Dec. 25, 1945. W. H. ROSS ET AL 2,391,480

LABORATORY HAMMER MILL

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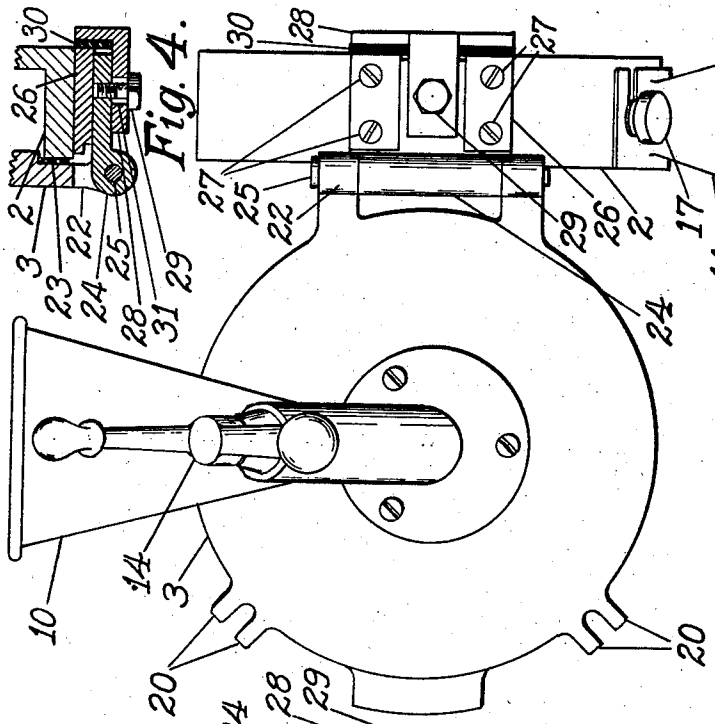


Fig. 4.

Fig. 3.

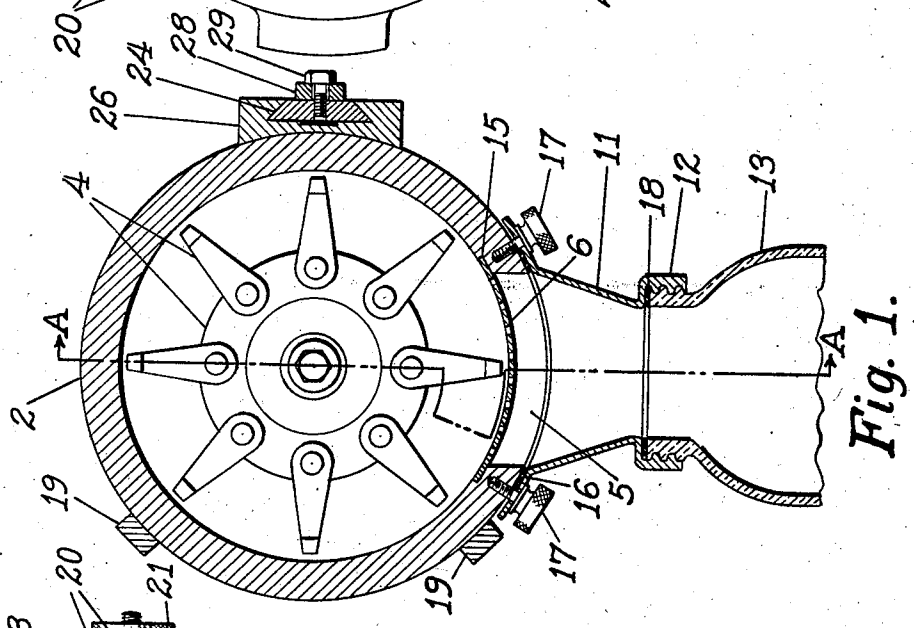


Fig. 1.

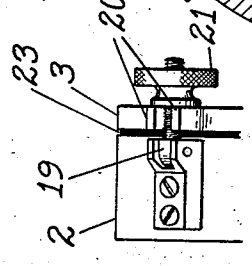


Fig. 5.

Inventors
W. H. ROSS
E. S. SHIPLEY
J. F. MULLINS
J. O. HARDESTY

By

Attorney

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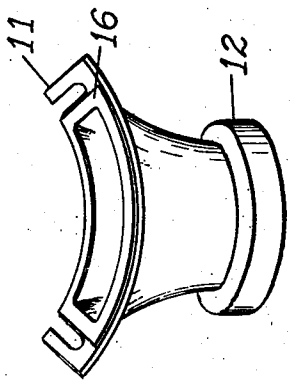


Fig. 6.

Fig. 2.

Inventors

W. H. ROSS
E. S. SHIPLEY
J. F. MULLINS
J. O. HARDESTY

By

Attorney

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LABORATORY HAMMER MILL

William H. Ross, Elias S. Shipley and Joseph F. Mullins, Washington, D. C., and John O. Hardesty, Hyattsville, Md., assignors to the United States of America as represented by the Secretary of Agriculture

Application January 18, 1943, Serial No. 472,682

3 Claims. (Cl. 241—100)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This application is made under the act of March 3, 1883, as amended by the act of April 30, 1928, and the invention herein described, if patented, may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to us of any royalty thereon.

This invention relates to an improved laboratory hammer mill for the dry grinding of samples of fertilizers and like materials for chemical analysis.

About 50 percent of the average mixed fertilizer of a few years ago would pass a 40-mesh sieve. A mixture of this kind contains sufficient finely-divided material to more than fill the interstices between the larger particles. Such a mixture exhibits little tendency to segregate in its original form and still less when ground for analysis. Within recent years there has been a tendency to increase the particle size of superphosphate and other components of fertilizer mixtures with a view to improving the drillability of the mixture. Little or no segregation is likely to take place in mixtures of this kind in the original form if the size of the particles is approximately the same. However, when mixtures containing a large proportion of coarse particles are ground for analysis to pass through 1-mm. openings in a sieve, as recommended in the official procedure of the Association of Official Agricultural Chemists, the proportion of relatively coarse to finely-divided material passing the sieve may be such as to cause segregation when the sample is handled or agitated.

It has recently been found, however, that good results are obtained in the analysis of the ordinary type of mixed fertilizers that have been ground to pass a 35-mesh Tyler standard screen scale sieve. The diameter of the opening in this sieve is 0.417 millimeter. A recommendation was accordingly adopted by the association that dry mixed fertilizers be ground for analysis to pass a 35-mesh Tyler standard sieve in place of a 1-mm. sieve.

Fertilizer mixtures as a rule are difficult to grind and any regulation that requires finer grinding would add considerably to the cost of preparing fertilizer samples for analysis if such grinding is to be done with the laboratory grinding equipment now on the market. This equipment includes such devices as the mortar and pestle, bucking board, Wiley mill, and various types of plate, roller and hammer mills. The electrically driven screen hammer mills are very effective for grinding the quantity and type of materials for which they are designed. The high speed of rotation of the hammers develops a strong current of air through these mills. This is an advantage when grinding any considerable quantity of a material as it tends to keep the mill cool. This current of air is a disadvantage, however, when grinding small samples for analysis. Some mills of this type are provided with a cloth tube which connects the outlet of the mill with the container in which the ground material is to be collected. The cloth tube permits the escape of the surplus air taken in through the screw feeder in the mill. The amount of fine dust which escapes through openings between attached fittings or through the mesh of the cloth tube in the initial stages of the grinding operation is insignificant when large quantities of material are being ground but, when small samples of ½ to 2 pounds are being ground for analysis, the loss of any dust becomes important to the true determination of the chemical composition of the sample. This is particularly evident when one ingredient of a fertilizer mixture shatters easily by impact of the hammers and is converted into a very fine dust while other ingredients of the same mixture are not reduced to such fineness. When the plant nutrient under consideration for analysis is mostly present in the finer material, its loss by dusting causes considerable discrepancy between chemical results and the actual nutrient value of the mixture.

Most fertilizers when finely divided are inclined to be sticky. This is due in part to the tendency of some fertilizer materials to become more hygroscopic with decrease in particle size. When a small sample is ground in a mill of the type previously employed, it is often found difficult to recover all the ground sample due to losses by dusting, to packing of the material in crevices and roughened surfaces on the interior of the mill, and to the tendency of the material to stick to the cloth tube through which the surplus air escapes.

The laboratory grinding devices now on the market have the further disadvantages that the material being ground is exposed to the air for a relatively long period, as usually happens when the sample is ground in a mortar and pestle, or to a strong current of air for a shorter period, as occurs when it is ground in mills of the hammer type. Many fertilizer materials have the property of rapidly absorbing moisture from the air on a humid day. If this is permitted to occur during the process of grinding, it not only changes the weight of the sample but also greatly increases the time required to grind the sample.

Furthermore, hammer mills used in the past have consisted of a large number of detachable parts which are difficult to clean and cumbersome to handle. To dismantle and reassemble such mills for a large number of small analytical samples is time-consuming and laborious.

An object of our invention, therefore, is to provide a laboratory hammer mill that is capable of grinding fertilizers and like materials in a much shorter time than other devices on the market.

A further object of this invention is to provide a laboratory hammer mill that is adapted to grinding fertilizers and like materials without loss or gain of moisture during the operation.

A further object of this invention is to provide a laboratory hammer mill that is capable of grinding a fertilizer or like material without appreciable loss of any portion of the sample by dusting.

Another object of our invention is to provide means for rapidly sealing and unsealing a laboratory hammer mill, thereby facilitating the handling of a large number of laboratory samples without loss of significant quantities of sample, and the cleaning of the mill in a minimum period of time after each grinding operation.

A still further object of the invention is to provide a laboratory hammer mill that can be readily and quickly cleaned, thereby avoiding any loss of material by adherence to any portion of the mill or contamination of any subsequent material entering the mill.

With the foregoing and other objects in view, this invention consists of such novel features of construction, combination and arrangement of parts as will be hereinafter more fully described and illustrated in the accompanying drawings and claims.

In describing the invention in detail, reference will be had to the accompanying drawings, wherein like characters designate like and corresponding parts throughout the several views, and in which:

Figure 1 is a vertical section of the improved hammer mill.

Figure 2 is a vertical section of the improved mill taken on line A—A of Figure 1 with the motor shown in elevation.

Figure 3 is a right side elevation of the improved mill with door open 90° and the support and motor not shown.

Figure 4 is a cross section of the door hinge as positioned when the door is closed.

Figure 5 is a part of the left side elevation of the improved mill showing door clamp.

Figure 6 is a perspective view of the removable funnel-shaped adapter shown in Figures 1, 2 and 3.

Referring more particularly to the drawings, the improved hammer mill of this invention comprises a base 1, whereby the mill proper may be mounted on a table or other support; a one-piece cylindrical mill housing 2 constructed of, or lined with, stainless steel or other corrosive-resistant material, and which with the hinged door 3 serves as a housing for the hammer assembly 4; a slotted outlet-opening 5 in the bottom of the cylindrical housing; a removable screen 6 for covering the slotted outlet-opening 5; a one-half H. P. motor 7 on the shaft 8 on which is mounted directly the hammer assembly 4; a spiral feed-screw conveyor 9 mounted on the hinged door 3 of the mill housing; a feed hopper 10 attached to the screw conveyor 9; a removable funnel-shaped adapter 11 below the slotted outlet-opening 5 of the mill housing; a screw cap 12 attached to the bottom of the adapter 11; and a bottle 13 of standard construction that can be screwed into the screw cap 12 of the funnel-shaped adapter 11.

The sample to be ground is fed into hopper 10 and is carried by means of the screw conveyor 9, which is inclined at about 20° and operated by handle 14 or by motor (not shown), through the center of the closed hinged door 3 into the mill housing 2 where the hammer assembly 4 operating at 8000 to 10,000 R. P. M. accomplishes pulverization of the particles and ejection of the ground material through the removable screen 6, which is held in place flush with the interior surface of the housing 2 and above the outlet-opening 5 by means of slots 15 situated at the edges of outlet-opening 5. The pulverized material then passes through the removable funnel-shaped adapter 11 which is sealed air-tight to the housing 2 by means of a gasket 16 and thumb screws 17. The pulverized material then passes into the receiving container 13 which is sealed air-tight to adapter 11 by means of screw cap 12 containing a gasket 18. Two swing-clamps 19, pivoted on the circumference of housing 2, fit between ears 20 on hinged door 3 in such a manner that pressure delivered on hinged door 3 by means of thumb screws 21 operates in conjunction with an adjustable hinge 22 and dove-tail assembly, as shown in Figure 4, to give equal pressure around the circumference of gasket 23 and seal the hinged door 3 to the face of housing 2.

The hinged door 3 is attached to a dove-tail 24 by means of a hinge pin 25. The dove-tail 24 slides in groove block 26 attached to the circumference of the housing 2 by means of screws 27 and is held in sliding position by means of L-shaped retainer plate 28 secured to dove-tail 24 by clamp-screw 29 and operating against a rubber cushion 30. Slot 31 in L-shaped retainer plate 28 allows adjustment of the L-shaped retainer plate 28 against the rubber cushion 30 so that when the door 3 is clamped in position on the face of housing 2 the dove-tail 24 and L-shaped retainer plate 28 slide forward exerting a pressure on rubber cushion 30 which causes the gasket 23 on hinged door 3 to be pulled tightly against the face of housing 2.

While the improvements herein disclosed have been described with relation to fertilizers, it is to be understood that the novel features of construction, and the combination and arrangement of means for obtaining these desirable results with small analytical samples, may be applied to any materials that can be satisfactorily subjected to pulverization in hammer mills.

We have found that, in grinding small samples for analysis, it is neither necessary nor expedient to have a flow of air through the mill, and that it is highly important to have the mill sealed air-tight at all places except at the feed inlet.

We have also found that the high speed rotation of the hammers in our mill creates an initial current of air which is blocked by the truly sealable means, causing a vacuum to be established at the center of rotation of the hammers and a corresponding pressure on the interior walls of the mill at and beyond the periphery of the hammers which prevents further passage of air unless the seals are broken. Thus, our mill is positively sealed against pressure from within when it is in operation.

Comparative tests made on various mills and grinders conducted on a large number of representative samples of fertilizer materials and mixtures showed that the above-described mill required an average of 37.2 percent less time for handling ½-pound samples than the most efficient of the other hammer mills tested. Furthermore, an average of 99.34 percent of the sample was recovered as compared to 97.33 percent for the most efficient of the other hammer mills. This, in addition to the fact that the samples did not change appreciably in moisture content during the grinding operation in our mill, is a remarkable improvement in the grinding of analytical samples for analysis.

Having thus described our invention, we claim:

1. In a hammer mill having a plurality of rotatable hammers enclosed in a housing and air-impermeable, discharge-collecting means attached to said housing by an air-tight connection, a sealable door forming a side of said housing parallel to the plane of rotation of said hammers, hinging means attached to said door, said hinging means including a dovetail tenon member slidingly received by a complementary mortice member on said housing, an adjustable L-shaped retainer plate the respective arms of which are adjacent said dovetail member and complementary mortice member, means to secure adjustably said dovetail member to the retainer plate, yieldable means positioned between the retainer plate and said complementary mortice member and sealing means positioned between said door and the adjacent edges of the housing, whereby an air-tight connection with said housing is effected when said door is in closed position, fastening means for securing said door in closed position, an inlet to said housing in said door adjacent to the axis of rotation of said hammers, and substantially air-tight means for introducing material into the housing through said inlet.

2. In a hammer mill having a plurality of rotatable hammers enclosed in a housing having an outlet at the bottom thereof and substantially air-tight means for introducing material into said housing, a sealable door forming a side of said housing parallel to the plane of rotation of said hammers, hinging means attached to said door, said hinging means including a dovetail tenon member slidingly received by a complementary mortice member on said housing, an adjustable L-shaped retainer plate the respective arms of which are adjacent said dovetail member and complementary mortice member, means to secure adjustably said dovetail member to the retainer plate, yieldable means positioned between the retainer plate and said complementary mortice member and sealing means positioned between said door and the adjacent edges of the housing, whereby an air-tight connection with said housing is effected when said door is in a closed position, fastening means for securing said door in closed position, a solid wall air-impermeable discharge member having openings at both ends positioned at the outlet of said housing, means for forming an air-tight connection between the discharge member at one opening and the housing at its outlet, an air-impermeable receptacle and air-tight means to attach said receptacle to the discharge member at its other opening, whereby the entire device is adapted to withstand pressure from within.

3. In a hammer mill having a plurality of rotatable hammers enclosed in a housing and air-impermeable discharge-collecting means attached to said housing by an air-tight connection, a sealable door forming a side of said housing parallel to the plane of rotation of said hammers, hinging means attached to said door, said hinging means including a sliding member at such angle to the edge of the annular wall of said housing as to oppose the motion of said door slidingly received by a complementary mortice member on said housing, an adjustable L-shaped retainer plate the respective arms of which are adjacent said sliding member and complementary mortice member, means to secure adjustably said sliding member to the retainer plate, yieldable means positioned between the retainer plate and said complementary mortice member designed to resist the closing motion of the door, and sealing means positioned between said door and the adjacent edges of the housing, whereby an air-tight connection with said housing is effected when said door is in a closed position, fastening means for securing said door in closed position, an inlet to said housing in said door adjacent to the axis of rotation of said hammers, and substantially air-tight means for introducing material into the housing through said inlet.

WILLIAM H. ROSS.
ELIAS S. SHIPLEY.
JOSEPH F. MULLINS.
JOHN O. HARDESTY.