*f***. As the shaft **51*b*** turns, the pressure beam **23*a*** lowers or raises.

In order completely to grind the surfaces of the workpieces **52*a*** running straight through the machine while not cutting through its edges, the pressure surface of the pressure beam **23*a*** moving to and fro with the movable parts of the longitudinal grinding mechanism **23** is controlled by an adjustment mechanism. This adjustment mechanism comprises a device for pre-adjustment according to the width of the passing-through workpieces **52*a*** as well as an automatically working mechanism which are both dependent on contact roller control and reverse motions for adapting the pressure surface of the pressure beam **23*a*** to the workpieces **52*a*** guided by a guide bar **52**.

The guide member **24** is closed at its free end by an end plate **53** (FIG. 2) on the upper end of which the reversible motor **42** and the spindle **43** are located. The lower end of this end plate **53** is provided with a vertical guiding device **54** (FIG. 4) in which one end of a guide rail **55** is guided so as to be unshiftable in its axial direction, whereas its other end rests in another vertical guiding device **56** arranged on the carrier arm **25**. The vertical guiding devices **54** and **56** permit the guide rail **55** extending through the pressure beam **23*a*** to move up and down with the same.

Because of its indirect connection with the end plates **28** and **29**, the pressure beam **23*a*** can move to-and-fro transverse to the direction the workpieces **52*a*** are fed through the machine. The guide rail **55** in the pressure beam **23*a*** is guided in a suitable way, for example by ball bearings and rollers **55*a*** (FIG. 5) which are adapted to the particular profiling of the guide rail **55**. As shown in FIG. 4, sliding rails **57** and **58** are guided to be movable and lockable in the guide rail **55**, which sliding rails **57** and **58** are provided with oblique surfaces **57*a*** and **58*a*** at the ends pointing towards one another. These oblique surfaces **57*a*** and **58*a*** extend adjacent both longitudinal edges of the workpieces **52*a*** passing through the machine and their slope corresponds to the necessary slight slope of the lower pressure surface of the pressure beam **23*a*** constructed as a steel plate **65**. For pre-adjustment and locking, the sliding rail **58** is provided with holes **59** in which a lock pin **60** engages according to the width of the workpieces **52*a*** passing through the machine, which lock pin **60** is passed on boht sides of the sliding rail **58** through a fork-shaped member **61** on the guide rail **55**.

As shown in FIG. 6, the steel plate **65** is carried by the lower ends of lifting rods **66** and **67** fixed intermediate the two longitudinal edges of the steel plate **65**. The upper ends of the lifting rods **66** and **67** are screwed into pivoting levers **68** and **69** fixed as well as a pivoting lever **70** on a common shaft **73** rotatably mounted in bearing blocks **71** and **72**. On its free end the pivoting lever **70** carries a roller **74** which rolls on the sliding rails **57** and **58**, respectively, during the to-and-fro motions of the pressure beam **23***a*.

The sliding rail **58** can be so adjusted that the gap between the free ends of the sliding rails **57** and **58** corresponds to the width of the workpieces **52***a*. Thereby the pressure surface of the pressure beam **23***a*, i.e. the steel plate **65**, presses always only there on the grinding belt **34** where a workpiece **52***a* under the pressure beam **23***a* is located, regardless of the to-and-fro motions of the pressure beam **23***a*.

The cross belt grinding machine **10** operates as follows: For grinding uniform workpieces **52***a* of a given width, the corresponding working width on the two pressure beams of the transverse grinding mechanisms **17** and **18** and on the sliding rail **58** of the pressure beam **23***a* as well as the extent of to-and-fro motions controlled by the limit switches **45** and **46** are adjusted. When the width of the workpieces **52***a* is not larger than the difference between the maximum width of the grinding belt **34** and the maximum to-and-fro motion limit, the full effective to-and-fro motion limit will be effective in the described embodiment of the invention.

The workpieces **52***a* on the conveyor belt **15** pass through underneath the pressure beams of the transverse grinding mechanisms **17** and **18** and the pressure beam **23***a*, which beams thereby are brought into and out of engagement with the workpieces **52***a* by the contact rollers arranged on their impact sides in a known manner.

In order to attain the best possible quality of grinding by cross grinding the traces of grinding, the pressure beam **23***a* and thereto connected parts of the longitudinal grinding mechanism **23** are moved within the set limits continually to and fro crosswise to the direction of feed of the workpieces **52***a*. The to-and-fro motions are transmitted from the reversible motor **42** through the spindle **43** to the reciprocating parts of the longitudinal grinding mechanism **23**. At the end of each motion the limit switch **45** or the limit switch **46** is actuated by its cooperating end plate **28** or **29** whereby the reversible motor **42** and their direction of rotation of the spindle **43** are reversed. The wide grinding belt **34** participates in these to-and-fro motions. The lateral thrusts resulting during the grinding operation lessen lateral disorientation of the grinding belt **34** which entails that the described mechanisms for centering the grinding belt **34** need be less effective while effecting a better grinding.

The pressure beam **23***a* also participates in these to-and-fro motions. Since on the one hand the workpiece **52***a* passes through the machine in a straight line and does not participate in the to-and-fro motions transverse to the feed direction, and on the other hand it must be contacted continuously as it passes through underneath the pressure beam **23***a* on its whole width by the grinding belt **34** pressed on by the pressure beam **23***a*, it is preferable that the actually effective pressing surface of the steel plate **65** displaces constantly on the same. To this end, the rollers **74** roll alternately on the locked sliding rails **57** and **58** in dependence on the adjustments for the to-and-fro movement and the width of the workpiece **52***a* or they are in the space between the two free ends of the sliding rails **57** and **58** above the workpiece **52***a* where they execute no function. Then, just at the certain moment of the to-and-fro motions when the rollers **74** do not roll on the sliding rail **57** or **58**, the lifting rods **66** and **67** are in their lowest positions and the corresponding region of the pressing surface of the pressure beam **23***a* presses the grinding belt **34** during the grinding operation against the passing through workpiece **52***a*. Since the guide rail **55** is not axially movable in the pressure beam **23***a*, it moves up and down with the pressure beam **23***a* and is guided together with the sliding rails **57** and **58** guided thereon in the vertical direction in the vertical guiding devices **54** and **56**.

The pressure beam **23***a* may have a rectangular or any other desired cross section, but it is advantageously box shaped and provided with a U-shaped rail **55***b* (FIG. 5) set in from above. The ball bearings of the rollers **55***a* are fixed to said U-shaped rail **55***b* and the rollers run on the guide rail **55** extending inside the U-shaped rail **55***b*.

As shown in FIGS. 5 and 6, a rubber or an air cushion **65***a* or the like is inserted between the pressure beam **23***a* and the steel plate **65** in order to form an elastically resilient pressure beam **23***a*.

The to-and-fro movements can also be brought about by other means, for instance by a mechanical displacement of the axles of a return roller in the horizontal or vertical direction or by a guide roll.

According to the described embodiment of the invention, the workpieces **52***a* moving along a straight line are transversely pre-ground by the two narrow grinding belts of the transverse grinding mechanisms **17** and **18** rotating in opposite directions and are thereafter ground in the direction of their travel by a wide grinding belt **34**, whereby an outstanding quality of the upper surface of the workpieces **52***a* is attained by the to-and-fro motions of the longitudinal grinding mechanism **23** cooperating with the two transverse grinding mechanisms **17** and **18**.

It lies within the scope of the invention alternatively to use another form of construction in which the workpieces **52***a* are passed through underneath a stationary longitudinal grinding mechanism while their longitudinal axes are held at a certain angle, i.e. oblique, to the original direction of travel, and after the termination of the grinding operation the workpieces **52***a* are fed back through the longitudinal grinding mechanism in the opposite (mirror image) direction onto the original feed-in way, whereby the effective pressing-on surfaces, such as for example the previously described steel plate **65**, are so shifted that they are always above the passing-through workpiece.

According to a further embodiment of the invention, the to-and-fro movements of the longitudinal grinding mechanism can be interrupted following the rythm with which the machine is fed with workpieces. Thereby the to-and-fro movements are always only effective in one direction on the single workpiece, because they are automatically switched, dependent on the speed they are fed in and on their length, by a contact roller arranged in front of the machine.

Instead of a pressure beam also a contact roller may be provided.

While the method of and machine for grinding large-area workpieces has been shown and described in detail, it is obvious that this invention is not to be considered as being limited to the exact form disclosed, and that changes in detail and construction may be made therein within the scope of the invention, without departing from the spirit thereof.

What is claimed is:

1. A machine for grinding plate-like large area workpieces comprising:

(a) means mounting a plurality of grinding assemblies on a frame structure,

(b) conveyor means to transport said workpieces sequentially below said grinding assemblies,

(c) at least one of said grinding assemblies provides transverse grinding of said workpiece,

(d) at least one of said grinding assemblies provides longitudinal grinding of said workpiece, and

(e) means to effect periodic back and forth movement of said longitudinal grinding assembly transversely to the direction of movement of said workpieces.

2. A machine as claimed in claim **1** wherein said transverse grinding assembly is laterally disposed from said longitudinal grinding assembly to first receive said workpieces transported by said conveyor means.

3. A machine as claimed in claim 2 wherein said conveyor means includes an endless belt conveyor which carries said workpieces below said grinding assemblies.

4. A machine as claimed in claim 3 wherein said transverse grinding assembly includes a vertically movable pressure beam located inside an endless grinding belt having a direction of movement transverse to the direction of movement of said workpieces.

5. A machine as claimed in claim 4 wherein said transverse grinding assembly includes an endless laminated pressure belt disposed between said endless grinding belt and said pressure beam.

6. A machine as claimed in claim 3 wherein said longitudinal grinding assembly includes a pressure beam located on the inside of an endless grinding belt having a direction of movement parallel to the direction of movement of said workpieces.

7. A machine as claimed in claim 6 wherein said longitudinal grinding assembly includes means to press said pressure beam against the inside surface of said longitudinal grinding belt to effect grinding of said workpieces.

8. A machine as claimed in claim 7 wherein there are two transverse grinding assemblies laterally disposed from each other and from said longitudinal grinding assembly to first receive said workpieces transported by said conveyor means.

9. A machine as claimed in claim 8 wherein said conveyor means includes an endless belt conveyor which carries said workpieces below said grinding assemblies.

10. A machine as claimed in claim 9 wherein said transverse grinding assembly includes a vertically movable pressure beam located inside an endless grinding belt having a direction of movement transverse to the direction of movement of said workpieces.

11. A machine as claimed in claim 7, wherein said longitudinal grinding assembly includes a device for adjusting the grinding belt to run in the middle portion of its drive and guide rollers.

12. A machine as claimed in claim 7, wherein the pressure beam with the drive for the grinding belt is arranged so as to be able to move to-and-fro in the machine.

13. A machine as claimed in claim 7, wherein the pressure beam and the grinding belt with its drive are mounted in lateral end plates displacable by a spindle.

14. A machine as claimed in claim 13, wherein the lateral end plates are mounted on a guide member arranged in the machine transverse to the direction of passage of the workpieces.

15. A machine as claimed in claim 14, wherein the guide member is pivotably mounted in the machine.

16. A machine as claimed in claim 14, wherein the guide member is constructed to have a cross section like a circle, a rectangle and the like with guideways arranged on opposing sides or edges for guiding rollers carrying the lateral end plates.

17. A machine as claimed in claim 7, wherein the pressure beam has a pressing surface which is variable by means of an adjustment mechanism.

18. A machine as claimed in claim 17, wherein a steel plate is provided to serve as the pressing surface of the resilient pressure beam, which steel plate is held in a lowered position where the grinding is taking place in the area of the effective pressing surface and in a raised position on the outer edges by lifting rods and pivotable levers.

19. A machine as claimed in claim 18, wherein the free ends of the pivotable levers are guided by means of rollers on two sliding rails extending parallel to the pressure beam and leaving a free space between them which corresponds to the desired effective pressing surface.

20. A machine as claimed in claim 19, wherein the free space between the sliding rails is adjustable as to length by the adjustable mounting of the sliding rails.

21. A machine as claimed in claim 19, wherein the sliding rails are mounted movably on a guide rail extending through the width of the machine.

22. A machine as claimed in claim 21, wherein the pressure beam is guided on the guide rail by means of rollers.

23. A machine as claimed in claim 21, wherein the pressure beam is box shaped and guided on the guide rail in its inside by rollers.

24. A machine as claimed in claim 7, wherein the pressure beam is connected by levers with a shaft which can be turned by means of a pressure-controlled adjustment apparatus.

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U.S. Cl. X.R.

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