April 13, 1943. E. F. KLENKE, JR 2,316,518

RUB-OUT MACHINE

Filed May 8, 1940 3 Sheets-Sheet 1

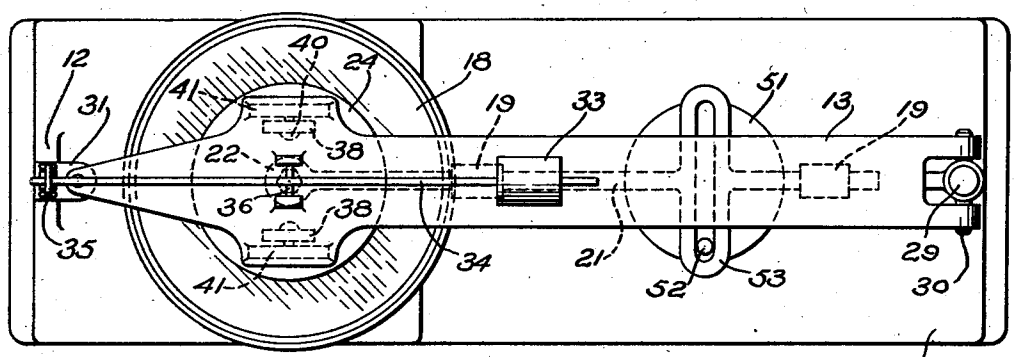
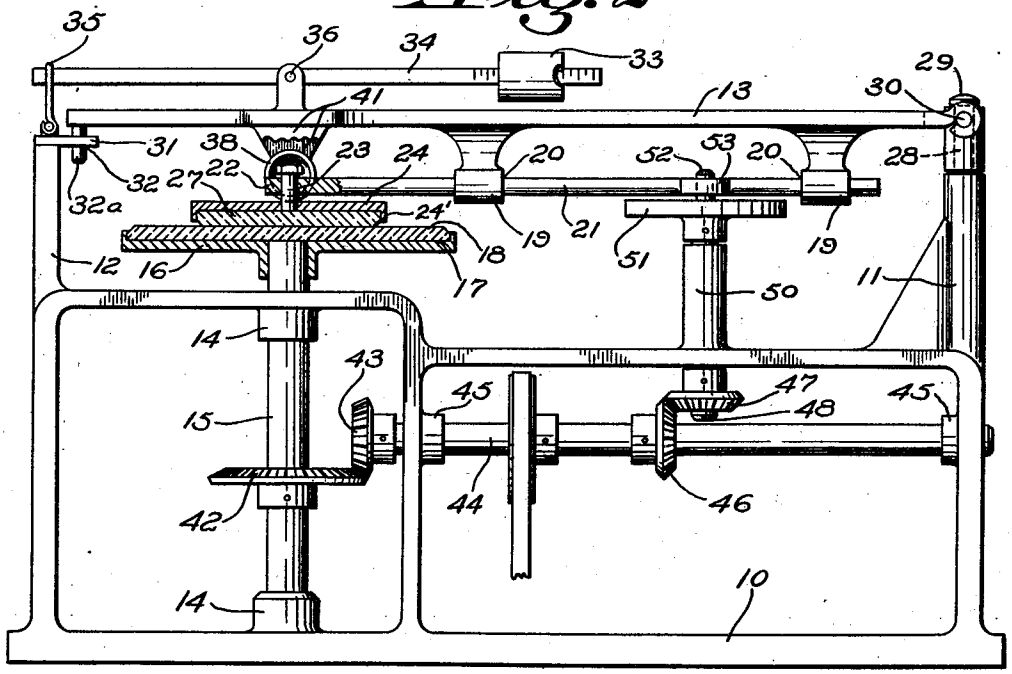


Fig. 1

Fig. 2



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RUB-OUT MACHINE

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Fig. 4

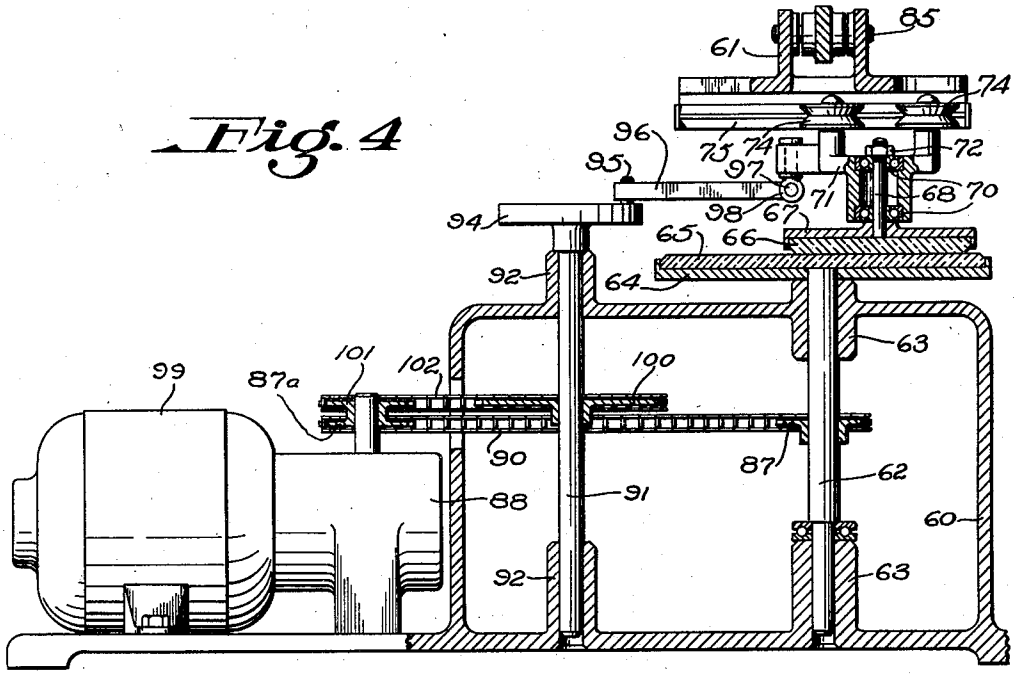

Fig. 3

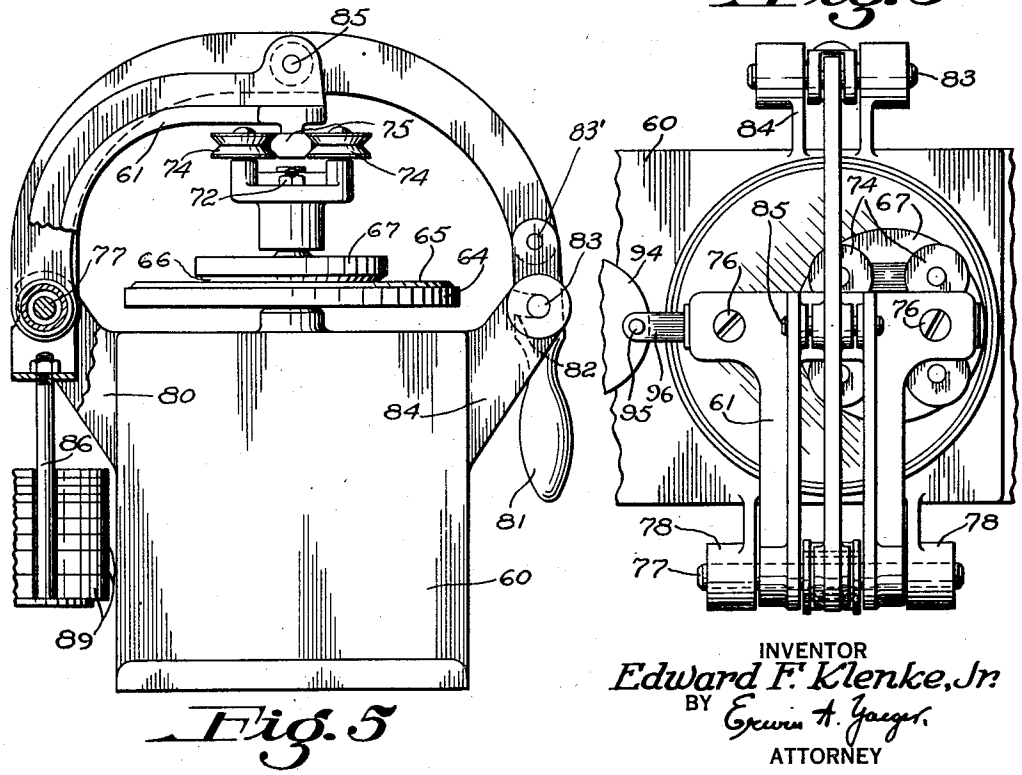

Fig. 5

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RUB-OUT MACHINE

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Fig. 6

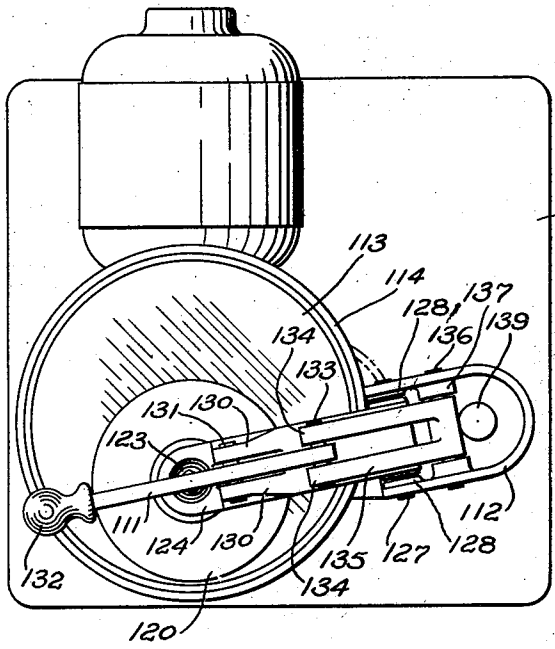
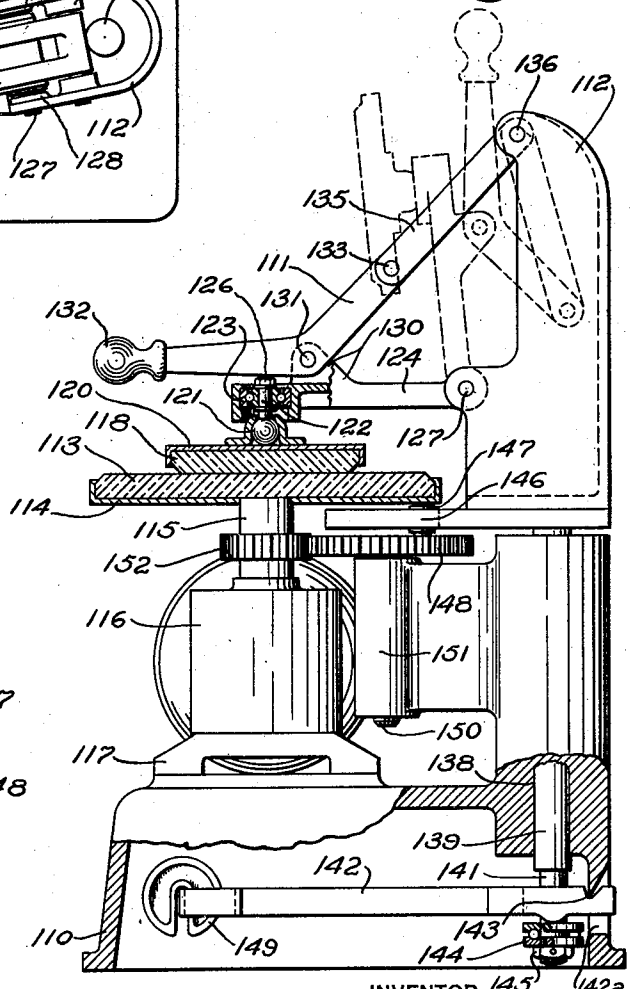


Fig. 7



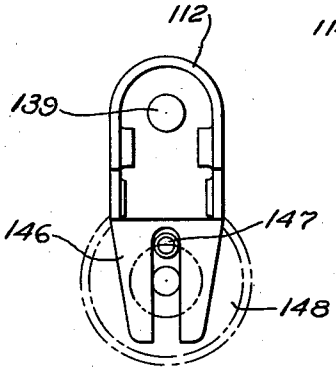


Fig. 8

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UNITED STATES PATENT OFFICE

2,316,518

RUB-OUT MACHINE

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Application May 8, 1940, Serial No. 333,930

9 Claims. (Cl. 73—51)

This invention relates to grinding apparatus and, more particularly, to devices of this kind for mulling pigments or other solids into oil and other vehicles.

Dry pigment colors are generally purchased on physical rather than chemical tests. While it is true that the exact chemical composition of a color may be desirable for certain uses, nevertheless, the value and suitability of colors for most purposes can be quickly evaluated by standard tests which comprise grinding the dry pigment into oil or other liquid vehicles and comparing them with standards prepared in a similar manner. Various methods of performing this grinding operation have been employed. When relatively large samples are to be tested, small scale mills of the commercial type may be used. However, a much more rapid method of testing, one requiring only a relatively small sample—the so-called "mulling" or "rub-out" test—in which a predetermined quantity of pigment is mixed superficially with a definite amount of oil or other suitable liquids and spread out on a glass slab for further treatment, is almost universally employed. In this testing procedure, the operator "mulls" the mixture of pigment and oil with a "hand muller" or other suitable implement by rubbing it back and forth over the glass slab on which the sample has been spread. The degree of mulling depends on a number of variable factors such, for example, as the amount of pressure exerted by the operator, the number of strokes, and the area covered. Furthermore, in order to get a uniformly mixed sample of approximately the same particle size, it is necessary to pick up the paste from the glass slab and spread it out for further mulling. In extreme cases, this operation must be repeated several times before a uniformly fine product is obtained. It is obvious that the personal element plays an important role in these tests, and the results are at best only empirical, even in those instances where a great deal of skill has been acquired by the operator. Identical operating conditions are, therefore, seldom, if ever, attained and exact duplication of results extremely unlikely.

Various mechanical means for eliminating the personal equation have been proposed. The usual devices of this kind have made use of a rotary plate of relatively large size on which the sample to be tested is placed. The grinding action may be obtained by placing thereon another flat plate which may act in a variety of ways. For instance, in U. S. Patent 2,150,603, dated March 14, 1939, and entitled "Apparatus for mulling pigment," the pigment and oil to be tested are placed on a stationary lower plate, and an upper plate of substantially the same size is made to rotate thereover at a constant speed. In another modification of the prior art mulling devices, a second plate of relatively smaller diameter is free to rotate about a fixed point offset from the center of a larger lower rotating plate, the rotation of said upper plate being provided by means of friction between the two mulling surfaces. In still another modification, a small grinding plate off center from a larger lower rotating plate is driven in a circular motion at a constant speed.

All of these devices have certain elements of value and are capable of successful operation. Nevertheless, they have disadvantages which result in inefficient operation or make exact duplication of results impossible. For instance, in the device disclosed in U. S. Patent 2,150,603, hereinbefore referred to, little or no mixing is obtained, and uneven grinding of the particles results. Those particles at or near the center receive little if any grinding action, while those at or near the periphery of the plates are ground exceedingly fine. Furthermore, those particles placed at or near the center tend to remain in their relative positions during the grinding operation, while those at or near the periphery maintain their relative positions throughout the entire grinding cycle. In order to overcome this objection, it is necessary to pick up the pigment, redistribute it on the plate, and repeat the mulling operation. In cases where extreme particle fineness is desired, it is necessary to repeat this operation several times.

In those devices employing a small off-center plate which either rotates by friction or by positive driving means, a limited amount of mixing as well as a grinding action is obtained. However, in all of these devices, there is a serious tendency to force the pigments or inks being milled out from under the off-center plate where it is picked up on the edges of this plate and permanently removed from the field of grinding. This tendency to pull the ink away from the edges of the plate is due partly to the type of motion imparted to the plates and their relative speeds. While beveling the edges of the off-center plate tends to reduce the amount of pick-up somewhat, this objectionable feature cannot entirely be eliminated thereby.

It is an object of this invention to provide an improved mulling machine for grinding pigments or other solids into oil or other vehicles so that duplication of results may be readily obtainable.

A further object is the provision of means for milling these solids to a uniformly fine particle size. A still further object is the provision of means for permanently retaining the pigments or inks in the field of grinding. Other objects will be apparent from the description of the invention hereinafter given.

The above objects are accomplished according to the present invention by an apparatus comprising two rotatable plates having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, means for positively rotating one of said plates, means for reciprocating the smooth surface of the other plate over the smooth surface of the positively rotating plate, and means for maintaining said smooth grinding surfaces in contact with each other under a predetermined constant pressure.

More specifically, the invention provided in accordance with a preferred embodiment of the present invention comprises a horizontally disposed lower milling plate of circular cross-section, the upper surface of which has been ground smooth, mounted at the end of a rotatable shaft; means for imparting rotary motion to said shaft; a smaller upper flat plate of circular cross-section with beveled edges, the lower surface of which has been ground smooth, disposed at the end of a reciprocating shaft and adapted to be moved into and out of contact with the smooth surface of the said larger plate, said smaller plate, when in contact with the milling surface of the larger plate, being free to simultaneously rotate and reciprocate thereover; means for imparting reciprocating motion to said smaller plate; means for stopping the relative movement between the plates after a predetermined number of movements of said plates, and means for maintaining said smooth grinding surface of each plate in contact with each other under a predetermined constant pressure.

In the drawings, which show the preferred embodiments of the invention:

Figure 1 is a top plan view of one embodiment of my novel milling machine;

Figure 2 is a front elevation of the machine shown in Figure 1, partly in section;

Figure 3 is a top plan view of an alternative embodiment of an especially preferred milling machine wherein the upper milling plate oscillates over the smooth surface of the lower milling plate in a straight path;

Figure 4 is a front elevation of the embodiment shown in Figure 3, partly in section;

Figure 5 is a side elevation of the embodiment shown in Figure 3;

Figure 6 is a top plan view of an alternative embodiment of the milling machine wherein the upper milling plate oscillates over the smooth surface of the lower milling plate in an arc of a circle;

Figure 7 is a front elevation of the machine shown in Figure 6, partly in section; and

Figure 8 is an enlarged detail of the oscillating mechanism for oscillating the upper milling plate over the lower milling plate.

Figs. 1 and 2, in which like reference characters denote similar and like parts, a base 10, right hand upright or standard 11, and left hand upright or standard 12 rigidly connected to the base, and a supporting arm 13, pivotally connected to the upright 11 constitute the main framework of the machine. The framework may be conveniently constructed of any material such as metal or wood, so long as a substantially rigid structure is provided. Supported by the base 10 and the upright 12 by any convenient means are bearings 14, 14, and journaled and free to rotate therein is shaft 15.

A lower milling plate support 16 having a circular recess 17 cut therein is suitably supported in position at the upper end of the rotatable shaft 15, and a removably mounted lower milling plate 18, upon which the pigment and oil are placed for testing, is fitted into recess 17 in such a manner that substantially no sliding movement takes place between the plate and the support. The plate 18 is conveniently circular in cross-section and substantially thicker than the recess into which it is fitted, thus projecting somewhat above the outside edge of the lower milling plate support 16. The upper surface of the plate is flat and ground uniformly smooth. The milling plate may be made of glass, metal, lithographer's stone, or other suitable materials. The plate is substantially in a horizontal position and centrally disposed with respect to the rotating shaft 15.

Attached to the underside of the supporting arm 13 by any convenient means are reciprocating rod supports 19, 19, having an opening 20 cut therein and into which is fitted a horizontally slidable reciprocating rod 21. Attached to the reciprocating rod in any convenient manner is collar 22 which fits over pin 23 with sufficient clearance to allow the pin to rotate within the collar but which prevents substantial vertical movement of the supporting arm 13 with respect to the pin 23. The collar likewise provides a fixed center about which the pin is free to rotate.

An upper milling plate support 24 with a circular recess 24' cut therein is suitably connected to the lower end of the pin 23. Mounted in the recess of the upper milling plate support is an upper milling plate 27 having a smaller diameter than the lower milling plate but similarly constructed, except that the edges thereof should be beveled at an angle of substantially 45°, although if desired, both plates may be beveled as shown.

In the present embodiment of the invention, the lower surface of the upper milling plate 27 is vertically and horizontally adjustable into and out of contact with the upper surface of the lower milling plate 18 so as to completely expose the milling surfaces of the milling plates. This adjustment is provided to permit easy access to the milling surfaces for placing the sample thereon and for removing same therefrom after the grinding action is completed. The supporting arm 13 is pivotally connected to a pivot pin 28 which is fastened rigidly to the top of the upright 11 substantially in the center thereof. The supporting arm 13 is free to oscillate about the pin 28 in a horizontal plane, but vertical movement of said member about said pin is prohibited by any convenient means, such, for example, as by pin 29. Upward vertical adjustment of the supporting arm 13 is provided about pin 30 as a pivot. As a result of these adjustments, the lower surface of the upper milling plate 27 is free to move into and out of contact with the upper surface of the lower milling plate.

For centering the supporting arm 13 when in its operable position, a centering pin support 31, disposed near the top of the standard 12 having a bore 32 cut therein, is provided. The supporting arm 13 with centering pin 32a attached thereto at one end is free to engage in the bore 32, thus assuring the proper positioning of the upper

mulling plate. It will be observed that the top surface of the centering pin support 31 is substantially lower than the bottom surface of the supporting arm 13 when the mulling surfaces of the mulling plates are in contact with each other

In the embodiment of the invention herein described, a constant load on the mulling plates is applied by means of a weight 33 slidably mounted for adjustment on a beam 34 attached to the upper end of the standard 12 by means of a hook or loop 35. The beam rests on a fulcrum point 36 which is suitably fastened to the top of the supporting arm 13. The load on the beam is transmitted to the top surface of the upper mulling plate 27 through wheels 38, 38 positioned on shafts 40, journaled in supports 41, 41 attached to the underside of the supporting arm 13. The magnitude of the pressure can be varied depending on the position of the weight 33 on the beam 34. The arm 13 and its associated parts are conveniently horizontally adjustable in order that collar 22 may be placed over pin 23. The entire arm 13 pivots about pin 29 and horizontally about pin 28. The hook 35 is adapted to engage beam 34, the weight 33 upon the arm 13 being in adjusted position, to thereby secure its action through the fulcrum point 36.

Rotary motion of the lower mulling plate, and reciprocating motion of the upper mulling plate may be obtained by any convenient means known to those skilled in the art. Rotary motion of the lower mulling plate in the embodiment herein disclosed is provided through miter gear 42 on shaft 16 through a miter gear 43 secured to the end of jack shaft 44 supported by any convenient means such as bearings 45, 45, said shaft being driven from a source of power not shown in the drawing. Reciprocating motion to the upper mulling plate may be obtained from the same or a separate source of power. Reciprocating motion of the upper mulling plate over the lower plate in the embodiment herein described is obtained by miter gear 46 attached to jack shaft 44 through a miter gear 47 on the lower end of a shaft 48 journaled in bearing 50 which is attached to the framework in any convenient manner. Wheel 51 with crank pin 52 rigidly secured to the upper side of the wheel substantially at its periphery is suitably secured to the upper end of the shaft 48. Reciprocating motion to the reciprocating rod is provided by means of pin 52 which engages in a dog on yoke 53 of the reciprocating rod 18. Rotary motion of the upper mulling plate about the pin 23 is obtained by means of friction between the surfaces of the mulling members, and the relative rotary movement depends on the slippage.

Figs. 3, 4, and 5 show an alternative embodiment of a mulling machine coming within the present invention. A base 60 and supporting arm 61 pivotally connected to the frame in any convenient manner constitutes the main framework of the machine. A rotatable shaft 62 journaled in bearings 63, 63 cast integrally with the frame 60 has suitably mounted at its upper end a lower mulling plate support 64 into which is fitted a lower mulling plate 65.

An upper mulling plate 66 is suitably mounted in an upper mulling plate support 67 attached to the lower end of an upper mulling plate shaft 68 journaled in bearings 70, 70 cast in a reciprocating housing 71. Vertical movement of the shaft 68 in the housing 71 is prevented by any suitable means such, for example, as by a nut 72 positioned on the upper end of said shaft.

The reciprocating housing 71 is provided with grooved wheels 74, 74 which fit on a runner or guide 75 attached securely to the under side of the adjustable arm support in any convenient manner, such as by bolts 76, 76 (Fig. 3). The guide or runner extends the entire width of the arm support and is suitably shaped, as shown, to conform to the running surfaces of the grooved wheels 74 in order to prevent the wheels from becoming derailed from the runner. The construction provides a relatively simple means for reciprocating the upper mulling plate over the upper surface of the lower mulling plate. The upper mulling plate is vertically adjustable into and out of contact with the upper surface of the lower mulling plate, said adjustment being obtained by raising or lowering the supporting arm 61, which is pivotally connected to the base 60 by shaft 77, journaled in bearings 78, 78, supported in bearing support 80, cast to base 60. The shaft 77 is substantially of smaller diameter than the opening in the supporting arm, thus leaving clearance between the shaft and the arm. The means for applying pressure to the mulling members is accomplished in a novel manner. The supporting arm 61, which also acts as a beam, is provided with a handle 81 and a notch 82 which is free to engage a locking bar 83 supported by supporting members 84, 84 cast integrally with the frame 60. The handle 81 pivots about a fulcrum point 83' located in the center of the supporting arm whereby the notch 82 can be caused to engage the bar 83 in a locking manner when the mulling plates are locked into position. This action of the engaging notch and pin shifts the arm 61 about its fulcrum 85 so that it no longer is in contact with the shaft 77, thereby locking the mulling plates in position. By applying weight 86 to the weight support 86 attached to the lower end of the supporting arm 61, a pressure of any given magnitude may be applied to the grinding surfaces of the mulling plates.

Rotation of the lower mulling plate may be accomplished by any known means such, for example, as by sprocket 87 attached to shaft 62 which is connected to sprocket 87a mounted on the vertical shaft of a reduction gear 88 by sprocket chain 90. The reduction gear unit may be driven by any suitable means such, for example, by motor 99. Reciprocating motion to the upper mulling plate can be produced either from the same source of power or by a separate driving mechanism. In the embodiment of the invention herein disclosed, the same source of power is employed. Shaft 91 journaled in bearings 92, 92, cast integrally with the base 60, has suitably mounted on its upper end a wheel 94 with crank pin 95 rigidly attached thereto at its periphery. Connecting rod 96 is vertically adjustable about the pin 97 which is fitted onto member 98 fastened to the reciprocating housing 71 in any convenient manner. The opposite end of the connecting rod is provided with an opening which fits over the crank pin 95. Reciprocating motion of the upper mulling plate may be provided by sprocket wheel 100 attached to shaft 91 which is connected to sprocket 101 mounted at the end of a vertical shaft of a gear reduction unit 88 by sprocket chain 102.

Figs. 6, 7, and 8 show still another modification coming within the present invention, wherein the upper plate, instead of reciprocating in a straight line motion over the lower mulling plate, oscillates through an arc of a circle.

The base 110, the vertically adjustable member 111, and the oscillating member 112, constitute the main framework of the machine. A lower mulling plate 113 is removably mounted in a lower mulling plate support 114 disposed at the upper end of a vertical shaft 115 of a gear reduction unit 116 mounted conveniently on a gear reduction support 117 of the base 110.

An upper mulling plate 118 positioned in an upper mulling plate support 120 secured to a universal joint 121 mounted at the lower end of a rotating and oscillating shaft 122 journaled in a bearing 123 is provided, the bearing element 123 being fitted into the lower arm 124, to which the vertically adjustable member 111 is secured by means of supports 130 and pin 131. Vertical movement of the shaft 122 within the bearing 123 relative to the lower arm 124, may be prevented by any convenient means such, for example, by nut 126. The universal joint 121 provides a means for maintaining the surfaces of the mulling plates in perfect alignment.

Vertical adjustment of the upper mulling plate is provided in the embodiment of the invention herein shown. The shaft 122 is attached to the lower arm 124 which carries the vertically adjustable member 111 and is secured for vertically rotatable movement to the oscillating member 112 at one end by pin 127 which is journaled in bearings 128, 128 of the oscillating member 112. The lower arm 124 is likewise provided with supports 130, 130 in which is journaled pin 131, the latter securing the member 111 to the arm 124. Mounted on the opposite end of the member 111 is handle 132 by means of which member 111 is rotated vertically about pin 131, and likewise vertically rotatable about pin 133 which is journaled in bearings 134, 134 of an upper arm 135 of the vertically adjustable member 111. The opposite end of the upper arm 135 is pivotally connected to pin 136 which is journaled in bearings 137, 137 at the upper end of the oscillating member 112.

This construction provides the necessary vertical adjustment to the surfaces of the mulling plates. A vertical force applied to the handle 132 causes the opposite end of the handle to take up a lower position, swinging about pin 136, as shown by the dotted lines in Fig. 7. Simultaneously, as the handle is raised, the lower arm 124 likewise raises, being rotated about pin 127. The raising of the lower arm positions the mulling surface of the upper plate out of contact with the mulling surface of the lower plate. When the upper mulling plate is in its extreme vertical position, as shown by the dotted lines, it has passed through an arc of substantially 90°, and in this position may, if desired, be locked in place by any convenient means. When the upper mulling plate is in this position, the bottom edge of the oscillating member 112 rests on the top edge of the base 110.

The oscillating member 112 is disposed at the upper end of a rotatable shaft 139 which is journaled in bearing 138 cast into the base 110. The shaft 139 not only rotates but is free to move vertically in the bearing. Attached to the lower end of the shaft, substantially in the center thereof, by any convenient means is pin 141, and mounted on the pin through opening 142*a* is adjustable weight beam 142 which is supported about fulcrum point 143 in the base 110. Suitably disposed on one end of the weight beam is a slidable and adjustable weight 149 adapted to be freely moved horizontally along the beam.

Disposed at the lower end of the shaft 139 is a roller bearing 144 which is rigidly held in place by nut 145. The lower race of the bearing is tightly fitted to the shaft and rotates therewith, while the upper race is free from the shaft and remains substantially stationary. When the mulling surfaces are in contact with each other, the shaft 139 is in its raised position, and the upper surface of the upper race of the ball bearing rests on the lower surface of the weight beam. The weight 149 is transmitted to the surface of the mulling plate through the bearing on the upper race of the ball bearing and the fulcrum point.

Oscillating motion of the oscillating arm 112 is provided through an oscillating finger 146 rigidly attached to the shaft 139 which is actuated by a crank pin 147 positioned at the periphery of a gear 148 attached to shaft 150 journaled in bearing 151 cast in the base 110. The gear 148 meshes with the teeth of gear 152 which is mounted on shaft 115.

It will be obvious to those skilled in the art that other modifications may be employed, and the present invention is not limited to the specific embodiments herein shown.

The design of the mulling plates for use in grinding the pigments or inks in oil or other vehicles may be altered. While circular plates have been employed, any conveniently shaped plates may be used. While glass is preferred, it is not essential that this material be used for the successful operation of this invention. With regard to the mulling surfaces, it is absolutely necessary that they be uniformly smooth and even, otherwise small particles will become lodged on the rough or uneven surfaces of the mulling plates and produce particles of non-uniform size. The mulling plates, preferably, should be readily adjustable on the mulling plate supports. Under some conditions of operation, it might be advantageous to employ different mulling plates for each grinding operation, so that, during the mulling of the next sample, the operator can remove the pigment and make the necessary tests on the sample previously ground.

The speed of rotation of the lower mulling plate and the reciprocating and rotary motion of the upper plate has not been found to be critical, and it is not intended to place any limitation thereon. In one machine, constructed according to the embodiment of the invention shown in Figs. 1 and 2, the lower plate rotates at a speed of 110 R. P. M. while the upper mulling plate reciprocates over the grinding surface of the lower mulling plate through a 2" stroke (one inch on each side of the center line) and with a frequency of one complete oscillation for approximately every 1½ revolutions of the larger plate. The average speed of rotation of the upper mulling plate is dependent primarily on the length of the reciprocating stroke. The instant the upper and lower mulling plates are exactly centered, these plates will rotate at approximately the same speed. As the upper mulling plate travels from its central position, either to the right or left, its rotary speed decreases and reaches a minimum at the end of the stroke. The actual relative variation in speed between the mulling plates is, therefore, not a constant, but varies between the maximum speed, which occurs when the plates are centered, and a minimum speed which is the speed obtained at the end of the stroke. Other factors such as the pressure between the plates and the viscosity of the materials

to be ground affect the rotating speed of the upper plate, but these factors are of relatively minor importance. Under the above-mentioned operating conditions, the upper mulling plate rotates at an average speed of approximately 100 R. P. M.

Various means for applying the pressure to the plates have been shown in the embodiments herein disclosed. Other means will be readily apparent to those skilled in the art.

It will likewise be apparent to those skilled in the art that certain factors will have a bearing on the final product. These factors comprise the travel of the reciprocatory plate, the time of mulling, the pressure on the mulling plates, the pigment or vehicle being tested, etc. The specific conditions for an optimum treatment will have to be determined on the basis of a few relatively simple trials, but this will be merely a routine matter to one skilled in the art of color testing.

It has been discovered, according to the present invention, that the pigments or inks being mulled are under no conditions of operation permanently removed from the field of grinding. In those mulling devices hereinbefore referred to where the upper mulling plate was off center with respect to the lower mulling plate, there is a serious tendency for the particles to become permanently removed from the field of grinding by their being picked up on the edges of the off-center plate. This disadvantage is entirely eliminated by the present invention, and pigments and inks once placed in the field of grinding remain permanently therein during the entire mulling operation. This outstanding advantage results from the particular motion imparted to the mulling plates and the relative speeds thereof. In the operation of the mulling plates herein disclosed, there is a pronounced tendency to pull the ink or pigment away from the edges of the upper mulling plate as fast as it gathers. With other types of mulling machines not constructed according to this principle, the tendency to pull the particles away from the edges of the plate is not so great and, consequently, the particles are picked up on the edges of the plate and permanently removed from the field of grinding. While beveling the edges of the upper mulling plate reduces somewhat the tendency to pick up the materials on the edges of the plate, this modification alone does not effectively eliminate this objectionable feature. Prior art devices having off-center mulling plates with beveled edges still exhibit this tendency to permanently remove the materials from the field of grinding. Correspondingly, the pick up of materials on the upper mulling plate of mulling machines constructed according to the present invention is relatively slight even with a mulling plate having sharp edges.

In the embodiments of the invention herein disclosed, all of the adjustments have been made in the upper mulling plate. While this is usually convenient, it is not an essential limitation, and the adjustments may be obtained in the lower plate either through vertical or horizontal movement. It is likewise not essential that the plate be horizontal, as vertical or inclined plates may be used.

Various arrangements of equipment have been shown for driving the mulling plates. Others will be readily apparent to those skilled in the art. The mechanism may be either electrically or hand driven. Furthermore, the use of automatic devices for stopping the machine after a designated predetermined number of movements has taken place may be readily adapted to the machine, said automatic stop either operating on the rotary motion of the lower or upper mulling plates or on the reciprocating motion of the upper plate. Devices of this kind are commercially available and can be conveniently added to the hereindescribed mulling machine. One such device is described and claimed in U. S. Patent 2,040,026 dated May 5, 1936, and entitled "Counter."

While the machine will have its primary use in the grinding of pigments and inks into oils or other vehicles, it is capable of many other uses, all of which will be readily apparent to those skilled in the art such, for example, as in the preparation of drugs and like materials which must necessarily be ground or mixed in small quantities.

The present invention provides an improved apparatus for grinding pigments and inks into oils, which was not known to the prior art. Due to the combination rotary and reciprocating motion, a product of uniformly fine particle size is obtained and can be readily duplicated. It is not necessary to employ skilled workmen to carry out the mulling operation. A grinding and mixing action as well as the permanent retention of the particles in the field of grinding is provided by the present invention, the combination of which, to my knowledge, has never before been obtained in prior art rub-out machines. The grinding and mixing action effectively eliminates the dead spot and gives a relatively uniformly ground product.

A constant pressure is at all times assured for any given set of conditions. Adjustments may be readily made to the machine to meet other requirements of operation. A further advantage of the device herein disclosed is that the ink or pigment need not be picked up and redistributed over the plates and subjected to further grinding action, but fine particles can be obtained in one grinding cycle. In fact, the preliminary superficial mixing with the oil and pigments is necessary only to prevent the partially wetted powder from caking and sticking to one or both of the mulling plates.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof; it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

I claim:

1. A grinding apparatus for mulling materials into oil or other vehicles, comprising two rotatable grinding plates having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, means for positively rotating one of said plates, means for reciprocating the smooth surface of the other plate over the smooth surface of the positively rotating plate, means for maintaining said other plate in operatively-disposed relationship continuously over the substantial center of said positively rotating plate, and means for maintaining, throughout rotation of said positively rotating plate, said smooth grinding surfaces in continuous contact with each other under a predetermined constant pressure.

2. A grinding apparatus for mulling materials into oil or other vehicles, comprising two plates having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out

of contact with each other, means for rotating one of said plates, means for reciprocating the smooth surface of the other plate over the smooth surface of the rotating plate, means for maintaining said other plate in operatively-disposed relationship continuously over the substantial center of said rotating plate and means for maintaining said smooth grinding surfaces in continuous contact with each other under a predetermined constant pressure during the rotation of said positively rotating plate.

3. A grinding apparatus for mulling materials into oil or other vehicles comprising two flat rotatable grinding plates having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, means for positively rotating one of said plates, means for reciprocating the smooth surface of the other plate over the smooth surface of the said positively rotating plate, means for maintaining said other plate in operatively-disposed relationship continuously over the substantial center of said positively rotating plate, and means for maintaining said smooth grinding surfaces in continuous contact with each other under a predetermined constant pressure during the rotation of said positively-rotating plate.

4. A grinding apparatus for mulling materials into oil and other vehicles, comprising two rotatable flat grinding plates of unequal size having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, means for positively rotating the larger of said plates, means for reciprocating the smooth surface of the smaller of said plates over the smooth surface of the said larger rotating plate, means for maintaining said other plate in operatively-disposed relationship continuously over the substantial center of said positively rotating plate, and means for maintaining said smooth grinding surfaces in continuous contact with each other under a predetermined constant pressure during the rotation of said positively-rotating plate.

5. A grinding apparatus for mulling materials into oil or other vehicles, comprising two rotatable flat grinding plates of unequal size having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, means for rotating the larger of said plates, means for reciprocating the smooth surface of the smaller of said plates over the smooth surface of the said larger plate, means for maintaining said smaller plate in operatively-disposed relationship continuously over the substantial center of said larger plate, and means for maintaining said smooth grinding surfaces in continuous contact with each other under a predetermined constant pressure during the rotation of said positively-rotating plate.

6. A grinding apparatus for mulling materials into oil or other vehicles, comprising two horizontally positioned flat rotatable grinding plates of unequal size and circular in cross-section having co-operating smooth grinding surfaces between which the materials may be placed for grinding and adapted to be moved into and out of contact with each other, the smaller of said plates having beveled edges, means for rotating the larger of said plates, means for reciprocating the smooth surface of the smaller of said plates over the smooth surface of the larger plate, means for maintaining said smaller plate in operatively-disposed relationship continuously over the substantial center of said larger plate, and means for maintaining said smooth grinding surface into continuous contact with each other under a predetermined constant pressure during the rotation of said larger plate.

7. A grinding apparatus of the class described, comprising a horizontally disposed lower mulling plate circular in cross-section, the upper surface of which has been ground smooth, mounted at the end of a rotatable shaft, means for imparting rotary motion to said shaft, a smaller upper flat plate of circular cross-section with beveled edges, the lower surface of which has been ground smooth, disposed at the end of a reciprocating shaft, and adapted to be moved into and out of contact with the smooth surface of the said larger plate, said smaller plate, when in contact with the mulling surface of the larger plate, being free to simultaneously rotate and reciprocate thereover, means for imparting reciprocating motion to said smaller plate, means for maintaining said smaller plate in operatively-disposed relationship continuously over a central point of said lower plate, and means for maintaining said smooth grinding surface of said plates in continuous contact with each other under a predetermined constant pressure during the rotation of said larger plate.

8. A grinding apparatus of the class described, comprising a horizontally disposed lower mulling plate circular in cross-section, the upper surface of which has been ground smooth, mounted at the end of a rotatable shaft, means for imparting rotary motion to said shaft, a smaller upper flat plate of circular cross-section with beveled edges, the lower surface of which has been ground smooth, disposed at the end of a rotatable and reciprocating shaft, and adapted to be moved into and out of direct contact with the smooth surface of the said larger plate, said smaller plate, when in contact with the mulling surface of the larger plate, being free to simultaneously rotate and reciprocate thereover, means for imparting reciprocating motion to said smaller plate, means for maintaining said smaller plate in operatively-disposed relationship continuously over a point central of said lower plate, and means for maintaining said smooth grinding surface of said plates in continuous contact with each other under a predetermined constant pressure during the rotation of said larger plate.

9. A mulling device for incorporating materials into oils and other vehicles comprising, in combination, oppositely-disposed mulling plates in substantially concentric relationship with each other and each provided with cooperating smooth grinding surfaces between which the material to be ground or mulled is placed, means for moving the grinding surfaces of said plates into and out of direct contact with each other, means for positively rotating one of said plates, means for applying a reciprocating motion to an oppositely-disposed rotatable plate over the smooth surface of said positively rotating plate, means for maintaing said latter plate in operatively-disposed relationship continuously over the substantial center of said positively rotating plate, and means for maintaining, throughout rotation of said positively rotating plate, the smooth mulling surfaces of said oppositely-disposed plates in substantially continuous contact with each other under a predetermined, constant pressure.

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