

Aug. 30, 1938.

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2,128,673

METHOD OF AND APPARATUS FOR BALANCING A GRINDING WHEEL

Filed Aug. 11, 1937

Fig. 2

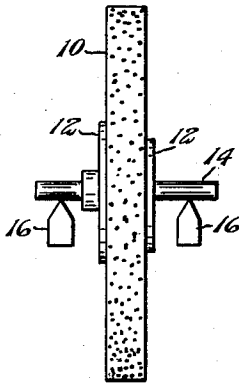


Fig. 3

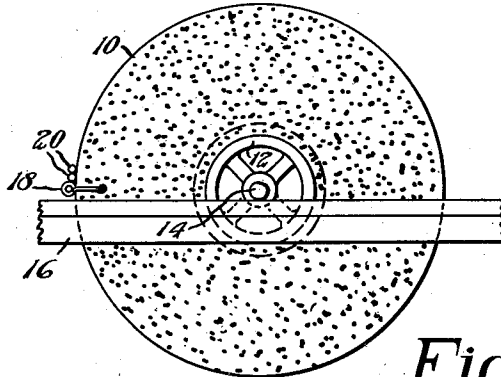


Fig. 5

Fig. 4

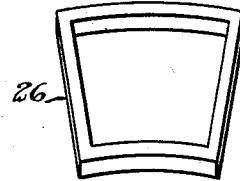
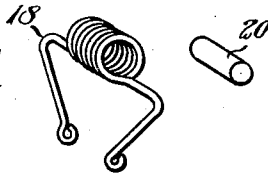


Fig. 1

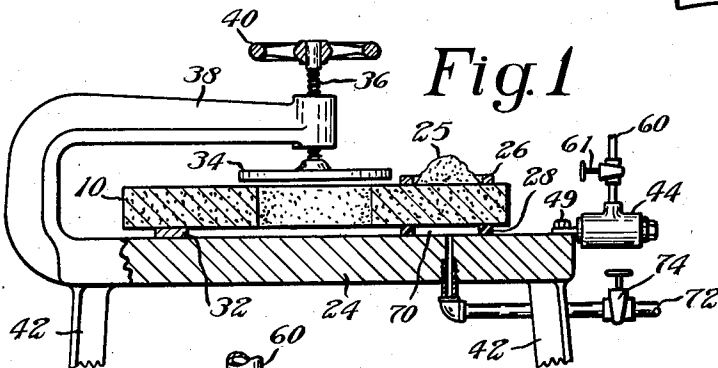
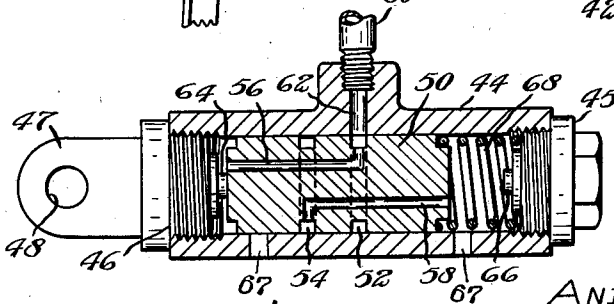


Fig. 6



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2,128,673

METHOD OF AND APPARATUS FOR BALANCING A GRINDING WHEEL

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Application August 11, 1937, Serial No. 158,582

4 Claims. (Cl. 51—278)

This invention relates to a method of and an apparatus for balancing a grinding wheel.

A grinding wheel is made of abrasive grains, such as silicon carbide or crystalline alumina, bonded by vitrified ceramic materials or other suitable bonds. According to the standard process of manufacture, the abrasive grains and the raw clay bond, together with sufficient water to develop plasticity, are mixed in proper proportions and then shaped in a mold to substantially the required size after which the molded article is fired in a ceramic kiln to vitrify the bond. The grinding wheel as thus made may in some cases be slightly out of balance, but the conditions of high speed usage in a precision grinding operation make it desirable that the wheel be in a substantially true balance so as to avoid the dangers of wheel breakage and of producing chatter marks on the work. This out of balance condition is due to an uneven distribution of the wheel material and may be corrected by adding to an area of lower density sufficient weight of material to provide a static balance for the portions of higher density. That is, the wheel may have a dense spot somewhere in its structure, and the addition of a suitable weight at a diametrically opposed point will balance that portion of excessive weight.

It is, therefore, one object of this invention to provide a method of balancing a grinding wheel whereby a material of suitable weight may be introduced into the pores of the wheel in such a manner that the wheel will be satisfactorily balanced.

A further object is to provide an apparatus to accomplish this method which may be economically, efficiently and readily operated and will insure a satisfactory penetration of the balancing material into the wheel pores. Further objects will be apparent in the following disclosure.

In accordance with this invention, a dry granular material may be lodged in the pores of the grinding wheel by vibrating the wheel structure and causing the material to work its way through the pore channels under the influence of gravity. Also, a dry powder may be drawn into the wheel pores by means of suction so applied to one side of the wheel, that a powder placed on the other side will be forced to penetrate the channels and open pores and become lodged therein. These two methods are preferably combined in such a manner that the vibration serves to distribute the material within the wheel pores while the suction applied to the opposite side of the wheel

will aid in drawing it deeply into the pore structure.

An apparatus suitable for accomplishing the combined method is illustrated in the drawing, as well as the various steps of the procedure involved. In the drawing:

Fig. 1 is a view, partly in elevation and partly in section and broken away, which shows a simplified form of apparatus suitable for both vibrating the wheel structure and applying suction thereto so as to distribute a dry balancing powder within the wheel pores;

Figs. 2 and 3 are end and side views respectively which show diagrammatically the method of determining the out of balance condition of the wheel;

Fig. 4 shows a spring clip and weight which are employed with the apparatus of Figs. 1 and 2;

Fig. 5 is a hollow structure adapted to serve as a dam for holding the dry powder in position on the top of the wheel or as a confining wall which is placed beneath the wheel and limits the application of the suction thereto; and

Fig. 6 is a sectional view of the vibrating apparatus which is applied to the wheel or its support for the purpose of vibrating the grinding wheel.

In order to determine the out of balance condition of the grinding wheel 10, the wheel may be temporarily mounted on a supporting iron center 12 which has an axially located arbor 14 projecting from its opposite sides. The arbor is placed on two parallel rails 16 which have knife edges for supporting surfaces and thus afford the minimum of friction. The operator causes the wheel to rock slightly on these rails and so determines where the wheel tends to come to rest. If the wheel is out of balance or heavy on one side, then that heavy side will cause the wheel to roll until the heavy part is at the bottom thereof. Then a mark is made at the top of the wheel to indicate the center of the light side of the wheel, or that peripheral point or radial line at which a given weight may be applied to balance the heavier side. To determine the numerical value of this out of balance condition, a spring clip 18 of the form illustrated in Fig. 4 is applied to the wheel near the mark at its light point, and one or more metal weights 20 are laid on the spring, as shown in Fig. 3, until the heavy side of the wheel is just balanced. From the number or size of the weights employed to bring the wheel into a static balance, one may determine the number of ounces of material which

need to be applied in a given sector on the light side of the wheel to balance it.

The next important step of the procedure is to place the wheel on its side on a table 24. Then, a pile of granular material 25 is placed in a sector which centers on approximately the radial line previously determined for the light side of the wheel, and by means of vibration or suction, or both, the powder is forced into the pores of the wheel.

A material which is satisfactory for this purpose is a fine abrasive powder, or silica, or other suitable granular material which will not detrimentally affect the grinding operation and which will become so thoroughly lodged within the pores of the wheel that it will remain there during a high speed grinding operation. It is preferred to employ powdered crystalline alumina for an abrasive wheel which is made of that type of abrasive; while for a silicon carbide grinding wheel one may use powdered silicon carbide. This avoids introducing into the wheel structure a material of different abrasive nature from that already present. However, it is within the scope of this invention to employ various types of materials which are suitable for the purpose. By using a dry powder, it is possible to introduce an exact weight of this powder into the wheel structure and not have to allow for evaporation of water as would be the case if the material were introduced as an intermixture of powder and water. The powder is preferably very fine, such as will pass through a screen of 600 meshes to the linear inch.

This powdered material of the type and quantity which it is desired to incorporate in the wheel pores is properly located on the side of the wheel by means of a dam or confining wall 26 of suitable material, such as rubber. This is preferably shaped as a portion of sector, as shown in Fig. 5, so that, as the wheel wears away during a grinding operation, the balanced condition is not seriously affected. A further sector shaped wall 28, similar to the structure of Fig. 5, and preferably made of soft rubber, is placed under the wheel and approximately beneath the dam 26 so as to form a suction zone where the pile of dry powder 25 is to be drawn into the pores. The wheel is also supported by means of a cross piece 32 of metal, wood or other material which is suitable for transmitting a vibratory movement to the wheel. This is aided further by means of a metal plate 34 mounted above the wheel and adapted to be clamped tightly thereagainst by means of a screw 36 threaded through the end of a V-shaped arm 38 which is secured to or formed integral with the metal table top 24, as shown in Fig. 1. The hand wheel 40 will serve to clamp the plate 34 against the grinding wheel and thus hold all of the parts rigidly connected together. This table is supported upon legs 42 or in any other suitable manner.

A vibratory motion may be applied to this table by means of the apparatus shown in Figs. 1 and 6. This comprises a hollow metal shell 44 of substantially the size shown in Fig. 6, or of other suitable size, which has a plug 45 screwed into one end and a further plug 46 threaded into the opposite end. The plug 46 has a lug 47 projecting therefrom which has a hole 48 there-through, so that by means of the bolt 49 this device may be securely fastened to the table 24 or to the metal arm 38 or to any other suitable part of the apparatus, such as a table leg, or beneath the table top 24, whereby vibration ap-

plied thereto is transmitted to the grinding wheel. This vibration is produced by means of a comparatively heavy piston 50 which slidably fits within the hollow cylindrical wall of the casing 44. This piston has two annular ports 52 and 54 as shown in Fig. 6. The port 52 connects with a longitudinal port 56 which extends through the piston to the lefthand end thereof, while the port 54 connects by means of a longitudinal port 58 to the opposite end of the casing. An air pipe 60 controlled by a suitable valve 61 is threaded into the side of the casing 44 and it connects with a port 62 which communicates with the inside of the casing. The ports 52, 54 and 62 are so located that when the metal piston 50 has struck an inwardly projecting pin 64 on the plug 46, the port 52 is in communication with the port 62. Hence, if compressed air is applied to the pipe 60 and the ports are in the positions shown in Fig. 6, then the piston 50 will be driven rapidly towards the right until it strikes another pin 66 on the plug 45. When this happens, the annular port 54 will communicate with the port 62 and air will be admitted to the right hand of the cylinder and serve to drive the piston back in the opposite direction. The ports 67 in the casing wall permit exit of the air from each chamber during the return stroke of the piston. A spring 68 located at one end of the casing will serve to move the piston towards the opposite end so that the ports may be initially in position for starting the apparatus when air under pressure is applied.

This vibrating apparatus is so constructed that the piston will move back and forth at an extremely high speed and apply a comparatively severe shock to any part rigidly connected to its casing. This vibration is transmitted through the supporting structure to the wheel itself and causes the granular material 25 to drift or work its way into the wheel pores in that position which is determined roughly by the outline of the dam 26.

The movement of the granular material into the wheel pores is materially aided by the application of suction, and it is preferred to employ either alone or with the vibrating apparatus a suction device which will withdraw the air from the space 70 defined by the rubber ring 28 which fits against the face of the wheel. This ring is preferably shaped the same as the ring 26 and located therebeneath, so as to localize the application of the granular material to the wheel pores. Any suitable apparatus may be employed for this purpose, comprising a pump, tanks and valves which are connected to the pipe 72 controlled by a further valve 74. In this way, the air is withdrawn from the chamber 70 defined by the ring 28 and table top, and suction is applied to the interconnected pores of the grinding wheel which causes the material 25 to be drawn inwardly into those pores in a localized area and to be distributed through the channels thereof. This suction tends to draw the material into the open pores, while the vibration may also lodge some of the material in pores which are only partly open and form pockets and from which the powder is not readily removed. Hence, it is preferred to employ both methods at the same time.

The apparatus may take many embodiments and forms, and numerous changes may be made in the structure illustrated as well as the method described, and it is to be understood that all such changes are within the scope of the claims appended hereto. For example, while the balancing powder 25 is preferably applied in a dry con-

dition, it is feasible to introduce a fluid cement, such as sodium silicate or water glass, to aid in holding the material in place after it has been forced or drawn into the wheel pores by the vibratory and suction actions. Other changes will be readily apparent in view of the above disclosure.

Having thus described this invention, what is claimed as new and protectable by Letters Patent is:

1. The method of balancing a grinding wheel comprising the steps of determining the location of the light side of the wheel and the approximate numerical value of its out of balance condition and then impregnating the pores of the light side of the wheel with the required amount of a dry granular powder by vibrating the wheel structure and exhausting the air from the light weight portion and thereby forcing the powder into the pore structure thereof.

2. The method of balancing a grinding wheel comprising the steps of determining approximately the location of the light weight portion of the wheel, placing a balancing powdered material on

that light weight portion and exhausting the air from said portion and causing the powder to penetrate the wheel pores and become lodged therein.

3. The method of balancing a grinding wheel comprising the steps of determining the approximate location of the light weight portion of the wheel, supporting the wheel on one side face, vibrating the wheel while in that position, and applying a powdered balancing material to said light weight portion and causing that material to penetrate the wheel pores under the influence of the vibrating motion.

4. An apparatus for balancing a grinding wheel comprising a table, means for clamping a grinding wheel in position thereon, a vibrating device connected to vibrate the wheel on said table and means including a ring engaging the wheel and a suction pipe connected to exhaust the air from beneath a localized area defined by said ring which causes a powder placed on the wheel to penetrate the wheel pores in that localized area.

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