CONICAL BALL SEPARATING MEANS FOR BALL ROLLING MACHINES

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My invention relates to ball separating means for ball rolling machines, and more particularly to conical ball separating means.

In order that grinding balls can be produced rapidly in the most economical and efficient manner, it is desirable to make the same from a steel or similar material in a continuous method involving the forming of the balls from the rod or other shape in a connected series and the separation of the balls from each other without halting the progress of the rod, which usually is supplied in coils of great length, through the forming apparatus.

It is desirable in order to carry out such a method in a practical and efficient manner to avoid all reciprocating motions of any machine parts that are involved in the forming of the ball-like or spherical formations from the rod or similar shape and the separation of these into separate balls or units. Unless this is done no great gain in speed of operation will result over forging of the individual balls by cutting off lengths of rod and then forging the individual balls from such cut-off blanks by a reciprocating die, as is common at the present time.

While suitable ball formations can be formed from a rod or similar member by means of rolling operations, this is of no advantage unless the reciprocating motions can be entirely avoided in separating the connected ball formations thus formed. I accomplish this by providing twisting means for separating the ball formations from each other, said twisting means comprising conical rollers that are grooved to receive the ball formations so as to twist the narrow neck portions located between said ball formations and the ball formations themselves from each other by twisting one ball formation off from the next adjoining one.

Attempts have been made to make grinding balls and other ball-like members between the balls of certain shapes that have spiral grooves of gradually changing pitch and depth to form ball formations on a round rod and eventually separate these into individual balls. However, as various sizes of balls have to be produced in practice, and as the rolls that are used for rolling such objects as grinding balls wear out after a certain amount of use and have to be replaced, the use of such spirally grooved rolls that gradually change in pitch and depth is so great that, even if these would successfully produce grinding balls, the cost would be so increased as to be prohibitive, and accordingly such apparatus is not practical.

It is the principal purpose of my invention to provide new and improved means for separating grinding balls that are made from a continuous length of rod by being formed in a series of ball formations that are connected by narrow neck portions, said apparatus comprising separating said ball formations at said neck portions to provide separate ball formations by twisting each ball formation into the next adjacent ball formation and continuing such relative twisting until the torsion exerted on said narrow neck formation separates one of said ball formations from the next adjoining one.

An improved apparatus specifically separates the ball formations, so connected together in series, along the series one after another without providing any moving parts that have a reciprocating motion, all of the moving parts being only in the form of conical balls that operate by a continuous rolling motion always in the same direction.

More specifically my invention comprises a plurality of conical ball separating rolls that have spiral grooves therein for receiving the ball formations separating said ball separating rolls rapidly increasing in diameter from one end thereof toward the other end thereof so that each adjacent turn or convolution of the spiral groove in each of said rolls is much longer than the next turn thereto toward the smaller end of the conical roll. As a result, each ball formation in the connected series increases in its rate of rotation about its own axis and then the convolution of the connecting narrow neck portion between it and the next adjacent ball formation, as it passes lengthwise between the separating rolls in a direction axially of the series, and as a result each ball roll advances away from the larger end of the rolls, and in contact with a convolution of each spiral groove nearer said larger end of the rolls, is rotating at a higher speed than the next adjacent ball formation thereto that is in contact with a convolution of each roll nearer the smaller end of the rolls.

Accordingly my apparatus causes each ball formation to be twisted about the axis of the connecting neck portion relative to the ball formation adjacent thereto throughout the time that it is in engagement with the twisting rolls.

It is a further purpose of my invention to provide conical ball separating rolls that are provided with spiral grooves of uniform depth for receiving the connected ball formations, which rolls are so shaped that the diameter thereof increases rapidly from the small to the large end thereof, in this case the ball formations to rapidly increase in rate of rotation from the small end of the rolls to the large end of said rolls, whereby each ball formation is successfully twisted off from the adjacent ball formation during the travel of the same lengthwise between the cooperating twisting rolls.

It is an important purpose of my invention to provide such ball separating apparatus with conical spirally grooved ball separating rolls that small rotation of the ball formations as they first engage with said separating rolls, so that no great amount of twist in the connected series of ball formations between the form ing rolls and the ball separating means is necessary, and thus to make it possible to eliminate any holding means to prevent rotation of the connected ball formations about the longitudinal axis of the series of connected ball formations between the forming rolls and the rolls.

It is another important purpose of my invention to provide ball separating means comprising a plurality of conical curved ball separating rolls of the above mentioned character, in which one of said rolls is yieldingly mounted so that it is held in cooperation relation with the other ball separating rolls cooperating therewith by spring pressure so that the elasticity of the rolls should any mal-formed or improperly spaced ball formations enter the separating rolls, and to provide means for moving said yieldingly mounted ball separating rolls in the same direction as the other ball separating rolls, said means being constructed and arranged so that the roll mounted for movement toward and away from the other rolls can be quickly separated thereto on other, thereby because of improper operation of the machine or because of mal-formed material entering the separating mechanism.

Preferably, the yieldingly mounted roll cooperates with a pair of similar rolls that are rotatable about fixed axes at an oblique angle to each other, said yieldingly mounted roll being held in a position at an oblique angle to the shaft of the rolls and being urged into such position by resilient means, the mounting for said yieldingly mounted roll comprising a shaft on which the same is mounted, that is mounted for swinging movement about an axis transverse to the axis...
of rotation thereof so as to be movable toward and away from the other pair of rolls and having means for swinging the same into and out of position that is self-locking in 24 a direction so as to prevent it being yeldingly urged into cooperative relation with the other pair of rolls.

It is a further purpose of my invention to provide device for the conical ball separating rolls, that is constantly in driving engagement whether said swingingly mounted roll is in cooperative relation with the other pair of rolls or not, and which rotates said rolls in 10 an opposite direction at the same time.

Other objects and advantages of my invention will appear as the description of the drawings proceeds. I desire to have it understood, however, that I do not intend by the figure details shown or described, except as defined in the claims.

In the drawings:

Fig. 1 is a view partly in side elevation and partly in vertical section, of my improved ball separating apparatus, showing a fragmentary portion of the ball forming means, the section being taken on the line 1—1 of Fig. 2.

Fig. 2 is a top plan view of my improved ball separating apparatus, showing a fragmentary portion of the ball rolling apparatus, the means for yieldingly holding the swingingly mounted roll with respect to the other pair of rolls being omitted, and the bracket mounting therefor being shown in horizontal section.

Fig. 3 is a section taken on the line 3—3 of Fig. 1 on a somewhat larger scale than Fig. 4.

Fig. 4 is a section taken on the line 4—4 of Fig. 1 on an enlarged scale.

Fig. 5 is a section taken on the line 5—5 of Fig. 1 on an enlarged scale.

Fig. 6 is an enlarged fragmentary section taken on the line 6—6 of Fig. 1.

Fig. 7 is an enlarged fragmentary section taken on the line 7—7 of Fig. 2, showing some of the connected ball formations in engagement with the ball separating rolls.

Referring in detail to the drawings, my improved separating mechanism is applied to a main drive shaft 10, which is driven from a suitable source by means of belts operating over a grooved pulley 11, said main drive shaft also driving the swinging rolls 12 through suitable gearing, including reduction gearing, not shown. Said swinging rolls 12 constitute the second set of swinging rolls in a ball forming machine, such as that disclosed in my co-pending application Serial No. 39,104 filed November 28, 1948, on Continuous Method and Apparatus for Forming Balls.

In such a ball forming machine the balls are formed from a rod or similar shape, the final swinging operation producing a connected series of ball formations, the same being connected by narrow neck portions, as will be explained below.

Mounted on the main drive shaft 10 is a pinion 13, which is mounted itself on a large idler gear 14 mounted on a suitable shaft carried by the frame 15. The idler gear 14 meshes with a gear 16, which is keyed to the shaft 17. Also keyed to the shaft 17 is a gear 18 that has a broad face and is beveled, as will be obvious from Fig. 1. The shaft 17 is mounted in suitable bearings on the upstanding portion 19 of the sub-base 23 on the base 15, said bearings being provided with suitable removable cap portions 20, as will be obvious from Figs. 1 and 2. Also extending upwardly from the sub-base 23 are a pair of bracket members 21 that have transversely extending pivot members 22 mounted thereon for a purpose to be described below.

The sub-base 23 is provided with upstanding bearing bracket members 24 and 25, the bearing bracket member 25 being shorter than the pivot member 22, and said bearing brackets having bearing portions 26 and 27 therein, with which the bearing caps 28 and 29 cooperate to mount a shaft 30 that has an end oblique to the base 15 from the bracket 25 toward the bracket 24, and also inwardly at an oblique angle toward the axis of the shaft 17 from the bearing on the bracket 25 toward the bracket 24.

A shaft 31 is similarly mounted on a pair of upstanding bearing brackets, the bearing bracket 32 corresponding to the bearing bracket 25, being shown in Fig. 6, and being shown as having a cap portion 33 thereon cooperating with the bearing portion 34 to mount the one end of the shaft 31 for rotation therein. The other end of the shaft 31 is mounted in an upstanding bearing bracket 35, the bearing bracket 35 shown in Fig. 1, and which has a cap portion 36 thereon, that cooperates with the bearing provided in the upper end of the bearing bracket to mount the shaft 31, in a similar manner to the bearing shaft 25 that is inwardly relative to the base 15 toward the left hand end thereof, as viewed in Fig. 2, and inwardly toward the axis of the shaft 17 toward said left hand end as shown in Fig. 2. The shafts 30 and 31 extend in equal angles to the shaft 17 on opposite sides thereof and to the base 15 so that the axes of the shafts 31 will meet at a point that lies on the axis of the shaft 17 on which the series of connected ball formations are fed into the separating rolls.

Mounted on the transverse pivot members 22 to pivot on an axis transversely to that of the direction indicated by the arrows on said gears in Fig. 6. Thus all of the shafts 30, 31 and 41 rotate in the same direction.

The mounting of the frame carrying the shaft 41 is such that it has limited movability both longitudinally and this limited movement is so small that the gear 45 will always be in mesh with the gear 18 in any operative position of the shaft 41, it being noted that the gear 45 is located on the shaft 31 but is not shown in position to align with the axis of the pivot member 22 (see Fig. 1). The upwardly bowed portion 37 on the frame serves as a housing means for the gear 45, as will be obvious from the drawings. A pair of pins and members 46 are provided on the sub-base 23 that have inwardly extending portions 47 and a pair of parallel upper end portions 48 that are connected together by a transversely extending portion 49. The frame member 38 of the swingingly mounted frame has a seat 50 thereon for a compression coil spring 51 and has a rod-like member 52 screw-threadedly connected therewith.

A follower 53 is mounted between the parallel inner end portions 48 of the members 46 for slidably sliding movement thereon. Such sliding movement of the member 53 may be provided in any suitable manner, as by providing a pair of flanges 54 on each side of said member 53 engaging the opposite side edges of the members 48, as shown in Fig. 5. The rod-like member 52 extends through a central orifice in the member 53, and said rod-like member has a threaded portion 55 at its upper end, with which a stop nut 56 is screw-threadedly engaged. It will be obvious that the stop nut can be adjusted to control the compression of the compression spring 51 on the frame, which tends to move the left end of the longitudinally extending portion 38 thereof downwardly, as viewed in Fig. 1. The member 53 is also provided with a link 57, and with a transverse orifice 58, in which the pivot pins 59 are mounted, said pivot pins traversing the slots 57. Said pivot pins 59 serve to pivotally connect the links 60 with the follower 53. Said links 60 are pivotally connected to said follower 53 with a link 61, which in turn is pivotally connected to a shaft 62.
connected at 63 with a slidably mounted block 64. Said block 64 is provided with flanges 65, by means of which it is mounted for guided sliding movement on the upper end portions 48 of the brackets 46, as will be obvious from Fig. 4.

The member 64 has a central slot 66 therein to accommodate the link 62 and a transverse opening for the pivot pin 67, within which the pin traverses the slot 66, as will be obvious from Fig. 3. A lever 67 extends from the link 62 near the pivotal connection 63 thereof with the block 64 and has an operating handle 68 thereon. While the block 64 is a single relatively broad portion 48, its position is definitely determined by means of an adjusting screw 69, which has screw-threaded engagement with a screw-threaded opening 70 in the transversely extending portion 49 and is screw-threadedly engaged in a screw-threaded opening 71 in the block 64. The screw-threaded member 69 has a head 72 thereon for adjusting the same, and is provided with a lock nut 73 that will hold the screw-threaded member 69 in adjusted position. Thus the position of the block 64 is fixed for any adjustment of the screw-threaded member 69.

If all the observations made as to the links 60 and 62 from a toggle mechanism, and when said toggle is in the position shown in Fig. 1 the link 62 will be in engagement with a stop 74 so as to cause the spring pressure exerted by the spring 75 to lock the toggle mechanism as shown. The adjustment of the spring 51 and of the stop member 69 is such that when the parts are in the position shown in Fig. 1 the shaft 41 will be urged toward the axis of the rolls and the twin 55 thereof with sufficient yielding pressure of the spring 51 that, in operating condition, the shaft 41 will have its axis passing through the points at which the axes of the shafts 30 and 40 are on each other. Thus in operative position, the shafts 30, 31 and 41 will all have their axes radiating from a common point and will all extend at equal angles from each other on the surface of a cone, the apex of which would be at the point at which said axes of said shafts intersect. Thus a three point support for the ball formations to be separated will be provided, with a series of great balls mounted therein, which will be described below.

The shaft 30 has a ball separating roll 75 mounted thereon, the shaft 31 has the ball separating roll 76 mounted thereon, and the shaft 41 has the ball separating roll 77 mounted thereon, the ball separating rolls being keyed to the respective shafts to rotate therewith. Said ball separating rolls are similar in construction and are of a particular character, having the small ends 78 thereof located nearest the ball forming mechanism and having the larger ends 79 thereof mounted remote from said ball forming mechanism and being of conical shaped rolls. These cones are provided with a spiral groove 80, which is of uniform depth from end to end of each of said rolls, and is concave in cross section, as will be obvious from Figs. 1, 2 and 8. The spiral grooves are so placed that the revolutions thereof are closely adjacent each other, as will be obvious from Figs. 1, 2 and 7, leaving rib portions 81 between the same. The apex angle of the cone in the case of each of said rolls is such that each convolution of the groove 80 is much longer than the next adjacent convolution thereto toward the small end of the roll, said apex angle of the cone of the rolls shown in Fig. 8 being nearly 50°.

Said rolls are furthermore quite small at the entrance end thereof, or the small end thereof, as compared with the length that is engaged by said rolls. Thus the small ends 79 of the rolls are only a fractional portion of the diameters of the ball formations 82 that are connected by the narrow neck portions 83, and which are to be separated from each other by the twisting rolls. The length of the convolution of the spiral groove 80 at the larger end 79 of each roll is a multiple of the length of the convolution at the smaller end of each roll and is, preferably, also of a length equal to or slightly greater than the circumferential distance around the ball formation 82.

By providing conical spirally grooved twisting rolls that have ball receiving grooves of uniform depth therein from end to end that have a small end that is only a fraction of the diameter of the ball formation, per large end that has a diameter a multiple of the diameter of the ball formations, the ball formations 82 that are between the forming rolls 12 and the twisting rolls will be turned only very slightly about the axis of the series of balls and thus about the axes of the connecting neck portions 83, having no appreciable twisting effect on the connected series of ball formations, until after these have entered between the twisting rolls 75, 76 and 77. However, as each successive convolution of the rolls 82 is engaged by any particular ball formation in the movement thereof axially of the ball twisting mechanism due to the cooperative action of the twisting rolls 75, 76 and 77, the ball formation 82 will be subjected to an increased convolution on each of said rolls, which will cause the rate of rotation of the ball formation 82, and the amount of rotation therewith of the axis of the series of connected balls to increase materially for every succeeding convolution of the spiral grooves on the twisting rolls, and by the time any ball formation 82 has moved into engagement with the last convolution of the twisting rolls it will have been rotated or twisted about the axis of the connected ball formations more than one complete turn.

In practice, it has been found desirable that this rotation be a total of more than two turns about the axis of the connecting neck portions 83 so as to be certain that the ball formation 82 in engagement with the last convolution of the rolls 82 with which it engages at the larger end of the rolls will be effectively separated from the next ball formation at the left thereof, or toward the smaller end of the rolls. The torsion exerted on the short, narrow neck portions connecting the ball forming 82 will, under these circumstances, be considerable and will result in the gradual twisting off of one ball formation from another as the ball forming 82 is continuously turned about the twist-off mechanism, as each ball formation 82 to the right or toward the larger end of the rolls from the next ball formation 82 will be rotating at a higher rate and will therefore be twisted continuously toward the right and connecting these ball formations from the time each of said ball formations enters the twist-off mechanism until it is separated from said adjacent ball formation.

By providing the mounting for the shaft 41 about the axis of the pivots 22 with yielding means 51 urging the shaft 41 and the roll 77 toward the rolls 75 and 76, a sufficient spring pressure will be exerting force, so that the ball formations will be firmly gripped and held in frictional engagement with the rolls 75, 76 and 77 under normal operating conditions, but in the event any mal-formations exist in the connected series of balls, or said connected series of ball formations should not engage properly with the twisting rolls 75, 76 and 77, the spring 51 will yield enough that damage of the rolls by engagement of such mal-formed or other undesirable material will not occur. Furthermore, it is necessary, the operator of the machine can strike the hand portion 68 of the stop member 69, quickly release the compression on the spring 51 and cause the roll 77 to yield upwardly, as the shaft 41 swings a limited amount about the pivot member 22, sufficiently to permit any such mal-formations of the stop member 69, or to permit suggestions, to be freed from close engagement with any of said rolls, this permitting removal of the undesirable or mal-formed material from between the twist-off rolls. After the mal-formed or other undesirable material has been removed, the series of connected ball formations can again be placed in position for proper engagement with the rolls 75 and 76, and the roll 77 moved into cooperation therewith.

What I claim is:

1. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a plurality of tapering rolls mounted to rotate about axes extending obliquely theretofrom end to end thereof, one of said rolls having a spiral groove therein extending from end to end thereof, one of said rolls having means yieldingly urging the same toward the other rolls, and means for rotating said rolls in the small end thereof.

2. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a plurality of duplicate, conical rolls mounted to rotate about axes extending obliquely to each other, said rolls each having a spiral groove at the small end thereof, means for feeding said connected ball formations into said rolls at the apex ends thereof, each of said rolls having a spiral groove of uniform depth therein extending from said apex end thereof to the
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other end thereof, and means for rotating said rolls in the same direction.

3. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a plurality of conical spirally grooved rolls mounted to rotate about axes extending obliquely to each other, the smaller ends of said rolls being the entrance ends thereof, said rolls being of smaller diameter than said ball formations at the smaller ends thereof, each of said grooves being concave in cross section and of the same depth from end to end thereof, and means for rotating said rolls in the same direction.

4. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a pair of tapering rolls mounted to rotate about fixed axes extending obliquely to each other, a tapering roll mounted for rotation about an axis movable toward and away from said pair of rolls, said roll being mounted on a shaft mounted to swing about an axis transverse to the axis of said roll, means for moving said shaft into a position with the axis of said roll at a predetermined oblique angle to the axes of said pair of rolls including yielding means urging said last mentioned roll toward said pair of rolls when stressed, and releasable means for stressing said yielding means, and means for rotating all said rolls in the same direction.

5. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a pair of tapering rolls mounted to rotate about fixed axes extending obliquely to each other, a tapering roll mounted for rotation about an axis movable toward and away from said pair of rolls, said roll being mounted on a shaft mounted to swing about an axis transverse to the axis of said roll, means for moving said shaft into a position with the axis of said roll at a predetermined oblique angle to the axes of said pair of rolls including yielding means mounted to swing the roll mounted on said shaft toward said pair of rolls, means for limiting swinging movement of said shaft toward said pair of rolls under the influence of said yielding means and releasable means for stressing said yielding means, and means for rotating all said rolls in the same direction.

6. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a pair of tapering rolls mounted to rotate about fixed axes extending obliquely to each other, a tapering roll mounted for rotation about an axis movable toward and away from said pair of rolls, said roll being mounted on a shaft mounted to swing about an axis transverse to the axis of said roll, means for moving said shaft toward said pair of rolls and releasable means for stressing said yielding means, comprising a toggle, and a lever for moving said toggle into alternate positions, and means for rotating all said rolls in the same direction.

7. In a ball forming machine, means for separating a plurality of ball formations connected by narrow neck portions comprising a pair of tapering rolls mounted to rotate about fixed axes extending obliquely to each other, a tapering roll mounted for rotation about an axis movable toward and away from said pair of rolls, said roll being mounted on a shaft mounted to swing about an axis transverse to the axis of said roll, means for moving said shaft into a position with the axis of said roll at a predetermined oblique angle to the axes of said pair of rolls including yielding means mounted to swing the roll mounted on said shaft toward said pair of rolls and releasable means for stressing said yielding means, and means for driving all said rolls in the same direction, said driving means including a gear on said swinging mounted shaft and a driving gear in mesh therewith in the alternative positions of said shaft.

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