July 15, 1958 F. W. STEIN 2,843,169

LABORATORY MILL FOR COMMINUTING MATERIALS TO FINE PARTICLE SIZE

Filed Aug. 4, 1954

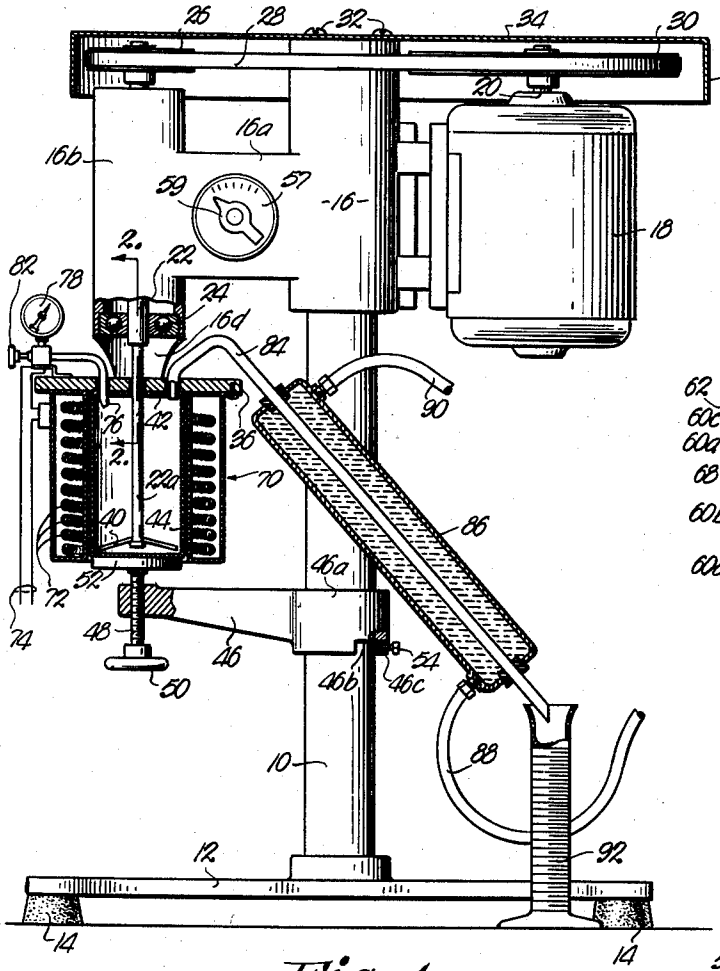


Fig. 1.

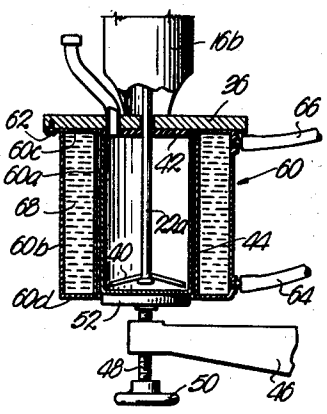


Fig. 3.

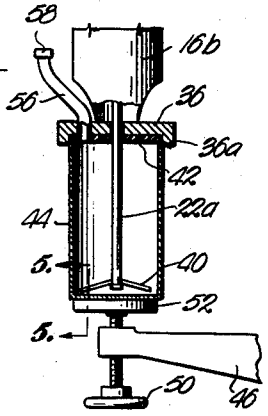


Fig. 4.

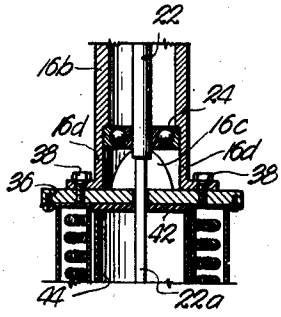


Fig. 2.

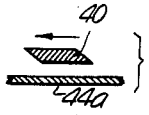


Fig. 5.

INVENTOR.
Frederick W. Stein

BY Thos. E. Scofield
ATTORNEY.

United States Patent Office 2,843,169 Patented July 15, 1958

2,843,169

LABORATORY MILL FOR COMMINUTING MATERIALS TO FINE PARTICLE SIZE

Frederick W. Stein, Atchison, Kans.

Application August 4, 1954, Serial No. 447,377

9 Claims. (Cl. 146—68)

The present invention relates in general to a method of and apparatus for treating materials; more particularly, it deals with the construction of a mill for comminuting materials to small particle size and with the use of the mill in processing materials of vegetable or animal origin.

In laboratory analysis or experimental treatment of various solids and semisolids it often proves necessary or desirable to comminute a sample of the material under consideration to small particle size for the purpose of making certain tests, or determining certain physical or chemical properties of the material or otherwise facilitating the analytical procedure. Such a need frequently arises, for example, in the agricultural research laboratory, the cereal chemistry research laboratory and, considering the industrial field, in laboratories serving the food canning industry, the grain milling industry and the meat packing or processing industry, to mention a few.

While my invention has many applications, it can be mentioned by way of illustration that determination of the moisture content of various grains and legumes, determination of the oil content of such vegetable materials as flax seed and soybeans, and determination of the fat content of such animal materials as hamburger meat, pork sausage and other dried and fresh meats are greatly facilitated by comminution; moreover, in connection with certain tests on vegetable and animal materials, it sometimes is desirable not only to reduce the material to fine particle size but also to thoroughly mix the particles with another substance of liquid or semiliquid character in order to form a homogeneously blended slurry.

An object of the invention, then, is to provide, for such uses as have been mentioned as well as others that will occur to those versed in the art, a laboratory mill capable of very quickly reducing to small particle size a given sample of material and, when the occasion arises, forming homogenous blends or slurries of semiliquid consistency.

Another object is to provide a unit of the character indicated which is capable of performing the desired milling and/or blending operation under conditions which prevent loss of any portion of the test material to the atmosphere, as is very important in making accurate quantitative analyses in the laboratory.

Still another object is to provide a device of the character indicated which, if necessary, is capable of performing the desired mixing or blending operations under controlled conditions of time and/or temperature.

A further object is to provide a laboratory mill which is extremely reliable in operation; which is sturdy and long lived; which is versatile as regards its ability to process a wide variety of materials and its ability to meet a wide range of conditions reflecting the varying laboratory needs in experimental work; which is simple and convenient to use; and which requires little or no maintenance.

Yet another object is to provide a laboratory mill

capable of processing solid or semisolid materials of either fluent or non-fluent character and which by its action generates in the material being treated heat which is useful in carrying out certain experimental tests on the material; a feature of the invention resides in the provision of means for adding additional heat when such will facilitate the procedure, or removing heat from the test specimen during the milling operation when such is desirable or necessary to the test procedure.

A further object is to provide an apparatus for rapidly extracting moisture from seeds, grains, legumes and other moisture-containing materials (or extracting other heat-volatile liquids from such materials) for the purpose of determining the moisture or liquid content thereof or for other purposes that will be self-evident to those versed in the art.

Still another object is to provide an improved method of and apparatus for making rapid determinations of the moisture content of grains or like substances.

Other and further objects of the invention, together with the features of novelty whereby the objects are achieved, will appear in the course of the following description.

In the drawings which form a part of the specification and are to be read in conjunction therewith, and wherein like reference numerals are used to indicate like parts of the various views:

Fig. 1 is a side elevational view of apparatus for extracting moisture from vegetable material or the like for the purpose of determining moisture content, which apparatus includes my improved milling unit; for purposes of illustration certain parts are broken away and others are shown in cross section;

Fig. 2 is a fragmentary cross-sectional view taken along the line **2—2** of Fig. 1;

Fig. 3 is a sectional elevation of a portion of my milling unit illustrating a modified form thereof;

Fig. 4 is a sectional elevation of a portion of my milling unit illustrating another modified form thereof; and

Fig. 5 is an enlarged cross section of the milling blade taken along the line **5—5** of Fig. 4 in the direction of the arrows.

Referring more particularly to Fig. 1, the numeral **10** indicates an upright post supported on a suitable base **12** having feet **14**. At the upper end of the post there is a rigid mount **16** carrying an electric motor **18**, the latter being positioned so that its shaft **20** is vertical. On the opposite side of the post from the motor the mount **16** has an integral arm **16*a*** extending laterally and terminating in a headpiece **16*b***.

A vertical shaft **22** is journaled in the headpiece, being carried by suitable bearings **24**. On the upper end of this shaft is a pulley **26** connected via belt **28** to a pulley **30** on the motor shaft **20** whereby the motor is drivingly connected to shaft **22**. It will be noted that mount **16** extends upwardly between opposite sides of the belt, and secured thereto by means of screws **32** or otherwise is a guard or shroud **34** which covers the belt and pulleys on the top, with its depending flange **34*a*** extending downwardly around the margin of the belt.

The headpiece **16*b*** is generally cylindrical and at its lower end is cut out as shown at **16*c***, forming opposed legs **16*d***. To these legs a horizontal disc-shaped cover plate **36** is secured in any suitable fashion as, for example, by means of bolts **38** (see Fig. 2). The cover plate is centrally apertured and shaft **22** has an extension **22*a*** of reduced diameter extending downwardly through this aperture. A milling or cutter blade **40** is secured to the lower end of the shaft being thus spaced below the cover **36**. On the underside of the cover is cemented or otherwise bonded a centrally apertured circular gasket **42**, the purpose of which will be made clear presently.

For use with my laboratory mill, I provide a generally cylindrical cup **44** for receiving a sample of the material to be comminuted. The upper rim of the cup is adapted to be clamped against the cover plate—in seating and sealing engagement with the gasket **42**—by the following means: Extending laterally from the post **10** is an arm **46** having at its outer end an internally threaded hole in which is received the externally threaded member **48**. The latter has a knob **50** at its lower end to permit turning it by hand, and at its upper end it has a circular rest or seat **52** to engage the bottom of the cup. Arm **46** is carried by a collar **46***a* encircling post **10** to turn thereon, and the collar is supported by means of a screw **54** received in a tapped hole in the post so that it extends radially outward therefrom as shown in Fig. 1. As will also be clear from this figure, the portion of the collar resting on the screw is a 90° segment cut out of the underside of the collar to form stop shoulders **46***b* and **46***c* limiting the swinging of arm **46** to a 90° arc about the post as an axis.

With the parts shown as positioned in Figs. 1, 3 and 4, cup **44** is clamped securely between the rest **52** and the underside of cover **36**, its rim being seated against the gasket **42** and the cup being concentric with shaft **22***a*. By turning knob **50** in a direction to relieve the clamping pressure, arm **46** can be swung to a position out of register with the bottom of the cup, whereupon the cup can be withdrawn downwardly from cover **36** to remove the cutter blade **40** therefrom. To replace the cup preparatory to another milling operation, it is advanced upwardly about the shaft until its rim engages the gasket; then arm **46** is swung back into the position shown, and knob **50** is turned in order to cause rest **52** to urge the cup upwardly, clamping it firmly in place.

For the purpose of controlling the temperature of the contents of the cup during a given milling operation, the cover plate **36** may be provided with a depending annular heating jacket or cooling jacket as shown in Figs. 1 and 3, or the jacketing may be omitted as shown in Fig. 4 where no such temperature control is required.

Referring first to Fig. 4, since this illustrates the simplest form of construction, it will be noted that the cover plate is provided with a depending annular flange **36***a* which encircles the margin of the cup to hold same coaxial with the shaft **22***a*. For introducing material to be milled into the cup after it is in place, the cover plate also is provided with a filling tube **56** having a removable cap **58**. Shaft **22***a* is driven at high speed—preferably of the order of 14,000 to 16,000 R. P. M.—and in a typical milling operation after the shaft has come up to full speed, a measured quantity of the grain or other material to be milled is introduced into the cup gradually through the filling tube in order to avoid throwing a heavy load suddenly onto the motor.

As will be seen in Fig. 5, the cutter blade **40** has sharpened edges and its direction of travel (as indicated by the arrow) is such as to propel the material downwardly toward the cup bottom **44***a*; material below the blade travels back upwardly along the walls of the cup past the tips of the blade (see Fig. 4), so there is continuous circulation of the material within the cup. The cutting or comminuting action takes place, of course, principally in the region near the tips of the blade.

At the high rate of speed at which the blade tips travel it is found that 100 grams of whole soybeans, for example, will, with as little as six minutes of milling in my unit, be reduced to such fineness that 96% to 98% of the solid matter will pass through a standard No. 40 sieve. If in addition to reducing the particles to fine size it is desired to blend the particles with a solvent or liquid of any character, the latter can be introduced through the filling tube **56** while blade **40** continues to turn, and in a very brief interval a homogeneous mixture is obtained. Whether the material is milled in "dry" condition or "wet" condition, it will be clear that there can be no loss of any portion thereof, inasmuch as the cup **44** is closed and sealed by the gasketed cover **36**.

In laboratory use, different materials will require different lengths of milling time, depending upon the character of the material being processed, the fineness to which it is desired to reduce the material, and various other factors. Thus a typical sample of wheat or other grain can be reduced to suitable fineness for determining its moisture content by conventional oven test methods with as little as one minute's preparatory milling in my apparatus, while other operations may require a ten-minute milling period or even more. In order that the milling time can be accurately controlled, yet flexible enough to meet all requirements, I provide my apparatus with an automatic time switch **57** (see Fig. 1) having a manually adjustable pointer-knob **54** by means of which the milling time can be preset; this switch is of known construction, and is so connected in the motor supply circuit (not shown) as to cut off the motor when the preset time has elapsed, thereby to terminate the milling operation.

Due to the impact of the cutter blade upon the material being treated and due also to the agitation and frictional engagement of the blade with the material, a very considerable amount of heat is generated directly in said material. For instance, milling a 100 gram sample of typical grain will raise its temperature to 100° C. in approximately two minutes and to 200° C. in approximately five minutes. This heating is of advantage in some experimental procedures; in others—say, where the heat would cause undesirable volitalization of liquid fractions of the test specimen—the cup can be artificially cooled during the milling operation, and for this I prefer to use the arrangement illustrated in Fig. 3.

The construction shown in Fig. 3 is essentially like that of Fig. 4 except that the cover plate **36** is larger in diameter and has a depending annular cooling jacket **60** secured to its marginal portion by means of screws **62** or otherwise. The cooling jacket comprises a hollow housing having a cylindrical inner wall **60***a*, a concentric outer wall **60***b*, a top wall **60***c*, and a bottom wall **60***d*. For the sake of clarity in the drawing, inner wall **60***a* is shown spaced slightly from the exterior wall of cup **44**, but it should be understood that in order to obtain a good heat exchange between the two, they should fit together as snugly as is possible without interfering with the removal of the cup when arm **46** is swung away from the bottom of the cup, as has been explained hereinbefore.

The jacket serves always to center cup **44** relative to shaft **22***a* during insertion and removal of the cup and of course maintains it coaxial with the shaft during milling. Accordingly, it is unnecessary that the underside of cover **36** have a central locating recess like that provided in the Fig. 4 embodiment for receiving the rim of the cup. However the central portion of cover **36** in Fig. 3 can be similarly recessed if desired, in which case the gasket **42** will be positioned in the recess.

The outer wall **60***b* of the jacket has nipples to which fluid inlet and outlet lines **64** and **66** are connected; by this means water or any other suitable coolant **68** may be continuously circulated through the hollow interior of the jacket during the milling operation. Obviously, should it be desired to supply additional heat to the cup during milling, steam or other heated fluid can be supplied to the jacket in place of the coolant.

An alternative way of heating the cup during milling is shown in Fig. 1 and this construction is preferred where heating is desired. Here the cover plate **36** has a depending annular jacket **70** which is fundamentally like the jacket **60** already described except that it has no inlet or outlet for fluid and instead is provided with an electrical resistance heating coil **72** between the inner and outer walls. Electrical current for energizing the coil is supplied through the conductors **74**. A temperature sensing element **76** extends into the upper portion of

the cup through an aperture in the cover plate **36** and actuates a gauge **78** to indicate the temperature within the cup. Associated with the gauge is a thermostatic control **80** of conventional character for turning the current to the resistance heater **72** on or off as may be needed in order to maintain the temperature within the cup at a selected value; the thermostatic control has an adjustment knob **82** for regulating the temperature at which the cup is to be maintained.

Also communicating with the interior of the cup when it is in place as shown in Fig. 1 is a vapor discharge tube **84** extending to a condenser of any suitable character, this having for convenience been illustrated in the drawing as a jacket **86** surrounding a portion of the tube with a cooling water inlet **88** and a water outlet **90** connected thereto; the condensed vapor may be collected in a conventional volumetric measuring device, for example, the graduate **92**.

It will be understood that if it is not desired to condense and collect vapor discharge from the cup **44** during the milling operation, tube **84** and the associated condenser can be omitted, in which case the vapor will discharge to atmosphere through the opening left in cover **36** by the removal of tube **84**; or, if desired, this opening can be plugged to keep the vapor within the sample cup **44**. The arrangement, as illustrated, however, is particularly useful in making determinations of the moisture content of grain or like substances, the procedure being as follows:

A known quantity of grain is placed in the sample cup along with a quantity of a liquid which is immiscible with water but which has a boiling point slightly above, but not too far removed from, that of water; for the latter I find it convenient to use orthodichlorobenzene or a blend of other naptha solvents having a boiling point of the order of 140° C. The quantity of liquid used is not critical but I prefer to use an amount approximately equal to the amount of grain. The cup is installed in my apparatus shown in Fig. 1 and the mill is placed in operation to comminute the grain and generate heat therein as has been previously described. Approximately five minutes operation without use of the heating jacket and a considerably shorter period of time using the heating jacket (the precise length depending upon the temperature maintained by means of the thermostatic control) will serve to vaporize all of the moisture originally contained in the grain and also vaporize the added immiscible liquid as well. The vapors leave the cup or test cell through the tube **34** and pass into the condenser, the condensate being collected in the graduate **92**. Due to the difference in specific gravity and immiscible character of the liquids, they will settle at different levels in the graduate, making it possible to easily determine the exact volume of water collected, and on the basis of this, it is possible to compute the moisture content of the original grain sample.

My purpose in using the orthodichlorobenzene or equivalent immiscible liquid is to wash from the condenser any water condensate that otherwise might remain therein in the form of dew collected on the inner wall of tube **84**, thereby to remove the possibility that the water collected in graduate **92** does not reflect the full amount of moisture contained in the grain. Thus, it will be evident that to accomplish the desired washing action the boiling point of the immiscible liquid should be at least as high and preferably a little higher than that of water in order that it will vaporize after all of the moisture in the grain has reached the condenser. If other means for washing residual water condensate from the condenser are used, it is of course unnecessary to add the immiscible liquid to the sample cup in the first instance, and the grain sample can instead be milled "dry." By the same token, the moisture content determination may be made with "dry" milling if the residual moisture remaining in the condenser is too little to affect the accuracy of the final measurement of the water collected in the graduate **92**, or if mathematical compensation is made for failure of any moisture vapor to reach the graduate.

While I have described the operation only as applied to determination of the moisture content of grain, it should be evident that if the material to be comminuted in my mill contains a volatile liquid other than water, the amount thereof likewise can be determined by the procedure described.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinbefore set forth, together with other advantages which are obvious and which are inherent thereto.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the appended claims.

Inasmuch as many possible embodiments of the invention may be made without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. In a laboratory mill, an openbottom housing having an apertured top, a suitable support for said housing positioned above the top thereof, a cup received in said housing, clamping means applying an upward thrust on said cup thereby to urge the rim thereof into seating engagement with the underside of said top, a vertical power-driven shaft journaled in said support and extending downwardly through the aperture in said top with its lower portion received in said cup, a milling blade on said lower portion of the shaft, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, the side wall of said housing comprising an annular skirt depending from said top and closely embracing the sides of the cup and centering same relative to said shaft, means in the side wall of the housing for heating said cup, and said clamping means being releasable to permit removal of the cup through the bottom opening of the housing.

2. A device as in claim 1 wherein said heating means comprises an electrical resistance having a source of electrical current connected thereto.

3. In a laboratory mill, an open bottom housing having an apertured top, a suitable support for said housing positioned above the top thereof, a cup received in said housing, clamping means applying an upward thrust on said cup thereby to urge the rim thereof into seating engagement with the underside of said top, a vertical power driven shaft journaled in said support and extending downwardly through the aperture in said top with its lower portion received in said cup, a milling blade on said lower portion of the shaft, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, the side wall of said housing comprising an annular skirt depending from said top and closely embracing the sides of the cup and centering same relative to said shaft, means in the side wall of the housing for cooling said cup, and said clamping means being releasable to permit removal of the cup through the bottom opening of said housing.

4. In a laboratory mill, an open-bottom housing having an apertured top, a suitable support for said housing positioned above the top thereof, a cup received in said housing, clamping means applying an upward thrust on said cup thereby to urge the rim thereof into seating engagement with the underside of said top, a vertical power-driven shaft journaled in said support and extending downwardly through the aperture in said top with its lower portion received in said cup, a milling blade on said lower portion of the shaft, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and inclose proximity thereto, the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, the side wall of said housing comprising an annular skirt depending from said top and closely embracing the sides of the cup and centering same relative to said shaft, said skirt containing a hollow cavity encircling said cup, fluid inlet and outlet ports in the skirt communicating with said cavity, and said clamping means being releasable to permit removal of the cup through the bottom opening of said housing.

5. In a laboratory mill, a cup, an upright post, an upper arm and a lower arm extending laterally from said post, one of said arms being swingably mounted on said post to travel in a generally horizontal arc between a first position and a second position, the outer ends of said arms being in vertical alignment in one of said positions, means for releasably clamping said cup between the outer ends of said arms when they are in vertical alignment, said means including, on the upper arm, a centrally apertured cover against which the rim of said cup seats, a power-driven shaft journaled in the upper arm and extending downwardly through the aperture in said cover, a single milling blade on the lower portion of the shaft received in said cup, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, and the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, and an annular housing concentric with said shaft and depending from said cover, said housing forming with said cover a downwardly opening cavity for receiving said cup and centering same relative to said shaft, said housing comprising a double-wall vessel containing a fluid, and said vessel having a fluid inlet and a fluid outlet to facilitate the circulation of fluid therethrough.

6. In a laboratory mill, a cup, an upright post, an upper arm and a lower arm extending laterally from said post, one of said arms being swingably mounted on said post to travel in a generally horizontal arc between a first position and a second position, the outer ends of said arms being in vertical alignment in one of said positions, means for releasably clamping said cup between the outer ends of said arms when they are in vertical alignment, said means including, on the upper arm, a centrally apertured cover against which the rim of said cup seats, a power-driven shaft journaled in the upper arm and extending downwardly through the aperture in said cover, a single milling blade on the lower portion of the shaft received in said cup, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, and the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, and an annular housing concentric with said shaft and depending from said cover, said housing forming with said cover a downwardly opening cavity for receiving said cup and centering same relative to said shaft, and means in said housing for cooling said cup when same is in the cavity.

7. In a laboratory mill, a cup, an upright post, an upper arm and a lower arm extending laterally from said post, one of said arms being swingably mounted on said post to travel in a generally horizontal arc between a first position and a second position, the outer ends of said arms being in vertical alignment in one of said positions, means for releasably clamping said cup between the outer ends of said arms when they are in vertical alignment, said means including, on the upper arm, a centrally apertured cover against which the rim of said cup seats, a power-driven shaft journaled in the upper arm and extending downwardly through the aperture in said cover, a single milling blade on the lower portion of the shaft received in said cup, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, and the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, and an annular housing concentric with said shaft and depending from said cover, said housing forming with said cover a downwardly opening cavity for receiving the cup and centering same relative to said shaft, and means in said housing for heating said cup when same is in the cavity.

8. A device as in claim 7 wherein said heating means comprises an electrical resistance having a source of electrical current connected thereto.

9. In a laboratory mill, a cup, an upright post, an upper arm and a lower arm extending laterally from said post, one of said arms being swingably mounted on said post to travel in a generally horizontal arc between a first position and a second position, the outer ends of said arms being in vertical alignment in one of said positions, means for releasably clamping said cup between the outer ends of said arms when they are in vertical alignment, said means including, on the upper arm, a centrally apertured cover against which the rim of said cup seats, a power-driven shaft journaled in the upper arm and extending downwardly through the aperture in said cover, a single milling blade on the lower portion of the shaft received in said cup, said blade comprising a unitary member having a plurality of arms extending radially from said shaft, each arm being in a plane generally parallel to the bottom of the cup and in close proximity thereto, and the leading edge of each arm being beveled to form an acute angle with the upper surface of the arm and an obtuse angle with the lower surface of the arm, and an annular housing concentric with said shaft and depending from said cover, said housing forming with said cover a downwardly opening cavity for receiving said cup and centering same relative to said shaft.

References Cited in the file of this patent

UNITED STATES PATENTS

165,442	Goddard	July 13, 1875
419,200	Kahlenberg	Jan. 14, 1890
848,616	Brown et al.	Mar. 26, 1907
982,765	Crisfield	Jan. 24, 1911
1,290,734	Goodhue	Jan. 7, 1919
1,392,116	Chopin	Sept. 27, 1921
2,078,190	Bemis	Apr. 20, 1937
2,361,844	Horner	Oct. 31, 1944
2,564,160	Jones	Aug. 14, 1951
2,665,724	Lundell	Jan. 12, 1954
2,710,743	Betry	June 14, 1955
2,734,728	Myers	Feb. 14, 1956