Nov. 15, 1966 H. W. STRATFORD 3,285,524

MOTOR MILL

Filed Jan. 13, 1964 2 Sheets-Sheet 1

Fig. 1.

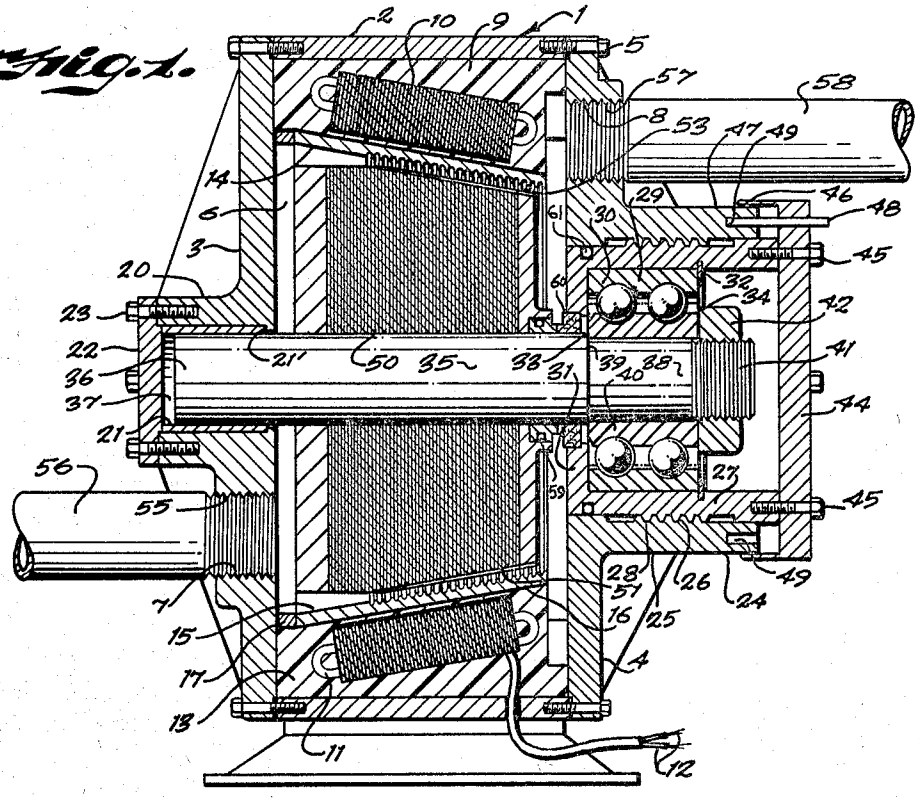


Fig. 2.

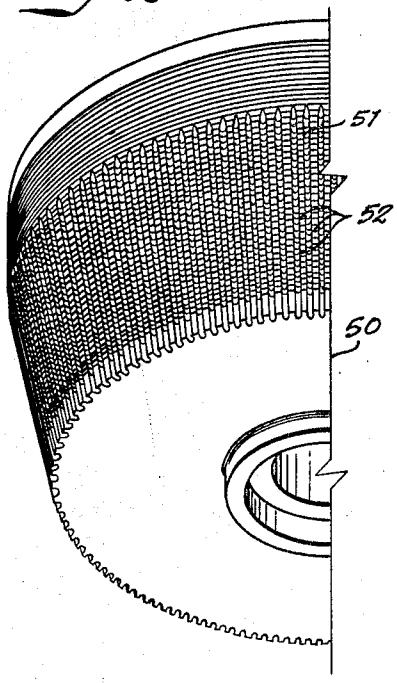
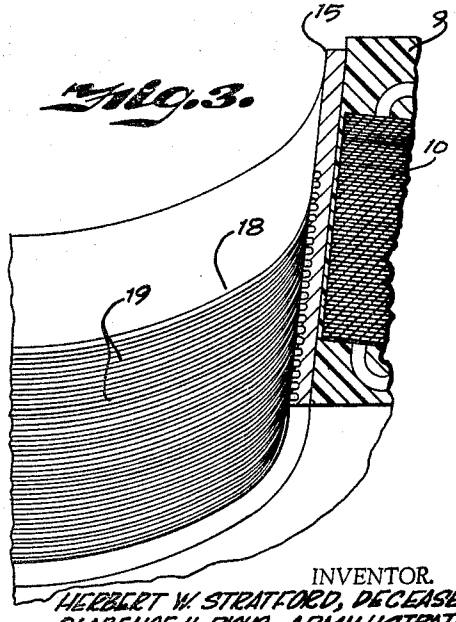


Fig. 3.



INVENTOR.
HERBERT W. STRATFORD, DECEASED,
CLARENCE H. DICUS, ADMINISTRATOR
BY
Fishburn and Gold
ATTORNEYS

Nov. 15, 1966 H. W. STRATFORD 3,285,524

MOTOR MILL

Filed Jan. 13, 1964 2 Sheets-Sheet 2

Fig. 4.

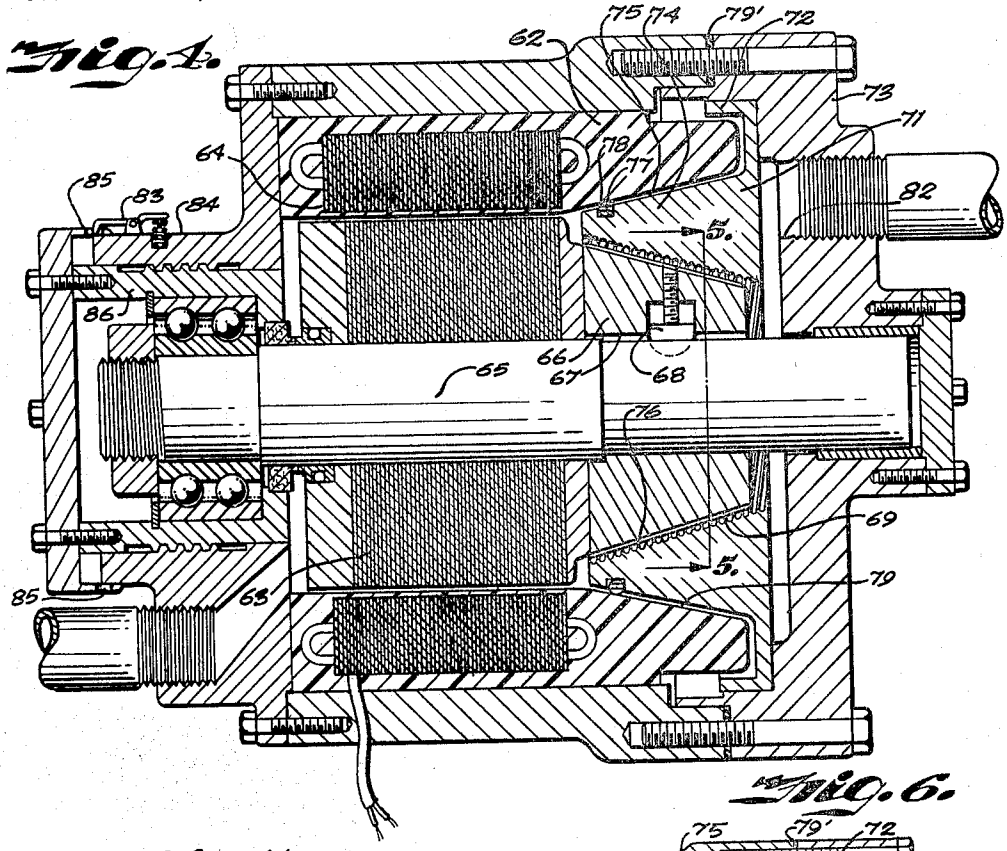


Fig. 6.

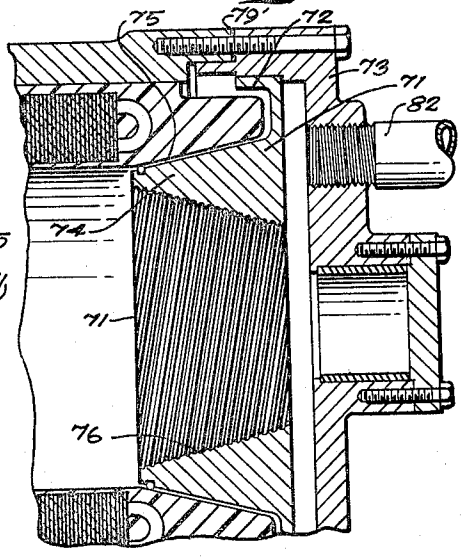
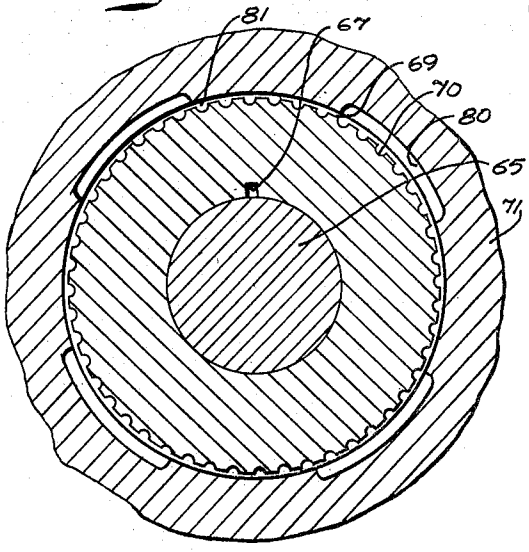


Fig. 5.



INVENTOR.
HERBERT W. STRATFORD, DECEASED,
CLARENCE H. DICUS, ADMINISTRATOR
BY
Fishburn and Gold
ATTORNEYS

United States Patent Office 3,285,524 Patented Nov. 15, 1966

3,285,524

MOTOR MILL

Herbert W. Stratford, deceased, late of Leawood, Kans., by Clarence H. Dicus, administrator, 1001 Dwight Bldg., Kansas City, Mo.

Filed Jan. 13, 1964, Ser. No. 337,993
7 Claims. (Cl. 241—256)

This invention relates to milling apparatus, and more particularly to rotary mills wherein the driving and milling structures are associated in the same housing.

Rotary mills for producing fine dispersions of materials are commonly used in the production of foods, cosmetics, asphalt, greases and the like. Such apparatus, however, have heretofore had separate driving members, such as electric motors, coupled thereto for driving the mill rotor. A flexible coupling device located between the motor and mill had to be relatively complex to allow for axial adjustability in the mill and to pass the high torque required for driving the mill. Thus, the entire apparatus included a separate motor, a coupling device and the mill itself, the combination constituting a large, heavy, unwieldly and expensive installation.

The principal objects of the present invention are: to provide a rotary mill apparatus wherein mill components and a driving electric motor are contained in a single housing substantially reducing the overall size and weight thereof; to provide such a driven mill which requires no complex coupling device; to provide an electric power driven mill wherein motor field coils are closely associated with the mill stator; to provide such apparatus wherein the electric motor rotor is also the mill rotor; to provide such mill apparatus which is easily adjustable in spacing or area between milling surfaces without substantial interference with motor operation and utilizes milling flow for motor cooling; and to provide such apparatus which is less complex in design, less expensive to produce, low in friction loss and more efficient in overall operatioin than conventional motor driven mills.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of this invention.

FIG. 1 is a cross-sectional view in side elevation illustraing a motor mill embodying this invention and particularly showing the milling rotor and stator portions associated with motor drive portions.

FIG. 2 is a fragmentary perspective view on a larger scale showing deails of the milling rotor.

FIG. 3 is a fragmentary perspective view on a larger scale illustrating details of the milling stator.

FIG. 4 is a cross-sectional view in side elevation illustrating a modified form of motor mill embodying this invention wherein the milling rotor and stator are slightly displaced from the electrical rotor and stator but contained in the same housing therewith.

FIG. 5 is a cross-sectional view through the motor mill taken on the line 5—5, FIG. 4, on an enlarged scale, showing the relationship between the milling rotor and stator.

FIG. 6 is a cross-sectional fragmentary view on a slightly reduced scale showing the motor mill of FIG. 4 with the milling rotor removed and particularly illustrating spiral milling grooves in the stator.

Referring to the drawings in more detail:

The reference numeral 1 (FIG. 1) generally indicates a motor mill embodying this invention. The motor mill 1 comprises a housing having an outer generally cylindrical shell 2 with a front cap 3 and a rear 4 secured to opposite ends of the shell 2 by means of suitable bolts 5 forming an enclosed chamber 6. The front cap 3 has an intake passageway 7 communicating therethrough into the chamber 6 and the rear cap 4 has a discharge passageway 8 communicating therethrough into the chamber 6.

An annular stator assembly 9 is located in the chamber 6 firmly secured against axial motion by contact at opposite ends thereof with the front and rear caps 3 and 4. The stator assembly 9 includes a laminated magnetic core 10 carrying a suitable field winding 11 having electrical leads 12 communicating therewith for directing electric current therethrough. The core 10 and field winding 11 are encapsulated in a suitable rigid synthetic plastic resin 13 covering all otherwise exposed surfaces thereof. The resin 13 defines an interior annular surface, in the illustrated example of FIG. 1 a frusto-conical surface 14 tapering inwardly as the rear cap 4 is approached. It is noted that the thickness of the resin 13 between the frusto-conical surface 14 and the laminated magnetic core is preferably very small, in the order of .020 inch for reducing, as much as practical, the distance between the magnetic core 10 and the electrical rotor described hereinafter.

A relatively thin frusto-conical mill sleeve 15 is fabricated on non-magnetic material which preferably has a hard and rigid exterior such as anodized aluminum. The sleeve 15 includes an outside surface 16 engaging the interior surface 14 and forming a removable part of the stator assembly 9. A suitable ring spacer 17 is engaged between the mill sleeve 15 and the front cap 3 for urging the mill sleeve into tight engagement with the surface 14. The mill sleeve 15 has an interior frusto-conical surface 18 with a plurality of annular closely axially spaced shearing or milling grooves 19 along the major axial length thereof.

The front cap 3 has a central cylindrical housing 20 protruding axially outwardly therefrom for supporting a sleeve bearing 21 coaxially of the chamber 6 against a shoulder 21'. When maintenance is necessary, the sleeve bearing 21 may be easily withdrawn from the housing 20 by first removing a mounting cover 22 secured to the wall of the housing 20 by means of suitable bolts 23.

The rear cap 4 has a central cylindrical housing 24 protruding axially outwardly therefrom. The housing 24 includes a stationary outer sleeve portion 25 having internal screw threads 26 and a rotatable inner sleeve portion 27 having external screw threads 28 engaging the internal threads 26 for coaxial movement therewithin. A thrust bearing, in the illustrated example, a double row ball thrust bearing 29 designed to withstand axial thrust in both directions, is supported by the outer race 30 in the inner sleeve portion 27 between a sleeve shoulder 31 and a suitable lock ring 32. In this position, the double ball thrust bearing has one side 33 facing the chamber 6 and the other or outer side 34 facing away from said chamber, the rotational axis of the bearing 29 coinciding with the axis of the chamber 6.

A shaft 35 is rotatably mounted at one end thereof in the sleeve bearing 21 but leaving a space 37 between the shaft and the housing cover 22 to permit axial adjustment of the shaft 35 within the chamber 6 for reasons noted below. The other end 38 of the shaft 35 is reduced in diameter forming a shoulder 39 bearing against the side 33 of the thrust bearing at the inner race 40. The end 38 is slidably received within the inner race 40 and extends through and beyond the thrust bearing 29 terminating in a portion having external screw threads 41. The screw threads 41 threadedly receive a nut 42 for bearing against the other side 34 of the thrust bearing 29 at the inner race 40 for retaining the shaft 35 against axial movement with respect to the bearing.

A cover 44 is secured by means of bolts 45 to the inner

sleeve portion **27** and may be removed to obtain access thereinto. The cover **44** include an axially extending lip **46** which overlaps a portion of the outer surface **47** of the sleeve portion **25**. The outer surface **47** and the lip **46** move relative to each other when the inner sleeve portion **27** is rotated with respect to the outer sleeve portion **25**. This latter rotation produces an adjusting axial motion of the shaft **35**. Suitable markings (not shown) may thus be placed on the lip **46** and outer surface **47** for indicating the relative axial position of the shaft **35** within the chamber **6**. A suitable locking member, in this example a pin **48**, is slidably received through the cover **44** and into one of a plurality of depressions or sockets **49** circumferentially spaced about the outer sleeve portion **25** for selectively locking the inner sleeve portion **27** in a desired rotational position.

A squirrel cage type laminated rotor **50** is carried rigidly on the shaft **35** within the chamber **6** and has a frustoconical outside surface **51** matching in slope angle the sleeve interior surface **18**. The rotor outside surface **51** has a plurality of closely circumferentially spaced axially extending shearing or milling grooves **52** therein which may be similar in cross-sectional shape to the grooves **19**. The rotor outside surface **51** and the sleeve interior surface **18** are located in closely spaced apart relation, for example .005 to .100 inch, forming a conical annular flow passageway **53** exposed to the sleeve grooves **19** and the rotor grooves **52** and having opposite ends opening into the chamber **6**. It is to be understood that the annular flow passageway **53** is both a magnetic gap and a milling passageway and is adjustable in cross-sectional area or spacing in response to the relative rotation between the rear cap inner and outer sleeve portions **27** and **25**.

The intake passageway **7** has an internal screw thread **55** threadedly receiving a material feeding tube **56** which thereby communicates with the chamber **6** and flow passageway **53**. The discharge passageway **8** is likewise threaded at **57** and receives a comminuted material or discharge tube **58** which also communicates with the flow passageway **53** through the chamber **6** but at the opposite end thereof. Thus, uncomminuted material contained in a suitable fluid vehicle may be pumped through the tube **56** into the narrow flow passageway **53** and out the tube **58**. By supplying suitable electric energy to the electrical leads **12**, the rotor **50** is driven in the manner of an electric motor and, by virtue of the shear or milling grooves **52** and **19**, a milling operation occurs within the flow passageway **53**.

In addition to the elimination of a flexible coupling device between the motor and the mill and the advantage of compactness and simplicity, the above-described motor mill is efficiently cooled by transferring heat generated by both the electrical function and the milling operation to the fluid flowing through the passageway **53** and out the tube **58**. Suitable seals are provided at **59**, **60** and **61** to prevent fluid leakage into critical areas which are not otherwise protected. All flow areas within the motor mill are narrow so that a minimum of material is contained therein at any time. The simple design and lack of coupling device permits great convenience in removing the various portions of the motor mill for maintenance.

Referring to FIG. 4, an additional embodiment of this invention is illustrated which is similar to the embodiment of FIG. 1 except as follows: The motor stator assembly **62** and motor rotor **63** form a cylindrical magnetic gap and passageway **64** therebetween instead of the conical gap and passageway formed in the embodiment of FIG. 1. The material to be milled passes through the gap passageway **64** for pre-mixing and removes heat from the electrical components. Fixed to the shaft **65** which supports the rotor **63** and located adjacent to the rotor **63** is a milling rotor **66** which is frusto-conical in shape. The milling rotor **66** has a central axial bore **67** through

which the shaft **65** is received and a suitable key assembly **68** to insure rotation with the shaft. The milling rotor **66** defines a frusto-conical exterior surface **69** having a plurality of closely circumferentially spaced axially extending milling grooves **70** thereon similar to the grooves **52** above-described.

The milling stator **71** in the embodiment of FIG. 4 is of annular generally conical shape and has a cylindrical lip or rim **72** engaging the rear cap **73** for location and support within the mill. The milling stator **71** includes a forwardly projecting central portion **74** forming an outer frusto-conical surface **75** and an inner frusto-conical surface **76**, the latter surface extending in closely spaced relation to the milling rotor surface **69**. The outer surface **75** includes an annular circumferential groove **77** for supporting an O-ring seal **78** in sealing contact with the inside conical surface **79** of the motor stator assembly **62**, the pressure against the seal **78** being determined by the thickness of a shim **79'**. The inner surface **76** of the milling stator **71** has milling grooves **80** extending thereinto which are generally transverse to the grooves **70** but, in the illustrated example, form a quadruple groove spiral, although other groove configurations may be used. The surfaces **76** and **69** are adjustably spaced slightly apart forming a conical milling passageway **81** communicating with the passageway **64** for receiving material therefrom. The spiral shape of the grooves **80** aid in moving the material toward the outlet passageway **82** during mill operation in the spiral moves toward the passageway **82** in the rotational direction of the milling rotor **66**.

In the embodiment of FIG. 4, as with that of FIG. 1, the electrical and magnetic portions of the motor stator **62** are encapsulated to avoid exposing same to the material passing through the mill, however, an axial adjustment of the shaft **65** to change the spacing in the milling passageway **81** does not change the spacing between the electrical rotor and stator. It is noted that the embodiment of FIG. 4 has the shaft adjusting members reversed from those of FIG. 1, however, the operation thereof is similar. A lock member **83** is hinged to the front cap **84** in the embodiment of FIG. 4 and is adpated to selectively engage in one of a plurality of circumferentially spaced stop portions **85** fixed with respect to the adjustable inner sleeve portion **86** for locking the shaft **65** against axial movement after adjustment.

It is to be understood that while certain forms of this invention have been illustrated and dscribed, it is not to be limited to the specific forms or arrangements of parts herein described and shown except insofar as such limitations are included in the claims.

What is claimed is:

1. A motor mill comprising, a shell having opposite open ends, a first and a second cap secured to said shell opposite ends forming an enclosed chamber, said first cap having an intake passageway communicating therethrough into said chamber, an electric motor stator assembly mounted in said chamber between said first and second caps and including a magnetic core carrying a field winding, said core being encapsulated in non-magnetic protective material and defining an interior annular surface, a relatively thin mill sleeve of non-magnetic material and having an outside surface engaging said stator assembly interior surface, said mill sleeve having an interior surface with a plurality of closely spaced milling grooves thereon, said first cap having a central housing, a bearing supported in said first cap housing coaxially of said chamber, said second cap having a central housing, a bearing supported in said second cap housing coaxially of said chamber, a shaft rotatably mounted at one end thereof in said first cap bearing and at the other end thereof in said second cap bearing, said shaft extending coaxially through said chamber and having a squirrel cage type electric motor rotor carried thereon within said chamber, said rotor having an outside surface with a plurality of closely spaced milling grooves thereon, said rotor outside surface

and said sleeve interior surface being located in closely spaced apart relation forming an annular flow passageway therebetween having opposite end portions opening into said chamber and communicating respectively with said intake passageway and said discharge passageway, and means for supplying electrical power to said stator field winding for rotating said rotor with respect to said mill sleeve.

2. The motor mill as set forth in claim 1 wherein said sleeve interior surface and rotor outside surface are frusto-conical in shape whereby said annular flow passageway is frusto-conical, and including means for axially positioning said rotor within said chamber for varying the thickness of said annular flow passageway.

3. A motor mill comprising, an outer generally cylindrical shell and a front and a rear cap secured to opposite ends of said shell forming an enclosed chamber, said front cap having an intake passageway communicating therethrough into said chamber, said rear cap having a discharge passageway communicating therethrough into said chamber, an annular stator assembly mounted in said chamber between said front and rear caps and including an electric motor laminated magnetic core carrying a field winding, said core being fully encapsulated in rigid synthetic plastic resin and defining an interior frusto-conical surface tapering inwardly as said rear cap is approached, a relatively thin frusto-conical mill sleeve of rigid non-magnetic material having an outside surface engaging said stator assembly interior surface, said mill sleeve having an interior frusto-conical surface with a plurality of annular closely axially spaced milling grooves therealong, said front cap having a central housing, a sleeve bearing supported in said front cap housing coaxially of said chamber, said rear cap having a central housing including a stationary outer sleeve portion having internal screw threads and a rotatable inner sleeve portion having external screw threads engaging said last-named internal threads, a thrust bearing supported in said inner sleeve portion coaxially of said chamber and having one side facing said chamber and the other side facing away from said chamber, means axially retaining said thrust bearing with respect to said inner sleeve portion, a shaft rotatably mounted at one end thereof in said sleeve bearing and rotatably mounted adjacent the other end thereof in said thrust bearing, said shaft extending coaxially through said chamber and having a shoulder bearing against said one side of said thrust bearing, said shaft other end having a threaded portion extending beyond said thrust bearing and threadedly receiving a nut bearing against said other side of said thrust bearing for retaining said shaft against axial movement with respect to said thrust bearing, locking means for selectively locking together said rear cap outer and inner sleeve portions to prevent relative movement therebetween, and a squirrel cage type laminated electric motor rotor carried on said shaft within said chamber and having a frusto-conical outside surface, said rotor outside surface having a plurality of closely circumferentially spaced axially extending milling grooves therein, said rotor outside surface and said sleeve interior surface being located in closely spaced apart relation forming a conical annular flow passageway having opposite end portions opening into said chamber and communicating respectively with said intake and discharge passageways, said annular passageway being adjustable in cross-sectional area in response to relative rotation between said rear cap inner and outer sleeve portions.

4. A motor mill comprising, a housing forming an enclosed chamber, an intake passageway and a discharge passageway communicating through said housing into opposed portions of said chamber, an electric motor stator assembly mounted in said housing and including a magnetic core carrying a field winding, a nonmagnetic enclosure for said core and winding and having an inner surface, spaced apart aligned bearing means supported by said housing, an integral shaft rotatably mounted on said bearing means and extending into said chamber, an electric motor rotor carried on said shaft within said housing in cooperative relation with said electric motor stator assembly and having a periphery spaced from said inner surface to form a flow passage therebetween communicating at one end with said intake passageway, said rotor including a portion forming a tapered rotating milling surface, means stationary within said chamber forming a stationary tapered milling surface in cooperative adjacent relation with said milling surface of said rotor portion and forming a milling passageway therewith communicating with said flow passage at one end and said discharge passageway at the other end, and means cooperating between said housing and said shaft for axially adjusting said rotor and rotor portion to vary the size of said milling passageway.

5. A motor mill comprising, a housing forming an enclosed chamber, an intake passageway and a discharge passageway communicating through said housing into said chamber, an electric motor stator assembly mounted in said chamber and including a magnetic core carrying a field winding, said stator assembly defining an interior annular surface, spaced apart aligned bearing means supported by said housing, a shaft rotatably mounted on said bearing means and extending into said housing coaxially of said stator assembly interior surface, an electric motor rotor carried on said shaft within said chamber and having an outside annular surface, said rotor outside surface and said stator assembly interior surface being located in closely spaced apart relation forming an annular magnetic gap and flow passageway therebetween communicating at opposite ends thereof with said respective intake and discharge passageway, means rotatable with said rotor and in said chamber forming a rotating milling surface, means stationary within said chamber forming a stationary milling surface in cooperative adjacent relationship with said rotating milling surface and forming a milling passageway therebetween, said stationary means being a non-magnetic internally grooved sleeve removably assembled within said stator assembly, said milling passageway being located with respect to said flow passageway whereby material entering said chamber from said intake passageway and discharging from said chamber from said discharge passageway passes through both said passageway and said milling passageway.

6. The motor mill as set forth in claim 5 wherein the means rotatably with said rotor and forming a rotating milling surface and said non-magnetic internally grooved sleeve forming the stationary milling surface have the cooperating milling surfaces frusto-conical in shape with the lesser diameter portion adjacent the discharge passageway.

7. A motor mill comprising, a shell having opposite ends, a first and a second cap on opposite ends of said shell forming an enclosed chamber, said first cap having an intake passageway communicating therethrough into said chamber, said second cap having a discharge passageway communicating therethrough into said chamber, an electric motor stator assembly mounted in said chamber between said first and second caps and including a magnetic core carrying a field winding, said core and winding being encapsulated in rigid synthetic plastic resin forming an enclosure thereof and including a relatively thin wall of rigid non-magnetic material defining an inner surface, said first cap having a central housing, a bearing supported in said first cap housing coaxially of said chamber, said second cap having a central housing, a bearing supported in said cap's central housing coaxially of said chamber, a shaft rotatably mounted at one end thereof in said first cap bearing and at the other end thereof in said second cap bearing, said shaft extending coaxially through said chamber, an electric motor rotor carried on said shaft within said chamber and having an outside surface substantially matching the inner surface of the field core enclosure and spaced therefrom defining a ma-

terial flow passage therebetween communicating at one end with the intake passageway, said rotor having a portion tapered inwardly toward the shaft remote from the intake passageway and defining a rotating milling surface, means stationary in said chamber forming a stationary milling surface in cooperative adjacent relationship with the tapered rotating milling surface of the rotor portion and forming a milling passageway therebetween, with the end of said milling passageway remote from said intake passageway communicating with the discharge passageway whereby material entering the chamber from the intake passageway passes through the flow passage between the inner surface of the field core enclosure and rotor and the milling passageway to the discharge passageway, and means cooperating between said shell and said shaft for axially adjusting said rotor and rotor portion to vary the

spacing between the rotating milling surface and the stationary milling surface.

References Cited by the Examiner

UNITED STATES PATENTS

951,368	3/1910	Dunker	241—260
1,399,976	12/1921	Manson	241—38 X
1,863,184	6/1932	Brazeau	241—256
2,909,332	10/1959	Brown	241—46
2,976,808	3/1961	Whitehurst	103—87
3,094,291	6/1963	Lindstrom	241—258

ROBERT C. RIORDON, *Primary Examiner.*

D. KELLY, *Assistant Examiner.*