Means and Method of Grinding Polygonal Articles

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This invention relates to a method of and apparatus for grinding edge faces of polygonal articles and more particularly to a grinding apparatus utilizing the principle of centerless grinding and adapted to automatically position a flat relatively thin polygonal article such as a tile for grinding of one edge thereof into precise parallel relation and microdimensioned distance from a plane defined by outermost edge extremities of an opposed edge thereof.

Prior methods and apparatus for grinding polygonal articles such as ceramic tile have used fixtures or holders for each individual tile. The fixtures were advanced by conveyor means in a path which was vertically, laterally and longitudinally nonyielding, to and through a grinding zone. The fixtures were spaced apart a precise distance, and tile were required to be fed to said fixtures in precise timed relation. In such prior apparatus the tile were required to be accurately positioned in said fixtures and each tile approached the grinding zone of the apparatus with an axis disposed parallel to the plane of the grinding edge face of a grinding means and substantially aligned with the path of travel of advancement. Obviously such prior grinding apparatus for such articles demanded careful attention in order to achieve accurate positioning of each tile in its respective fixed fixture and often such tile were individually handled. Obviously such careful attention and intermittent individual handling of the tile required a slower operation of the grinding apparatus.

This invention contemplates an improved continuously fed grinding apparatus wherein a plurality of tiles may be successively fed to a conveyor means without regard to longitudinal spacing thereof and which are automatically properly positioned and supported on the conveyor means for entry into and through a grinding zone without the use of fixtures for each tile. The invention also contemplates a grinding apparatus wherein the edge face of such a tile may be ground to tolerances closer than those permitted by prior proposed grinding apparatus for this purpose. The invention employs a centerless grinding principle whereby precise accurate grinding of an edge face of a tile into parallelism and a preselected accurate microdimensioned distance of minimum tolerance from an opposed edge of a tile may be readily and quickly accomplished so that maximum production may be achieved.

It is therefore the primary object of this invention to disclose an apparatus for and a method of grinding thin flat polygonal articles into precise dimension and with extremely close allowable tolerances.

An object of this invention is to design and provide a grinding apparatus wherein each tile is automatically positioned with respect to the grinding zone regardless of its initial position upon being transferred to a conveyor means advancing said tile to said zone.

An object of this invention is to disclose and provide a grinding apparatus wherein the initial position of tile fed to said apparatus is not critical.

Another object of this invention is to provide a novel improved grinding apparatus for polygonal tile wherein guide means are provided for advancing each tile to and through a grinding zone with the longitudinally disposed axis of the tile arranged at an angle to the directio of its path of travel and to the grinding edge face of grinding means.

Still another object of this invention is to disclose and provide means on the grinding apparatus for directing tile against guide means prior to the grinding zone whereby each tile will be properly positioned for grinding.

A further object of this invention is to disclose and provide a grinding apparatus wherein work conveying means is provided with limited lateral yieldability along its length for facilitating positioning of a tile for grinding.

Still further object of this invention is to disclose and provide a grinding apparatus wherein work conveying means and guide means for said work are disposed in converging relation and are synchronized in movement for advancing a tile in proper position to a grinding zone.

Generally speaking this invention contemplates a novel improved method of and apparatus for grinding edge faces of flat thin polygonal tile wherein work conveying means is provided to advance said tile in a path of travel in a horizontal zone and wherein said work conveyor means includes opposed spaced parallel conveyor lays movable in the same direction. One of said conveyor lays may be variably biased in the direction of the other lay. Grinding means including a cup type grinding wheel is adjustably mounted at one side of said conveyor means for adjustable spacing from said path of travel and is provided with a grinding edge face lying in a plane virtually parallel to said path of travel. Longitudinally extending guide means are provided on the opposite side of the conveyor means and may include an endless metal band having an inboard lay disposed at an angle to said path of travel and converging therewith, said inboard lay being movable in the same direction and at virtually the same rate of speed as the opposed work conveyor lays. Means are provided at the feed end of the conveyor means for directing tile against said inboard lay of the guide means whereby said tile will be advanced to and through a grinding zone of predetermined width as defined by said grinding edge face and an intermediate opposed portion of said inboard guide lay for precise grinding of said edge face of said tile.

Other objects and advantages of this invention will be readily apparent from the following description of the drawings in which an exemplary embodiment of this invention is shown.

In the drawings:

Fig. 1 is a diagrammatic view of a grinding apparatus embodying this invention showing its arrangement in a production line.

Fig. 2 is a top view of a tile to be ground by the apparatus of this invention.

Fig. 3 is a top view of the grinding apparatus embodying this invention.

Fig. 4 is an elevational view of the apparatus shown in Fig. 3, the elevation being taken in the plane indicated by line IV—IV of Fig. 3.

Fig. 5 is a fragmentary side elevational view taken in the plane indicated by line V—V of Fig. 3.

Fig. 6 is an end view taken from the right of Fig. 3.
Fig. 7 is an end view taken from the left of Fig. 3. Fig. 8 is a fragmentary sectional view taken in the plane indicated by line VIII—VIII of Fig. 4. Fig. 9 is a fragmentary transverse sectional view taken in the plane indicated by line IX—IX of Fig. 4.

Fig. 7 is an end view taken from the left of Fig. 3. Fig. 8 is a fragmentary sectional view taken in the plane indicated by line VIII—VIII of Fig. 4. Fig. 9 is a fragmentary transverse sectional view taken in the plane indicated by line IX—IX of Fig. 4.

The grinding apparatus of this invention, a flat polygonal article such as a tile 19 in Fig. 2 is illustrative of an article which may be ground with parallel edge extremities to precise dimension. Exemplary tile 10 is provided with pairs of opposed edge faces 11 and 12, each edge face 12 being provided with a plurality of tile-spacing elements 13 transversely and nonuniformly arranged with respect to the axes of said tile. The elements 13 have outermost edge extremities which define a plane. One element 15 may be disposed in close proximity to one end of edge face 12. It is desired that opposed edge face 11 which may be plain and uninterrupted be made precisely parallel to said plane and be precisely dimensioned a preselected distance from said plane. Such a tile is described and claimed in co-pending applications Serial No. 391,979 and Serial No. 310,659. Such a tile with precisely dimensioned outermost extremities in precise parallelism affords tile which may be installed rapidly in a pattern wherein courses of said tile may be accurately laid so that opposed planes of edge extremities are precisely parallel and spaced apart and thus provide uniform joint lines between said tile.

In general, such tile 10 may be pressed oversize so that the edge faces 11 may be ground to precise dimension. In Fig. 1 a line of tile 10 in abutment may be continuously fed to a grinding apparatus 15 embodying this invention by a suitable feed conveyor 16 moving at a preselected speed. At apparatus 15 the tile are longitudinally spaced by a grinder conveyor means 17 which receives the tile and which moves at a rate of speed greater than feed conveyor 16. On the grinder conveyor 17 the tile are passed through a grinding zone G and through a settling zone F. After discharge from the settling zone F, the tile are turned 90° and then fed to a second similar grinding apparatus 15′ for grinding the other edge face 11. The tile discharged from the second grinding apparatus 15′ may be stacked and handled in any well-known suitable manner.

The grinding apparatus 15 embodying this invention comprises in addition to the grinder conveyor 17, grinding means 19 and a settling means 20 at one side of the grinder conveyor 17, and a work guide means 21 at the other side of the grinder conveyor 17. The several means 17, 19, 20, and 21 may be supported by a suitable frame structure 22 fragmentarily shown and which may comprise any well-known construction.

The grinder conveyor 17 may comprise top and bottom endless belt means 24 and 25 having opposed layers movable in the same direction and speed, the top belt means extending through the grinding zone G and the bottom belt means through both the grinding and settling zones. The bottom belt means 25 serves to define a longitudinal path of travel for a tile through the grinding apparatus 15. The belt means 25 may comprise a pair of laterally spaced parallel endless flexible V-belts 36 supported at their ends by pairs of end pulleys 27 and 28. End pulley 27 may be carried by a shaft journaled in an upstanding member member 29 (Fig. 6) secured to a transverse plate 30 provided on spaced longitudinal angle beams 31. End pulleys 28 (Fig. 7) may be carried on a shaft 32 journaled in a block 33 supported from beams 31 by a plate 34, shim 35 and a longitudinal bar 36. The end pulleys 28 may be supported at its other end by means later described. Pulleys 28 may be connected to driving means (not shown) in any suitable manner.

In the approach to and in the grinding zone G the top layers of belts 25 are supported for movement in a selected relatively unyielding horizontal plane by a plurality of pairs of longitudinally spaced pulley wheel assemblies 38. Each assembly 38 (Fig. 8) includes a shaft 39 journaled by suitable bearing means 40 in a longitudinal member 41. The longitudinal member 41 is secured at one end to the upstanding member 29 by suitable stud bolts 42 and at the other end to an upstanding member 43 positioned between the ends of the belt means and approximately parallel to the longitudinally spaced and nonuniformly arranged elements 13. The upstanding member 43 is supported on a plate 44 carried by beams 31 and serves also to support the inner end of longitudinal bar 36. It should be noted that in the approach to the grinding zone the spacing of assemblies 38 is relatively great, while in the grinding zone the assemblies are spaced apart a minimum distance to accurately support movement of a tile along its path.

Means for tightening endless belts 26 may be conveniently provided by movable tightening wheels 46 carried by a supporting element 47 pivotally mounted at 45 to the upstanding member 29. A threaded bolt 49 and a lock nut 50 serve to adjust the wheels 46. A second adjusting pulley 51 may be mounted on a shaft 52 movable vertically in parallel slots 53 provided in the upstanding member 43 by a suitable wedge 54a actuated by a longitudinally movable block 54 slideable in a slot 55 provided in longitudinal bar 36. In the course of said travel (Fig. 9) the top lay of the endless belts 26 may be supported by a plurality of vertically spring-biased movable wheel assemblies 56. Each assembly 56 includes a transverse shaft 57 antifrictionally mounted in a block 58. The block 58 is provided with slots 59 on opposite sides thereof which slidably receive pins 60. The pins 60 may be carried by spaced parallel side plates 61 which are connected at their bottom portions to the longitudinal bar 36 by suitable stud bolts 62. Each block 58 is spring-biased upwardly by means of a coil spring 63 received within a downwardly opening recess 64 provided in the bottom portion of block 58. The upper end of the spring 63 is seated against a washer carried by bolt 67 in recess 64. The other end of the spring 63 may be seated against an adjustable insert 65 which is threadedly received within a port 66 in the bar 36. The insert 65 is provided to receive securing bolt 67 which extends through the insert and which may be provided with a threaded end for threaded engagement with the block 58. The insert 65 may be adjustable so that the compression of spring 63 may be varied.

The top endless belt means 24 of the grinder conveyor 17 comprises a pair of laterally spaced parallel endless V-belts 70 carried by pairs of end pulleys 71 and 72. The end pulleys 71 are supported by a transverse shaft 71a which may be carried by a frame structure 72 fragmentarily shown and which may comprise any well-known construction.

The end pulleys 72 may be carried by a transverse shaft 77 antifrictionally mounted in a suitable supporting block 78 which may be fixed by suitable stud bolts 79 to the rigid bar 74. Means for supporting the top belt means 24 in selected position over the bottom belt means 25 may comprise a pair of transverse, longitudinally spaced frame members 81, each provided with a pair of transverse slots 82 open at the end of members 81. The slots 82 receive securing stud bolt assemblies 83 for supporting the longitudinal bar 74. The slots 82 permit adjustment of the top belt means 24 laterally of the apparatus and at a selected angle to the longitudinal bar 36. The end pulleys 72 may be carried by a transverse shaft 77 antifrictionally mounted in the top belt means. Preferably, the axis of the top belt means is slightly inclined to the path of travel of the tile and converges therewith at the grinding zone.

The bottom layers of the endless top belts 70 are guided by a plurality of vertically adjustable, downwardly spring-biased, closely spaced pulley wheel assemblies 85. Each wheel assembly 85 (Fig. 8) includes a transverse shaft 86 carried in a vertically adjustable block 87. Opposite
The work guide means 31 (Fig. 1) also comprises a bottom longitudinal plate 121 and vertical members 122, 123, and 124 which support the longitudinal plate 120 thereabove. The bottom plate 121 is adjustably mounted on the transverse plates 30 carried by the frame angle members 31 by suitable bolt and nut assemblies 126, said bolt and nut assemblies being received within transversely disposed slots 127 provided in the transverse members 30.

It will thus be apparent that the entire work guide means 21 may be moved laterally with respect to the conveyor 17 and may be positioned on the inboard guide face 118 of the metal band at a selected distance from the grinding wheel so as to accommodate tile of different width. The adjustable mounting of the work guide means 21 also permits the guide means to be adjusted into a selected angular relationship to the path of travel of the tile and to precisely determine the dimension to which the tile are to be ground. This precise dimension is determined by the spacing of the inboard face 118 from the last edge of contact of the annular grinding edge face 111 with a tile as indicated at D (Fig. 1). The inboard face 118 is disposed so as to converge to this critical dimension and to thereby guide and position tile for precise grinding.

It may also be noted that the inboard guide face 118 is supported opposite the feltting zone so that in the feltting operation the tile is properly positioned for providing a suitable bevel on the edges thereof.

At the feed end of the slider conveyor 17 suitable means may be provided for directing tile received therewith and against the inboard guide face 118 of metal band 116. Such means may comprise an angularly disposed member 128 carried by the frame structure 22. The member 128 provides a smooth flat inboard surface which may extend into close proximity with the bottom belt means 25 for positively urging a tile thereacross into contact with the metal band.

In the apparatus of this invention described above it will be understood that suitable synchronized drive means may be provided for driving the top and bottom endless belt means 24 and 25 and the work guide metal band 116 at the same speed. The drive means do not form part of this invention and are therefore not described.

At the feltting zone P a plurality of suitable feltting grinding units 129 may be mounted. Each provides a downwardly biased, free-rotatable grinding member 130 pivotally supported from a horizontally disposed horizontal member means (not shown) carried by the frame structure 22. In the exemplary embodiment of this invention the grinding wheel 110 may be fixedly and rigidly mounted, but it is understood that said grinding wheel may be adjustably mounted so as to move the grinding edge face 111 toward and away from the path of travel of the tile if so desired. A cover guard 112 may be provided for the grinding wheel.

At the other side of the slider conveyor 17 the guide means 21 may be suitably adjustably supported from the frame structure 22 (Figs. 1, 5, 6 and 7). The guide means 21 may comprise a pair of longitudinally spaced horizontally disposed pulley wheels 114 mounted for rotation about vertical axes provided by vertical shafts 115. One of said wheels 114 is located opposite the feed end of the bottom endless belt means 25 and the other pulley wheel 114 is located at the discharge end thereof. The pulley wheels 114 support, and drive through suitable means (not shown), an endless flat belt 116 which provides an inboard face 117 having an inboard guide face 118 lying in a vertical plane and in the same horizontal plane as the path of tile through the grinding apparatus. The inboard face 117 may be supported throughout its length against lateral yieldability by a suitable rigid guide bar 119 supported from a longitudinally extending plate 120 which may carry journals for the wheel shafts 115.
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tile disposed on the side of the work guide means is initially directed toward and into contact with the inboard guide face 118 of the metal band 116.

As a tile advances between the opposed lays of the top and bottom belt means 24 and 25, the angular disposition of the belt means with respect to the bottom belt means causes the edge face or edge extremities of the edge of the tile opposite to the edge to be ground to be urged against the inboard guide face 118 for the entire length of the edge of the tile. The tile is thus positioned with its longitudinal axis disposed angularly with respect to the longitudinal axis of the bottom belt means, which is serving to define a path of travel for the tile. In this manner, each tile is advanced toward the grinding zone and is so positively positioned against the inboard guide face 118 of the metal guide band that it will readily pass by the annular grinding edge face 111 nearest to the feed end of the conveyor 17.

As each tile advances through the grinding zone, the angular inclination of the top belt means continues to position each tile with its longitudinal axis parallel to the inboard guide face 118 of the metal guide band by urging edge extremities of the tile against said guide face. In addition, each tile is resiliently gripped between the opposed lays of the top and bottom belt means and is floatably held thereby. It must be remembered that the top and bottom belt means are provided with flexible V-belts and that the lower lay of the top belt means is downwardly biased under a selected biasing pressure by the pulley wheel assemblies 38.

The grinding wheel 110 is rotated so that the grinding edge face 111 is moved downwardly on the side remote from the feed end of the conveyor 17. As each tile comes into contact with the grinding edge face 111, static pressure is developed that urges the tile firmly against the inboard guide face 118, the flexible belt means permitting limited movement thereof. The spacing of the last grinding edge element directly opposite from the inboard guide face 118 is preslected and readily achieved by proper positioning of the work guide means and the grinding wheel. Thus, as each tile engages the grinding wheel, the edge face of the tile to be ground will be precisely parallel to the plane of the edge extremities of the opposite side of the tile in contact with the work guide face 118.

Each tile continues along the bottom belt means with one edge in contact with the inboard guide face 118 as it passes through the grinding zone. The grinding discs 130 are suitably positioned so that the sharp top edge resulting from grinding of the tile is cut away to provide a beveled top edge corresponding to the nonground top edges of the tile. After each tile is discharged from the grinding zone it may be turned 90° in a well-known manner to position the other edge face to be ground for grinding in a second grinding apparatus of the same construction and operation as that described above.

It will thus be understood by those skilled in the art that a novel apparatus and method for grinding edge faces of articles has been described above wherein essential features of centerless grinding are utilized. Thus, a precise, accurately dimensioned tile is achieved by this apparatus and method which when installed in a pattern will provide uniform parallel courses with uniform joint lines wherein care and skill required to install the tile is reduced to a minimum.

It will also be understood that while the apparatus has been described for use with an exemplary ceramic tile, other articles of different material may be readily ground to precise dimension with parallel edge faces by the apparatus and method of this invention.

The modifications and changes may be made which come within the spirit of this invention and all such changes and modifications within the scope of the appended claims are embraced thereby.

I claim:

1. In an apparatus for grinding an edge face of an article into precise parallel and microdimensioned distance from a plane determined by opposite edge extremities of said article comprising, in combination: a conveyor means for advancing at one side of said conveyor means successively along a predetermined horizontal path at a preselected rate of speed, said conveyor means including spaced apart opposed lays adapted to move in the same direction, said lays being adapted to resiliently grip an article therebetween and having limited lateral movement; a grinding means opposite to said conveyor means comprising a plurality of articles successively disposed on a vertical plane facing said path; a longitudinally extending guide means at the other side of said conveyor means, said guide means comprising an endless metal band having an inboard lay provided with an inboard edge face lying in a vertical plane convergent to said path, a rigid guide bar supporting said vertical inboard lay; positioning means adjacent said grinding means and the feed end of said conveyor means and extending inboard of the plane defined by said annular grinding edge face for cooperation with the opposed end of said guide means for causing an article advanced on said conveyor means to become disposed with its axis angularly related to said path and parallel to the inboard edge face of said guide means; said guide means defining with a portion of said annular grinding edge face a grinding zone of predetermined microdimensioned width whereby articles advanced along said conveyor means and guided by said guide means are passed through said grinding zone with their axes at an angle to the path of travel.

2. An apparatus as stated in claim 1 wherein said guide means extends beyond said grinding zone in said direction of advancement.

3. An apparatus as stated in claim 1 wherein said guide means is adjustable mounted for movement toward and away from said path of travel for precisely spacing the inboard face of the inboard lay of said metal band from said grinding means.

4. In an apparatus for grinding edge faces of articles into precisely parallel and microdimensioned spaced relationship the combination of: a conveyor for advancing articles to be ground along a predetermined horizontal path at a preselected rate of speed and including means for limiting vertical displacement of said articles from said path, said limiting means being disposed at an angle to said path; a grinding means opposite to said conveyor means comprising an endless belt having an inboard horizontal lay with a vertical inboard face, said vertical inboard face lying in said plane convergent to said path, said inboard face of said inboard lay intermediate its ends being spaced apart a predetermined distance from the grinding edge face of said grinding means to define a grinding zone; and means at the feed end of said conveyor means to direct an article fed to said conveyor means against said inboard lay of said guide means and wherein the inboard lay is advanced in synchronism with said conveyor means.

5. In an apparatus as stated in claim 4 wherein said endless belt of said guide means is adapted to be driven in synchronism with said conveyor means whereby said inboard lay is advanced at the same rate of speed as said conveyor means.

6. In an apparatus as defined in claim 4 wherein a rigid guide bar supports said inboard lay of said guide means opposite to said grinding edge face.

7. In a grinding apparatus for thin flat polygonal tile, the combination of: a conveyor means for advancing successively to be ground along a selected path lying a first plane; grinding means at one side of said path provided with a grinding edge face lying in a second plane facing one side of said path; guide means opposite to said grinding means and
presenting a guide face lying in a third plane disposed at an angle to said path and in converging relation thereto, said planes of said guide face and said grinding edge face defining a grinding zone of predetermined dimension; means at the feed end of said conveyer means to direct a tile fed to said conveyer means against said guide face prior to said grinding zone whereby a leading corner of a tile is positioned in contact with said guide face.

8. In a grinding apparatus as defined in claim 7 wherein said guide face is adapted to be movable at a rate of speed virtually the same as the speed of the conveyer means.

9. In a grinding apparatus as defined in claim 7 wherein said conveyer means includes a pair of spaced lays adapted to move in the same direction at the same speed, one of said lays being virtually nonyieldable in a vertical direction and the other of said lays being variably biased toward the other lay throughout its length for yieldably limiting vertical displacement of said tile.

10. A grinding apparatus as defined in claim 9 wherein each of said lays of said conveyer means are limitedly laterally movable adjacent said grinding zone for floatingly aligning said tile with said grinding zone.

11. A grinding apparatus as defined in claim 9 wherein one of said lays is disposed at an angle to said path to positively urge and hold a tile in contact with said guide face.

12. In a grinding apparatus for grinding opposite faces of an article precisely parallel, the combination of: a grinding means including an annular grinding edge face rotatable in a plane; a work guide means having a guide face inclined to said plane, said guide face being spaced a preselected distance from said grinding edge face in a grinding zone and adapted to be contacted by an article being ground; and conveyer means for advancing an article through the grinding zone and comprising top and bottom belt means having opposed lays adapted to resiliently grip and position said article against said guide face in the approach to and in the passage through said grinding zone.

13. In a grinding apparatus as defined in claim 12 wherein the longitudinal axis of one of said belt means is angularly disposed to the longitudinal axis of the other belt means.

14. In a grinding apparatus as defined in claim 12 wherein said guide face extends beyond said grinding zone; and setting means are provided opposite said extension in transverse spaced relation thereto for grinding an edge of an article ground in the grinding zone.

15. In a grinding apparatus for grinding a face of an article precisely parallel to an opposite face, the combination of: a grinding means including a grinding edge face lying in a vertical plane; a work guide means spaced from said grinding means and providing a vertical guide face inclined to said plane and spaced a preselected distance from said plane at a grinding zone; conveyer means between said guide face and said grinding edge face for advancing an article through the grinding zone, said conveyer means including a horizontal belt means having its longitudinal axis extending generally parallel to the plane of the grinding edge face and a second belt means spaced from and cooperating with the first belt means for gripping an article to be ground during advancement into and through the grinding zone, said second belt means having an axis angularly disposed to the plane of said grinding edge face whereby said second belt means is adapted to urge and hold an article being ground against said guide face.

16. In a grinding apparatus, the combination of: a conveyer means for advancing successively at a selected rate of speed, articles to be ground along a predetermined path lying in a first plane; grinding means at one side of said path provided with a grinding edge face lying in a second plane perpendicular to the first plane and facing said path; guide means opposite to said grinding means and provided with a longitudinally extending guide face lying in a third plane perpendicular to said first plane and converging in angular relation to said second plane in the direction of advancement of said articles, said guide face being spaced from said grinding edge face at a grinding zone, said guide face extending beyond said grinding zone and continuing to be disposed in convergent relation to said second plane.

17. A method of grinding an edge face of a flat polygonal article precisely parallel to an opposite edge face, comprising the steps of: rotating a grinding face in a plane at a grinding zone; advancing such an article with an edge face opposite to the edge face to be ground lying in a plane inclined to the plane of said grinding face; supporting the edge face opposite to the edge face to be ground in said inclined plane as said article engages said grinding face; and limitedly, yieldably resiliently positioning an article in its advancement toward the grinding zone and during passage thereforth.

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