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1

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POLISHING METHOD AND MEANS

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This invention relates to the art of polishing or surface finishing and more particularly to a method and means for polishing the surfaces of metals and the like materials in a low cost, continuous, mass production technique.

In my copending application, Serial No. 793,764, filed February 17, 1959, and entitled "Polishing Method and Device," description is made of a novel method and means for porducing a polished metal surface. In accordance with the concepts of the aforementioned application, a high polish can be achieved on the surface of a work piece of metal or the like by the projection of a particulate resilient material onto the surface in a manner which provides for a relative movement between the surface of the projected material and the surface of the work in the presence of a polishing or buffing agent. For this purpose, the resilient particulate material is thrown onto the surface of the work with a combination of linear and non-linear movement for travel directionally towards the work with a non-linear movement, such as a spinning movement, such that the desired relative movement will occur between the surface of the particulate substance and the work during the time that the particulate material is in engagement therewith.

In a device of the type described, the particulate substance acquires a rolling motion as the particulate substance in the form of a pellet is displaced centrifugally outwardly over the surface of radially extending vanes rotated at high speed about a central axis. In such arrangement, the spinning motion is a function of the linear speed, whereby it becomes difficult to vary the ratio as between linear and non-linear movement, as might be desired for various purposes.

It has been found that considerable advantage can be derived from flexibility of operation to impart a high degree of relative movement to the particulate substance prior to engagement with the surface to be treated and to permit variation as to the linear speed and relative movement to increase or decrease one or the other or both in response to a particular state of desirable conditions.

Thus, it is an object of this invention to provide a method and means for imparting linear and non-linear movements concurrently to particulate resilient substances for use in surface treatment, and it is a related object to provide a method and means for varying the degree of linear to non-linear movement for increase or decrease of one relative to the other.

More specifically, it is an object of this invention to provide a method and means for projecting resilient particulate substances linearly directionally onto a surface for treatment while simulaneously imparting a spinning or rotational movement of said particulate substance, and it is a related object to provide means of a type described wherein the degree of linear and spinning action can be varied to increase or decrease one or the other or both.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings in which—

FIGURE 1 is a perspective schematic view of a device embodying the concepts of this invention;

FIGURE 2 is a perspective view similar to that of FIGURE 1 showing a slight modification thereof;

2

FIGURE 3 is a perspective view similar to that of FIGURE 1 showing a still further modification of a device embodying the features of this invention;

FIGURE 4 is a perspective view similar to that of FIGURE 1 showing a still further modification of a device which may be employed in the practice of this invention;

FIGURE 5 is a perspective view of a device similar to that shown in FIGURE 3, but embodying a modification thereof;

FIGURE 6 is a sectional view illustrating a still further modification embodying the features of this invention; and

FIGURE 7 is a sectional view showing a modification of the construction illustrated in FIGURE 6.

It has been found, in accordance with the practice of this invention, that the desired combination of linear motion and non-linear or spinning motion can be imparted to such particulate substance when the particulate substance is engaged at opposite sides by two surfaces moving in opposite directions, but when the one surface is moving at a higher rate of linear speed than the other surface. Under such circumstances, the particulate substance will be displaced in a linear direction between such surfaces while simultaneously imparting a spinning motion. By variation of the surface speed of the surfaces, the linear speed and the spinning speed of the particulate substance can be varied to any desirable degree, since the linear speed will be found to be a function of the difference of the speeds of the two surfaces while the spinning speed will be found to be a function of their sum.

Having set forth the basic concepts of this invention, illustration will now be made of various methods and means whereby these concepts can be put into practice. For this purpose, the construction and arrangement of elements will be set forth diagrammatically for the various modifications embodying the practice of this invention, it being understood that adaptation to commercial practice can be fully derived therefrom.

With reference now to FIGURES 1 and 2, illustration is made of a device embodying a pair of rollers 20 and 22, mounted for rotational movement about parallel horizontally disposed axes 24 and 26 with the periphery of the rollers being spaced one from the other to provide an area 28 therebetween, dimensioned to correspond to the cross-section of the resilient particulate substance, such as the pellets 30, whereby the resilient pellets will be in surface engagement with the peripheral surface of the adjacent rollers when displaced therebetween.

The rollers 20 and 22 are adapted to be rotated by conventional drive means, such as an electrical or other power driving motor (not shown) provided with sheaves on the drive shaft for interconnection by belts with pulleys, mounted on the ends of the roller shafts for rotational movement. Other conventional means, such as gear means, or even separate motor drives may be employed, for individual rotational driving movement of the rollers.

The rollers 20 and 22 should be rotated in the same angular direction, that is, each roller should be rotated about its axis in the clockwise direction, as indicated by the arrows in FIGURE 1, or else in the counterclockwise direction; however, one roller such as roller 20 should be driven at a rate to provide for higher peripheral speed than the other. There are various ways in which this can be accomplished. If both of the rollers are of the same diameter, then the one roller 20 should be rotated at a higher number of revolutions per minute than the other. Instead, the rollers may be rotated at the same number of revolutions per minute if one roller 20 is larger in diameter than the other roller 22ª to provide for a greater peripheral speed by comparison to the other roller. Still further, both speed and diameter may be different to provide for still greater flexibility in differential speed on the adjacent surfaces between which the particulate substances or pellets are displaced.

Assuming now that the peripheral surfaces of the rollers are traveling at different speeds, with the surface of the roller **20** traveling at higher speed than the adjacent surface of the other roller, when pellets **30** are introduced into the bight between the two rollers, the pellets will be displaced downwardly between the two rollers at a rate which is a function of the difference between the surface speeds of the two rollers; and as a result, as the pellets are released from between the two rollers, they will be thrown linearly from the rollers at a velocity which has a close relationship to the rate of displacement or momentum built up during displacements between the rollers. Simultaneously, the engagement of the pellets by the surfaces moving in opposite directions will impart a relative movement of the pellets which will be a direct function of the sum of the surface speeds of the two surfaces to cause rotational movement of the pellets at high speed as they are released by the rollers. Thus, the pellets are given a linear movement in combination with a rotational movement as they leave the rollers and are thus thrown onto the surface of the work **32** to be polished or otherwise processed.

The linear movement of the pellets can be increased by increasing the linear speed of the one roller **20** by comparison with the other or by decreasing the surface speed of the other roller **22** or otherwise increasing the differential between the speeds of the surfaces. Conversely, the linear movement imparted to the pellets can be decreased by decreasing the differential between the surface speeds of the rollers as by decreasing the speed of one or increasing the speed of the other, but always with a positive differential in favor of the roller turning in the direction for displacement of the pellets.

The turning movement of the pellets can be increased without increase of linear movement by increasing the surface speeds of both of the rollers or turning movement can be decreased by decreasing the surface speeds of both rollers. Turning movement and linear speed can be increased by increasing the surface speed of one roller and turning movement can be increased while decreasing the linear movement by increasing the surface speed of the other roller.

From the foregoing, it will be evident that by control of the surface speed of the rollers a large number of variables become possible. For example, turning movement of the pellets can be increased or decreased without corresponding increase or decrease in linear movement. By the same token, the linear movement of the pellets can be increased or decreased without corresponding change in turning movement.

It will be understood that the rollers may be dimensioned to any width desired for surface treatment, depending upon the width of the surface or surfaces to be treated. It will also be understood that the surfaces of the rollers may be formed of a good wearing, high friction material, for more effective engagement with the pellets displaced therebetween, and that the surfaces may be formed smooth, as shown, or grooved, for channelling the pellets therebetween more effectively to impart linear and rotary spinning motion to the pellets processed therethrough, it being understood that the spacing between the rollers would then be calculated from the base of the aligned grooves in the pair of rollers.

In practice, the pellets **30** are fed in the desired amount and distributed into the bight between the rollers. The roller having the greater linear speed will dominate the direction of linear movement of the pellets between the rollers. If both rollers are turning in the same angular direction, the rate of linear displacement will be a function of the difference in linear speed, while the amount of spinning action will correspond to the sum of the linear speeds. If the rollers are turning in opposite angular directions, the linear speed imparted to the pellets will be a function of the sums of linear speeds at the surfaces of the rollers, while the amount of spinning action will be proportional to the difference in linear speeds at the surfaces of the rollers. Thus, the pellets will be thrown from between the rollers onto the surface of the work **32** aligned with the exit, with a combined linear movement and spinning movement. As in the aforementioned copending application, polishing material can be supplied as a precoat on the surface of the work, or it can be applied simultaneously with the pellets, or it can be formulated into the pellets to provide the desired polishing action.

Having described the main concepts and illustrated the theoretical considerations involved, description will now be made of a number of modifications with which the afore-mentioned theoretical concepts can be practiced.

Instead of making use of a pair of laterally spaced apart rollers, use can be made of a pair of endless belts **40** and **42** or webs having their adjacent inner runs **44** and **46** laterally spaced by a distance corresponding to the cross-sectional dimension of the pellets for engaging the pellets when displaced therebetween. Each belt is operable about a different pair of pulleys, with the belt **40** operable on pulleys **48** and **50** and belt **42** operable on pulleys **52** and **54**, with at least one pulley in each pair being a driven pulley for imparting linear displacement of the respective belts. One belt **40** is adapted to be displaced at a linear speed differing from the rate of displacement of the other, whereby the desired relationship of spinning action and linear speeds imparted to the pellets displaced therebetween will correspond in theory as previously described with reference to the roller construction.

The described combination which makes use of a pair of spaced belts offers greater control since the run between the belts is much greater than that existing between a pair of cylindrical rollers, whereby the pellets are engaged between the belts over a greater period of time. This provides a longer period of driving contact with the pellets to permit more positive control of acceleration, spinning action, and direction of throw. As in the roller construction, the belts can be constructed to any desired width to increase or decrease the capacity or coverage of the machine, and the belts can be fabricated with or without receiving grooves in the adjacent surfaces, or with or without surface roughness to influence the frictional grip between the surfaces of the displacement means and the elements to be displaced therebetween.

FIGURE 4 illustrates an arrangement which embodies a combination of the belt construction of FIGURE 3 and the roller construction of FIGURE 1, including one portion formed of an endless belt **60** operable about rollers **62** and **64** and one or more rollers **66** and **68** mounted for rotational movement about a parallel axis with the periphery in spaced relationship with the surface of the belt corresponding to the cross-sectional dimension of the resilient pellets adapted to be displaced therebetween. As in the previously described modification, the rollers are rotated for displacement of the adjacent peripheral surface in a direction opposite the line of travel of the belt, preferably with the belt speed dominating to throw the pellets in direction of movement of the belt at a speed corresponding to the difference and with a spinning action corresponding to the sum of the speeds. The modification illustrated in FIGURE 4 makes use of a pair of rollers in vertically spaced apart relation, but only one roller or more than two rollers can be employed.

It will be apparent that any or all of the rollers represented by B and D of FIGURE 4 could be a belt or belts similar to that represented by E in FIGURE 3 or FIGURE 4 without deviating from the invention. It will also be apparent that the speeds of these rollers and/or belts can be chosen to suit the best operating condition without deviating from the invention.

In the arrangement described, all of the rollers or pulleys are mounted for rotational movement about parallel axes. The concepts described can be adapted also for use with pulleys rotating about different axes, especially when use is made of the belt arrangement of the type shown in FIGURE 3. Under such circumstances, the belts can be skewed around for feeding the pellets in one direction and emission of the pellets in another direction.

As illustrated in FIGURE 5, the pulleys 70 and 72 at the inlet end portion are rotatable about a horizontal axis while the pulleys 74 at the exit end portion are rotatable about a vertical axis. As a result, the belts 75 and 76 are twisted from a horizontal run at the start to a vertical run at the end with the adjacent runs of the belts being parallel and spaced one from the other by an amount resiliently to grip the pellets therebetween. While in the illustrated modification, the pulleys at the entrance end are at right angles to the pulleys at the exit end, any desired angular relation or direction of travel can be achieved to enable feed of the pellets at one end for throwing pellets at the other end in any direction or at any near or remote station to which the belts can be stretched, provided that the belts are constructed with variable circumferences along their widths for equal tension in the proper skewed position. One run, such for example as the belt 75, is adapted to travel at higher linear speed than the other traveling in the opposite direction for positive linear displacements of the pellets at a rate which is a function of the difference in linear speeds and a spinning action which is a function of the sum.

Instead of making use of cylindrical surfaces or linearly traveling belts, the desired relationship between the surfaces spaced one from the other for relative movement in the opposite directions, with spaced relationship therebetween for pellet displacement, can be achieved by a pair of conical surfaces telescoped one within the other. One such modification is illustrated in FIGURE 6, in which the internal member comprises a cone 80 mounted for rotational movement about its center in a bearing 82 and in which the external member comprises a shell 84 of conical shape mounted for rotational movement about the same axis as the internal cone 80 and supported by an upper bearing member 86. Sufficient clearance exists between the external surface of the internal cone and the internal surface of the external cone to accommodate the pellets 30 therebetween.

In this arrangement, it is possible to locate the apex 88 of the internal cone within the confines of the external member to provide a chute 90 at the top into which the pellets may be fed for ultimate displacement between the conical surfaces. One of the conical sections, preferably the outer section, can be adapted to turn at a higher linear speed, preferably in a direction opposite to that of the other conical member.

In operation, pellets 30 are fed into the open end 90 of the assembly for displacement into the area of the opposite rotating conical surfaces. Because of the increasing diameter of the conical sections, the pellets are gradually displaced downwardly toward the base, while the acceleration of the pellets is gradually increasing due to the increasing linear speeds occasioned by the increasing cone diameters.

If the base of the inner cone 80 extends to or beyond the base of the outer conical section, the pellets 30 will be thrown centrifugally outwardly upon emission from between the conical sections to engage the work 32 arranged about the periphery with a linear movement combined with a high spinning movement.

While the illustration of FIGURE 6 shows conical members, it will be apparent that the shape of these members could be modified without departing from the invention. For example, the cones could be paraboloids, hyperboloids or surfaces of revolution generated by any convenient curve.

If it is desired directionally to control the pellets thrown from between the conical sections, a rigid member 92 having a slight spiral shape can be stationarily positioned between the conical sections adjacents the outlet portion in the base to engage the pellets displaced between the conical members as they approach the outlet end portion. The plate 92 operates to guide the pellets to leave the assembly at a predetermined position. Thus, the pellets are thrown from a controlled portion of the wheel in a predetermined direction to engage the work projected into the path thereof.

It will be apparent from the foregoing that I have presented a new and novel concept in polishing surfaces by centrifugal means, wherein a resilient member is thrown onto the surface of the work with a positive linear movement in combination with a spinning movement more effectively to utilize polishing materials in achieving a desired polishing action.

It will be apparent from the foregoing that the concepts described are capable of adaptation in various modifications and that numerous changes may be made in details of construction, arrangement and operation, without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In the method of polishing surfaces by projecting particles of resilient material onto said surfaces with a motion having a linear component and a rotational component comprising feeding the particles between opposed surfaces moving in opposite directions with the one surface moving in the direction of the linear component having a higher rate of surface speed than the other surface, whereby the particles are thrown from between the surfaces with a linear speed that is related to the difference in surface speeds between the surfaces and a rotational movement which is related to the sum of the speeds of the surfaces, and positioning the surface to be polished in the path of the particles thrown from between the surfaces.

2. The method as claimed in claim 1, which includes the step of simultaneously making a polishing material available on the surfaces to be polished during engagement by the resilient particles.

3. The method as claimed in claim 2, in which the polishing material is embodied as a component of the resilient particles thrown onto the work.

4. A device for polishing surfaces of work by the projection of resilient particles onto said surfaces with a motion having a linear component and a rotational component comprising a pair of adjacent surfaces spaced one from the other by an amount corresponding to the cross-sectional dimension of the resilient particles for simultaneous engagement of the particles when displaced therebetween, means for feeding said particles into the area between said adjacent surfaces, and means for displacement of said surfaces in opposite directions with one surface travelling at a surface speed greater than the other, whereby the particles displaced therebetween will be thrown from between said surfaces with a linear component in the direction of the surface of higher linear speed and a velocity related to the difference between the surface speeds and with a rotational component which is related to the sum of the speeds of said surfaces, and means for positioning the work surface to be polished in the path of the particles thrown from between said surfaces.

5. A device as claimed in claim 4, which includes means for providing a polishing agent to the surface to be polished during engagement by the resilient material.

6. A device as claimed in claim 4, in which said pair of adjacent surfaces comprise a pair of rollers rotating in same direction with a spaced relationship between the rollers corresponding to the cross-sectional dimension of the particles.

7. A device as claimed in claim 6, in which the rollers are of the same diameter but rotated at different speeds.

8. A device as claimed in claim 6, in which the rollers are rotated at the same number of revolutions per minute but are of different diameters.

9. A device as claimed in claim 4, in which the surfaces are rotated at a different number of revolutions per minute and are of different diameters.

10. A device as claimed in claim 4, in which grooves are formed in the surfaces of the rollers to extend peripherally about said rollers.

11. A device as claimed in claim 4, in which said surfaces comprise a pair of endless belts having adjacent runs spaced one from the other by an amount corresponding to the cross-sectional dimension of the particles.

12. A device as claim in claim 4, in which said surfaces comprise the combination of an endless belt moving in one direction and a roller having the adjacent peripheral portion turning in the opposite direction with the adjacent surfaces spaced one from the other by an amount corresponding to the cross-sectional dimension of the particles.

13. A device as claimed in claim 4, in which the said surfaces comprise nested inner and outer surfaces of revolution mounted for rotational movement about a common axis with the outer surface of the inner section spaced from the inner surface of the outer section by an amount corresponding to the cross-sectional dimension of the particles.

14. A device as claimed in claim 13, which includes a spiral shaped guide plate positioned in a space between the adjacent surfaces of revolution near the base portions of the conical sections to engage the resilient particles displaced therebetween for projection from between the surfaces at a predetermined location.

15. In the method of polishing surfaces by projecting particles of resilient material onto said surfaces with a motion having a linear component and a rotational component comprising feeding the particles between adjacent surfaces spaced by an amount corresponding to the dimension of the particles with both surfaces moving in a direction corresponding to the linear component but with one surface moving at a greater surface speed than the other whereby the particles are thrown from between the surfaces with a linear speed greater than the surface speed of the slower surface but less than the surface speed of the faster surface and with a rotational component proportional to the differences in the surface speeds, and positioning the surface to be polished in the path of the particles thrown from between the surfaces.

16. The method as claimed in claim 15 which includes the step of simultaneously making a polishing material available to the surfaces to be polished during engagement of the surfaces by the resilient particles.

17. A device for polishing surfaces of work by the projection of resilient particles onto said surfaces in which the particles have a movement embodying a linear component and a rotational component comprising a pair of adjacent surfaces spaced one from the other by an amount corresponding to the cross-sectional dimension of the resilient particles for simultaneous engagement of the particles when displaced therebetween, means for feeding said particles into the area between the adjacent surfaces and means for displacement of said surfaces in the same direction with one surface traveling at a surface speed greater than the other whereby the particles displaced therebetween will be thrown from between said surfaces with a linear component corresponding to the direction of movement of said surfaces and a velocity related to the linear speed of the slower surface plus about one-half of the differences between the speeds of the surfaces and with a rotational component which is related to the differences of the speeds between said surfaces, and means for positioning the work surface to be polished in the path of the particles thrown from between said surfaces.

18. A device as claimed in claim 17 which includes means for providing a polishing agent to the surface to be polished during engagement by the resilient material.

19. A device as claimed in claim 17 in which the pair of adjacent surfaces comprises a pair of rollers rotating in the opposite directions.

20. A device as claimed in claim 19 in which the rollers are of the same diameter but rotated at different speeds.

21. A device as claimed in claim 19 in which the rollers are rotated at the same number of revolutions per minute but are of different diameters.

22. A device as claimed in claim 17 in which the surfaces are rotated at a different number of revolutions per minute and are of different diameters.

23. A device as claimed in claim 17 in which grooves are provided in the surfaces of the rollers to extend peripherally about said rollers.

24. A device as claimed in claim 17 in which the surfaces comprise a pair of endless belts having adjacent runs spaced one from the other by an amount corresponding to the cross-sectional dimension of the particles.

25. A device as claimed in claim 17 in which said surfaces comprise the combination of an endless belt moving in one direction and a roller having an adjacent peripheral portion turning in the same direction with the adjacent surfaces spaced one from the other by an amount corresponding to the cross-sectional dimension of the particles.

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July 23, 1963 J. C. STRAUB 3,098,324

POLISHING METHOD AND MEANS

Filed May 1, 1961 2 Sheets-Sheet 1

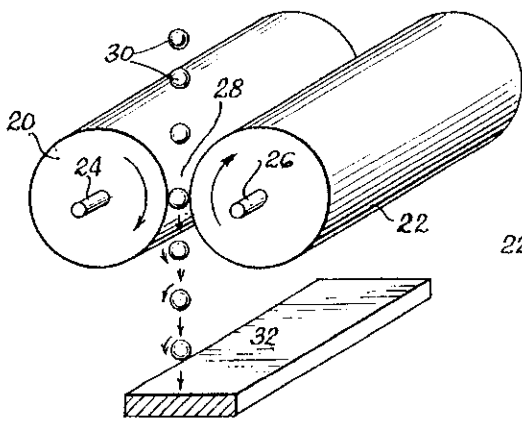

FIG. 1

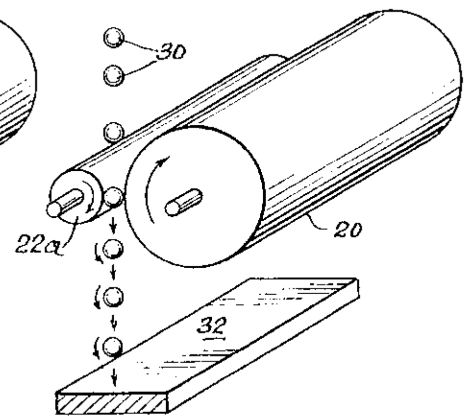

FIG. 2

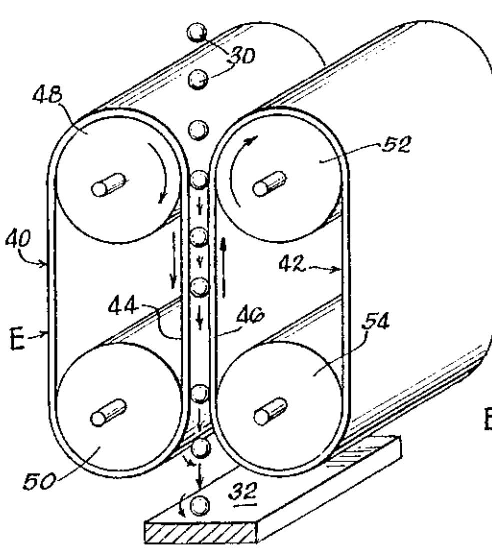

FIG. 3

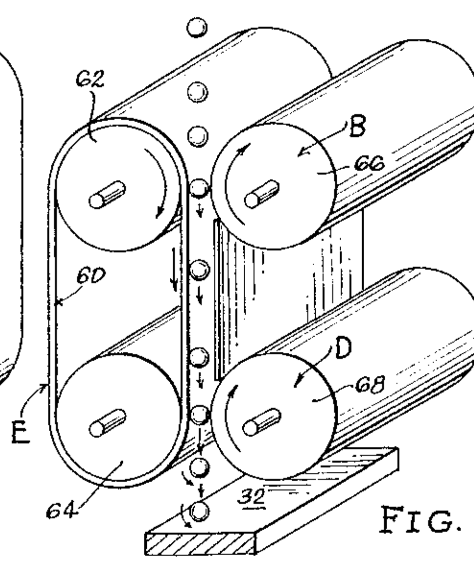

FIG. 4

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July 23, 1963 J. C. STRAUB 3,098,324

POLISHING METHOD AND MEANS

Filed May 1, 1961 2 Sheets-Sheet 2

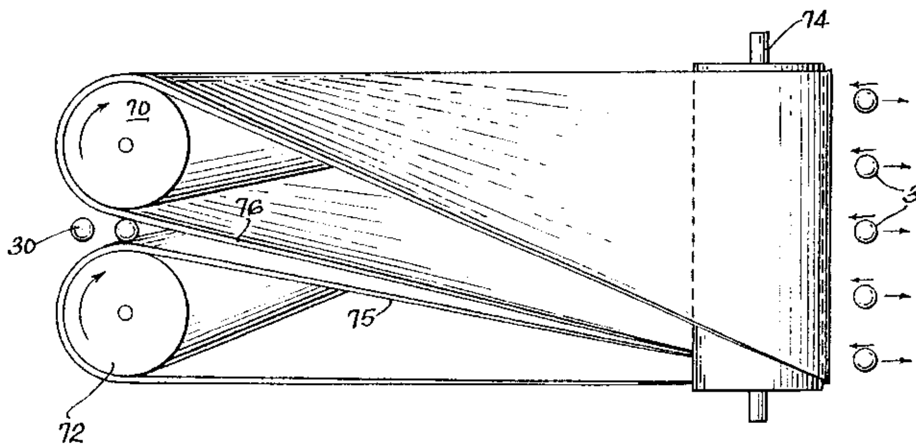

FIG. 5

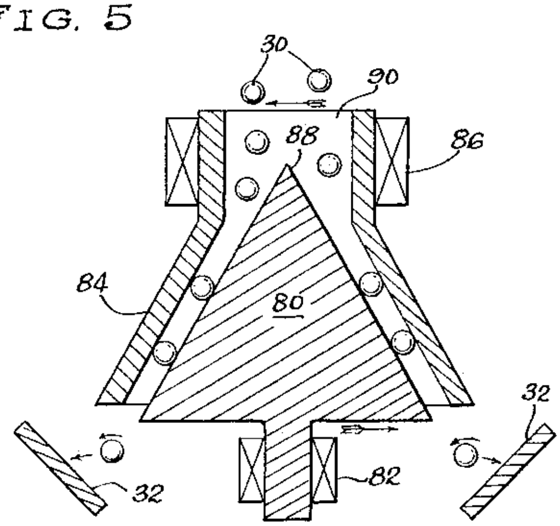

FIG. 6

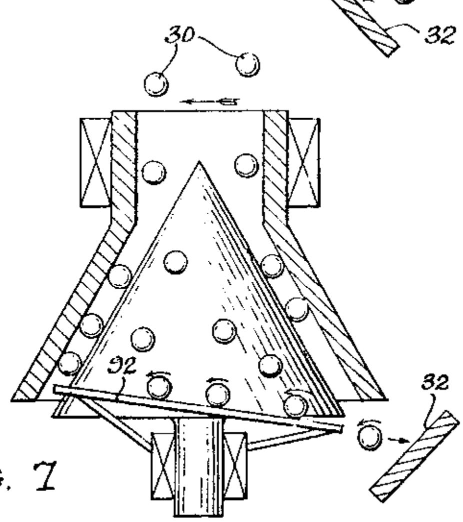

FIG. 7

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