United States Patent

[11] **3,604,489**

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[21] Appl. No. **887,489**
[22] Filed **Dec. 23, 1969**
[45] Patented **Sept. 14, 1971**
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[54] **GRINDING MILL**
8 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **146/123,** 131/145, 131/149, 146/184, 241/291
[51] **Int. Cl.** **A24b 3/00**
[50] **Field of Search** ..... 146/117 R, 123, 129 A, 184, 220, 239, 242; 241/291; 76/101 A; 131/145, 149; 143/133; 29/95 A, 95 C, 95 D

[56] **References Cited**

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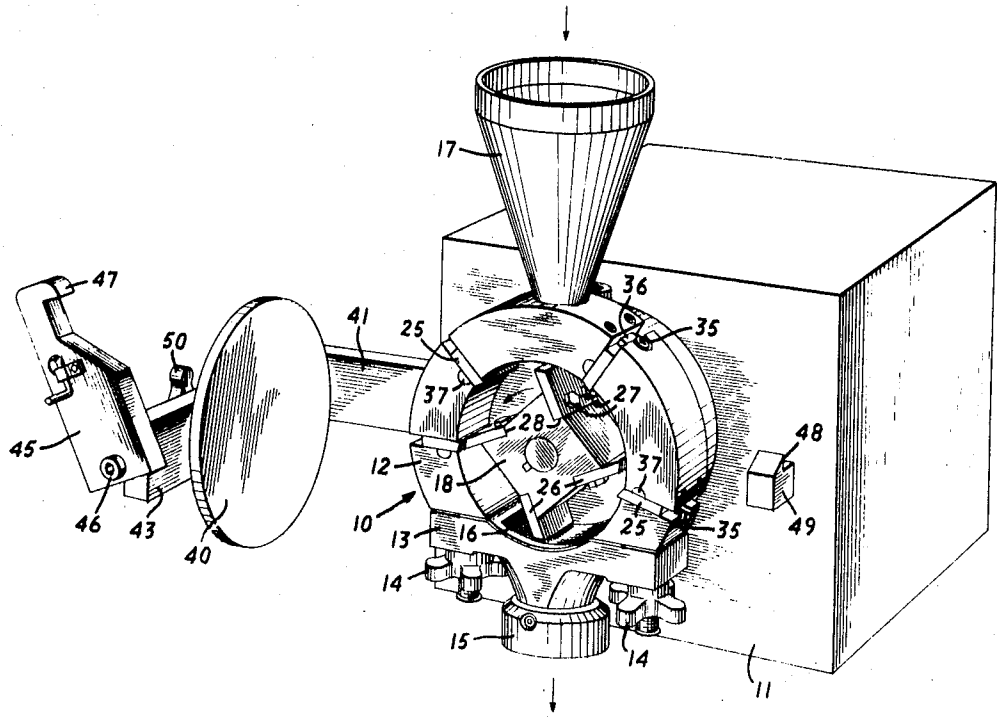
ABSTRACT: A grinding mill of a type adapted for grinding vegetable material such as samples of tobacco for analysis having the internal operating parts coated with a thin layer of a high temperature refractory metal compound highly resistant to abrasion and to adherence of the material thereto the compound being applied to the parts by cathodic sputtering.



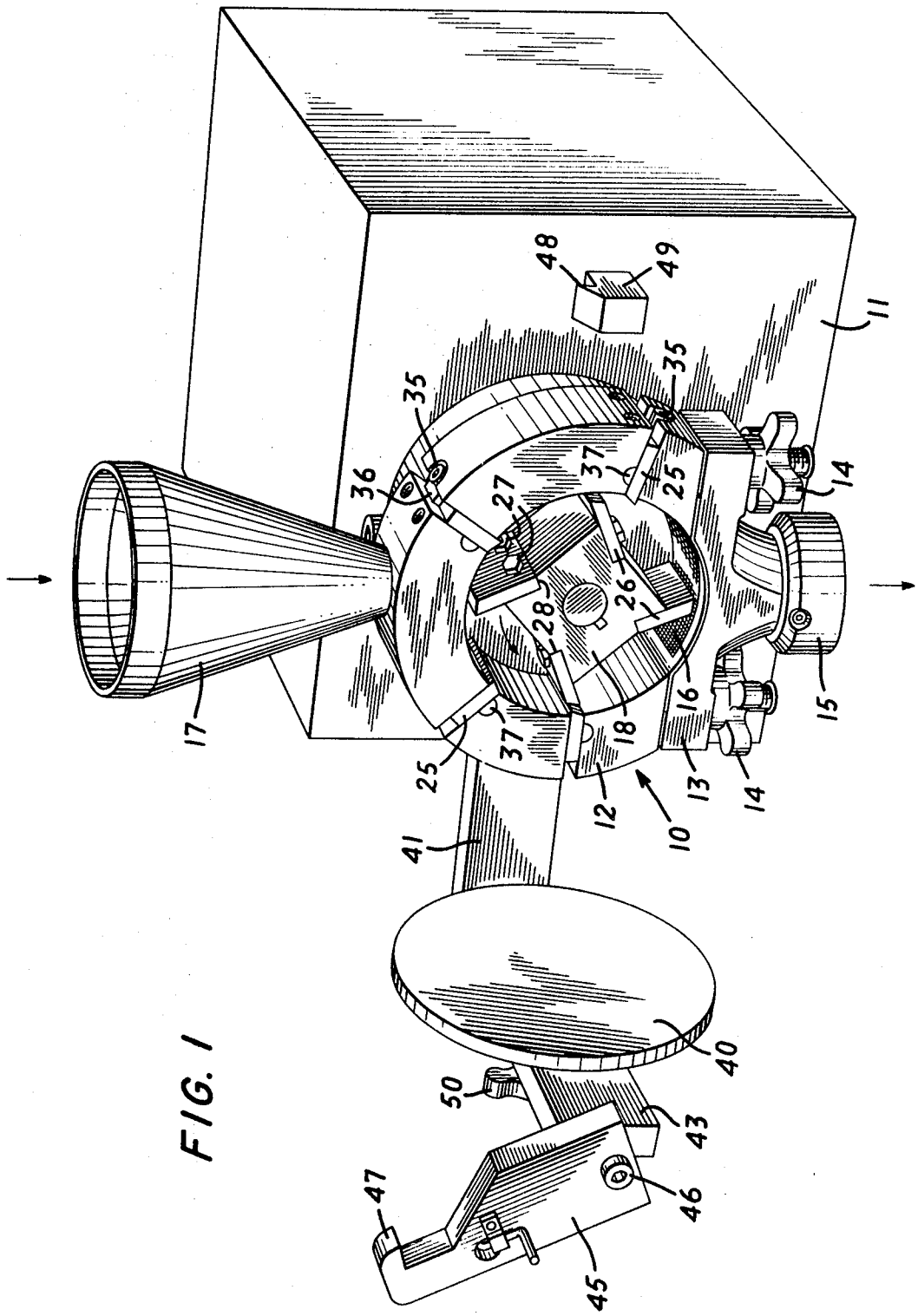

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FIG. 1

FIG. 2

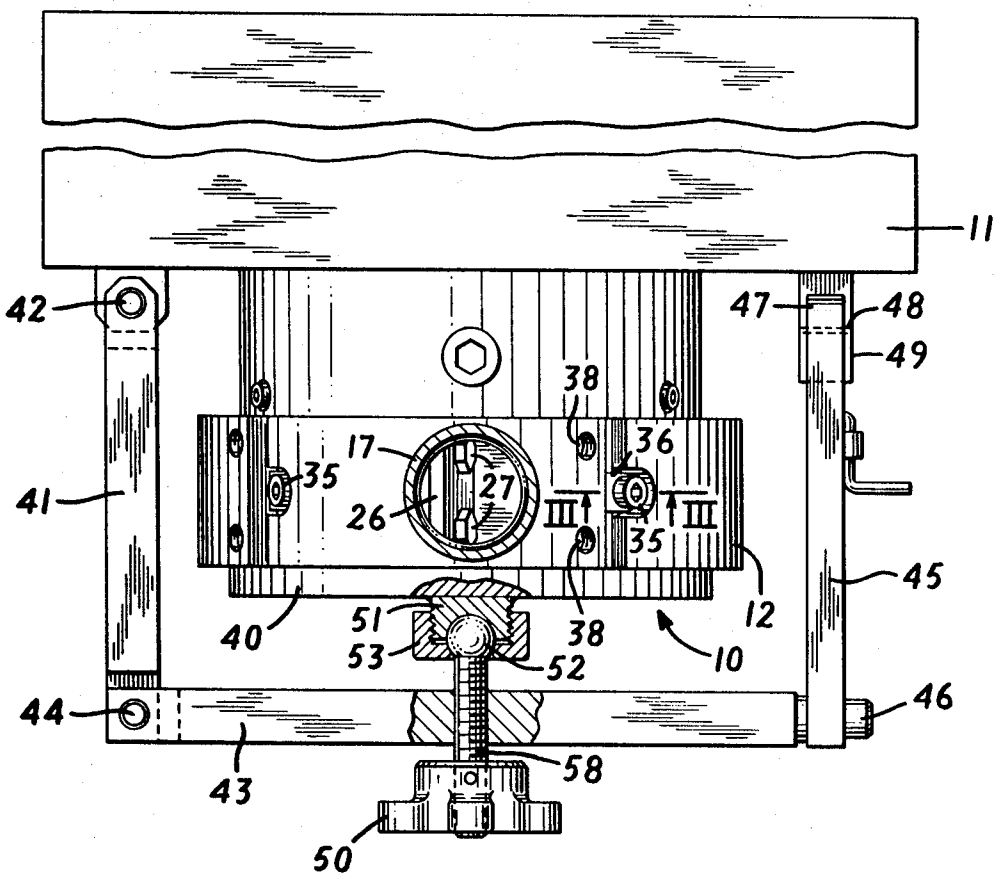
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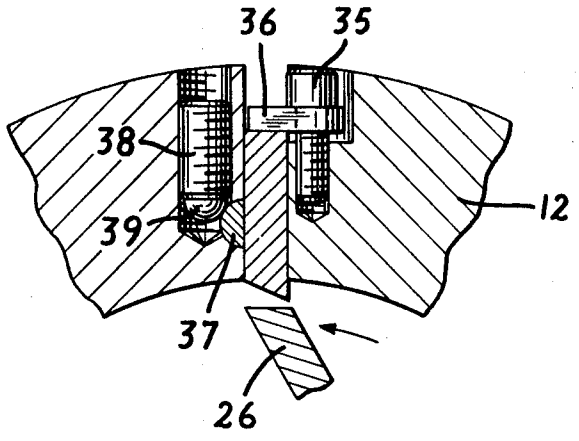
FIG. 3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GRINDING MILL

GENERAL DESCRIPTION OF THE INVENTION

In the selection, study and evaluation of tobacco of various types and grades by a tobacco company such as a manufacturer of cigarettes it is necessary to make analyses thereof to ascertain as accurately as possible the chemical composition and other characteristics of the tobacco. The tobacco is prepared for analysis by grinding small quantities to a suitable degree of fineness preliminary to laboratory testing. Many such processed samples are required in the constant study and selection of tobaccos. Certain difficulties were encountered in the past, however, in pursuing such a program. Contrary to what might be expected, tobacco materials are quite abrasive of the metal grinding surfaces due in part perhaps to the presence in some samples of sand particles. The resulting wear in addition to requiring frequent sharpening and adjustment of the blades caused contaminations of the ground samples by the metal particles eroded from the mill parts and consequent errors in the desired precise chemical analyses. Further difficulties resulted also from the fact that tobacco material strongly adhered to the grinding surfaces requiring that the mill be opened up and cleaned after each operation otherwise residue from one grinding would carry over into the next grinding. Because of the stickiness of the tobacco it was necessary to remove the coating by hand scraping the entire inside surface including particularly the exposed blade areas.

The present invention is directed to the remedy of the above problems and to the accomplishment of further advantages. It was found that the grinding surfaces could be coated with a high-temperature refractory compound which reduced the wear to a very small amount compared to that in an ordinary mill, thereby greatly increasing the useful number of grindings before sharpening and adjustment was required, reduced the grinding time, and reduced to a negligible amount the contamination of the tobacco with metal particles. A further and surprising advantage resulted when high-temperature refractory coating compounds of the character hereinafter described were employed in that the adherence of the normally sticky tobacco material to the grinding surfaces was practically eliminated so that cleanout operations between grindings could be easily accomplished by blowing with compressed air. Various specific coating compounds serve the purpose prominent among which is aluminum oxide. It is important that the coating layer be relatively thin particularly so as not to dull the blade edges. An especially practical method of coating, particularly to achieve a thin but complete and uniform layer, is by way of cathodic sputtering.

The invention is described particularly with reference to tobacco but it is adaptable for the grinding of other vegetable material such as grains, linseed, peanuts, fodder of various types, oil cake and vegetable materials in general which exhibit a tendency to stick to the metal parts and/or are abrasive in character.

The various features and advantages will be made more apparent from a consideration of a representative embodiment of the invention as described hereinafter and depicted in the drawings in which:

FIG. **1** is a perspective view chiefly in elevation of the complete mill with the front cover in open position;

FIG. **2** is a top plan view with the cover closed;

FIG. **3** is a fragmentary detailed cross-sectional view taken on the plane III—III of FIG. **2**.

The drawings disclose a grinding mill representative of the type adapted for the grinding of samples of vegetable material such as tobacco. The particular mill pictured is commercially available under the trade name THOMAS-WILEY. The mill **10** is mounted on a suitable support such as that indicated in general at **11** within which are located power driving and control means.

The mill **10** includes a body member **12** to which is secured a plate **13** by appropriate clamping means **14** the plate having a discharge chute **15** communicating with the interior of the mill through an arcuate screen **16** of preferably stainless steel, the arcuate shape conforming to the interior cylindrical form of the mill. Fixed to the upper part of the body is the cone-shaped supply chute **17**. Within the body member **12** is the rotor **18** rigidly supported in bearing means at the rear and connected to the driving means.

The rotor and body member are provided with cooperating shear elements comprising the stationary blades **25** fixed in the body member and the movable blades **26** mounted in the rotor. One set of the blades is made adjustable with respect to the other set to effect close cooperation and to compensate for wear. In the present mill the rotor blades **26** are rigidly clamped by bolts **27** in notches in the rotor at a suitable angle to the rotor axis the inner edges of the blades being engaged against a solid shoulder **28** in each case.

The stationary blades **25** are firmly clamped in adjusted position by means which may be of the character shown particularly in FIG. **3**. The blades are closely fitted in a generally radial slot and are forwardly adjustable by a setscrew **35** which carries a plate **36** engaged against the rear edge of the blade which is clamped in adjusted position by a half-round bar **37** the flat face being engaged against the rear surface of the blade and the rounded surface being engaged by a pair of setscrews **38** each having a ball-shaped end **39** forced into rigid contact with the rounded rear face of the bar **37**.

Access to the interior of the body member **12** may be had through a front cover or door **40** shown in open position in FIG. **1** suspended on a frame or linkage which includes a link **41** pivoted at **42** to the main support **11**. A bar **43** is pivoted at **44** to link **41**, the bar carrying the cover **40**. The outer end of bar **43** carries a latch member **45** adapted to swing in a vertical plane about the pivot pin **46** and carrying a hook shaped end **47** adapted to engage over the shoulder **48** of the lug **49** secured to the main support **11**. After the cover is swung into closed position and the latch **47**, **48** engaged the cover **40** may be clamped tight by any suitable means which in the present case comprises a stud **58** screw threaded through the bar **43**, the stud having secured to its outer end a hand knob **50** and its inner end having a universal ball joint connection to the cover **40** comprising a lug **51** secured to the cover having a socket to receive the ball **52** of the stud **58** which is secured in the lug **51** by a cup-shaped nut **53** threaded over the lug. In closing the mill the latch **47** is engaged with the plate **40** retracted and then the plate is clamped tight by operation of the knob **50**.

As hereto fore described a critical feature of the invention is the coating of the principal internal operating parts of the mill with a surface layer of material having exceptional wear resistance and freedom from adherence of the material to such parts.

Sources of surface coating materials suitable for the purpose principally include the high-temperature refractory compounds of transitional metals with oxygen, carbon, nitrogen and silicon metalloids. These materials are characterized by high melting points in the range of 1,500°–3,000° C., chemical inertness, high densities and extremely high hardness and resistance to wear.

The most common and readily available high temperature refractory metal oxide which has been found particularly effective is aluminum oxide ($A1_2\ O_3$). Others include chromic oxide and tantalum carbide.

Other high-temperature refractory compounds contemplated for use as coating materials include the interstitial compounds of the transitional metals with carbon, nitrogen and silicon, particularly the interstitial compounds of Groups V and VI metals. Representative interstitial metal carbides, nitrides and silicides are described in NATO Advisory Group for Aeronautical Research and Development Report No. 99, O. A. Sandven entitled "Cermets as Potential Materials for High Temperature Service." Specific interstitial metal carbides and nitrides contemplated as coating materials are carbides and nitrides of chromium, titanium and tungsten.

The coating should be uniform and complete over the critical working parts but thin particularly at the blade cutting edges. Sputtering has been found to be an effective and efficient method of accomplishing the desired results. Various types of sputtering apparatus are well known and available commercially for the purpose and the general principles are described in publications see e.g. Advances in Sputtering by Jack Hohenstein in Material Research, pages 81–86, Sept. 1968; and Sputtering by Gottfried Wehner in Science and Technology, pages 32–39, Sept. 1968. Reference may be had also to U.S. patents to Sinclair U.S. Pat. No. 3,139,396 and Blankenship U.S. Pat. No. 3,071,533. **A coating of** 2,000 angstroms up to perhaps 10,000 angstroms (1 micron) is considered a useful and practical range although a somewhat lower thickness than the top value mentioned is preferable particularly at the cutting edges in order to maintain the sharpness. A coating of about 5,000 to 6,000 angstroms is regarded as probably the most practical with most materials suited for the purpose. The parts to be coated of the mill disclosed herein comprise particularly the rotor, the curved wall of the body member or main housing and the exposed portions of the stationary and rotatable blades. It is desirable but not necessary to coat also the inside flat front and rear walls and the stainless steel screen at the outlet.

In one specific example all of the above parts except the screen and the inner surface of the cover were coated with aluminum oxide by cathode sputtering by conventional radio frequency technique and employing an aluminum oxide target. As is preferable in most cases the coating operation was preceded by a thorough degreasing of the parts and a reverse sputtering to further purify and degas the surfaces. The coating was about 5,000 to 6,000 angstroms in thickness. Samples of tobacco were ground in the coated mill and in a like but uncoated mill. After a series of samples, examination of the interior of the mills showed tobacco strongly adhering particularly to the blades of the uncoated mill such that considerable manual effort was required to remove the tobacco mass. In contrast thereto in the case of the coated mill any remaining tobacco material was readily removed by blowing from an air hose.

Blades for a mill in which 4 -ounce tobacco samples were ground were coated with aluminum oxide and gave a satisfactory grinding of 3,000 samples, whereas uncoated mills gave a maximum of about 900 grindings. In another mill employed for 1-pint, unthreshed samples (contaminated with sand), coated blades were good for 2,200 samples before replacement. Coated mills grind a tobacco sample in approximately half the time required by the uncoated mills, so that there is a further improvement in efficiency and saving of operator time.

It will be understood that the particular grinding mill shown in the drawings is representative only of grinding mills in which the invention may be embodied and that the coatings and method of application may vary and accordingly all descriptive matter should be interpreted as illustrative and not in a limiting sense.

We claim:

1. In a grinding mill adapted for grinding tobacco or other vegetable material, said mill having cooperating relatively movable metal shear elements, said elements having applied to the exposed areas thereof a thin coating of a hard, dense, abrasion wear and tobacco adhesion resistant high-temperature refractory compound of a transitional metal and a metalloid selected from the group consisting of oxygen, carbon, nitrogen and silicon.

2. A grinding mill according to claim 1 in which the high-temperature coating material is aluminum oxide, chromic oxide, or tantalum carbide.

3. A grinding mill in accordance with claim 2 in which the coating material is aluminum oxide.

4. A grinding mill according to claim 1 wherein the high-temperature refractory material is an interstitial compound of a transitional metal and a metalloid selected from the group consisting of carbon, nitrogen and silicon.

5. A grinding mill according to claim 4 wherein the transitional metal is a Group V or VI metal.

6. A grinding mill according to claim 4 wherein the interstitial compound is a nitride or carbide of chromium, titanium or tungsten.

7. In a grinding mill having a casing and a rotor mounted therein said casing having fixed shear blades and said rotor having shear blades movable adjacent the fixed shear blades the blades having cooperating complemental shear edges, at least the areas at and adjacent said shear edges having a thin coating of aluminum oxide.

8. A grinding mill in accordance with claim 7 in which the coating comprises a sputtered aluminum oxide.