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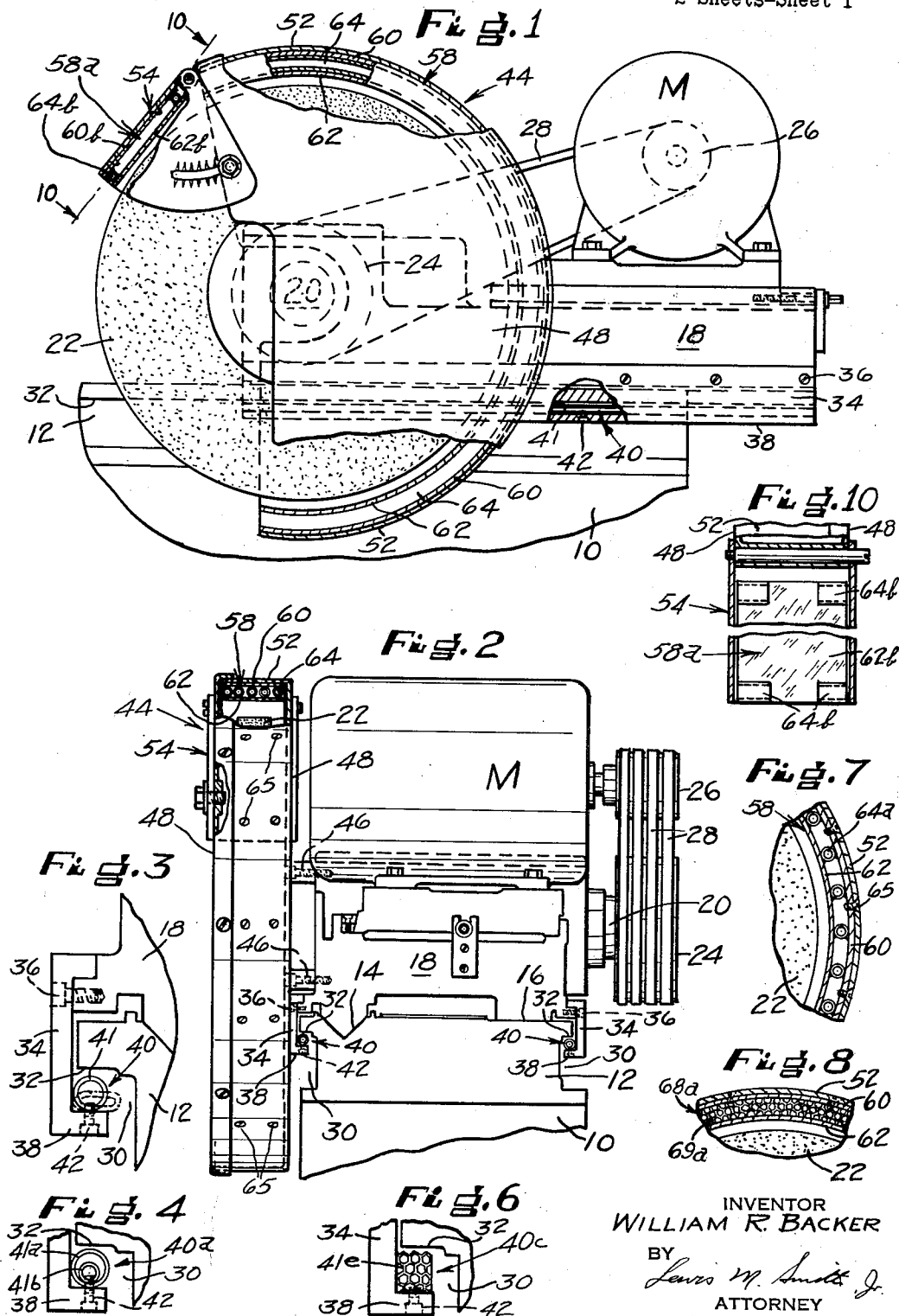
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3,129,537

PROTECTIVE DEVICE FOR GRINDING MACHINES

Filed July 31, 1961

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

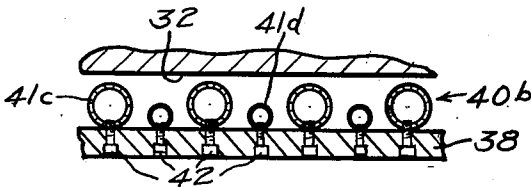


Fig. 5

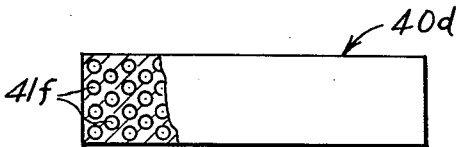


Fig. 9

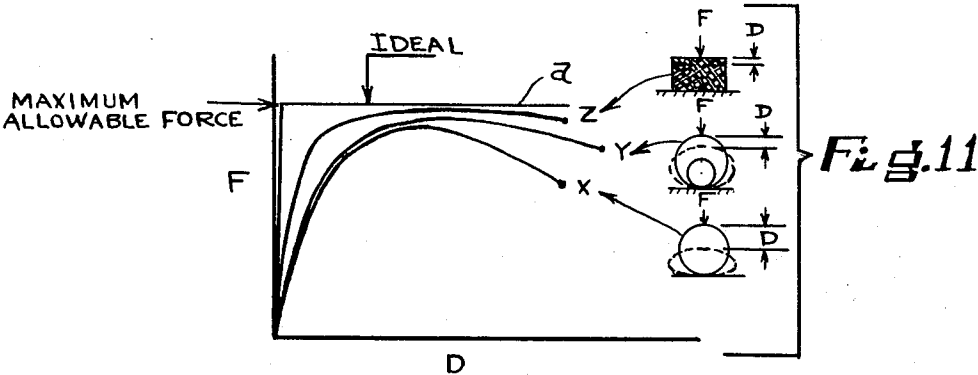
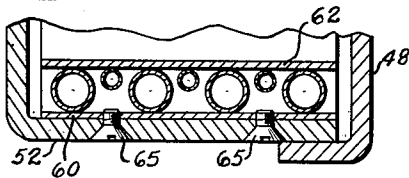


Fig. 11

Fig. 12



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PROTECTIVE DEVICE FOR GRINDING MACHINES

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35 Claims. (Cl. 51-166)

This invention relates to grinding machines and more especially to means for protecting the operator and the machine from wheel breakage.

It is customary to mount a heavy metal hood on the wheel slide over the wheel so that if fragments of the wheel break off, or the whole wheel disintegrates, the flying pieces will be constrained by the hood and hence will not injure the operator. With the constant improvements made in wheel construction and reinforcement, the speeds of rotation have been increased considerably and it is anticipated that even higher speeds will eventually be employed. The kinetic energy in a rotating wheel increases as the square of the speed hence if a high-speed wheel breaks a large amount of energy is released and the impact of the flying fragments on the hood is extremely high. The effect of the impact is two fold in that it may not only destroy the hood itself, thus adding parts of the hood to the flying fragments of the wheel, but may additionally actually lift the entire slide off its ways thus seriously damaging the grinding machine.

The principal objects of this invention are to provide means for allaying the destructive effect of the kinetic energy released by breaking of a high-speed grinding wheel, both for the purpose of preventing destruction of the wheel hood and preventing dislodgement of any of the movable parts of the machine; to provide means which will substantially nullify the forces of impact without rebound; to provide means which can be readily incorporated in an existing machine without extensive modification of the latter and which will not interfere with its normal operation; to provide means which can easily be renewed after it has served its purpose; and to provide means which is of inexpensive construction.

As herein illustrated, the machine is provided with a support having horizontally disposed ways and a wheel slide mounting a wheel and hood therefor, for translational movement of the wheel relative to a work support. The invention resides in providing deformable means arranged to dissipate the kinetic energy of the fragments of the wheel as they strike the inside surface of the hood. Since the impact forces imparted to the inside of the hood have components perpendicular to the ways supporting the slide, the invention resides, on the one hand, in dissipating the lift imparted to the wheel slide by impact of the fragments with the inside of the hood and, on the other hand, preventing destruction of the hood itself. To nullify the lift, interlapping guides are provided on the slide and support adjacent the ways and deformable means are disposed between them. For the purpose of preventing destruction of the hood itself, additional deformable means are placed within the hood against its inner wall and peripherally of the wheel. The deformable means may be in the form of hollow collapsible elements, for example one or more rigid metal tubular members which will crush without rebound. The tubular members may be arranged side-by-side with their axes lengthwise or crosswise of the guide or the inside of the hood, may be of different diameters so as to operate successively, or may be integrated so as to operate collectively. Optionally, the deformable member may be a rigid skeletal-like structure, deformable by collapse of internally situated openings to dissipate the energy of im-

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pact. The dissipater in any of its several forms may be removably fastened to the guides or to the inside of the hood so that when damaged it can be replaced.

It is usual to have a cover at the front of the hood and shock-dissipaters of the kind referred to above may be fastened to its inner side to dissipate impact sustained by the cover.

The invention will now be described in greater detail with reference to the accompanying drawings wherein:

FIG. 1 is a side elevation of a grinding machine showing a support, a wheel slide mounting a wheel enclosed within a hood, a motor, and ways on the support supporting the wheel slide for translational movement, the wheel slide, hood and cover being sectioned in part to show one form of energy dissipater means;

FIG. 2 is an elevation as seen from the right side of FIG. 1 showing the energy dissipating means for the wheel slide and the hood, the latter being broken away in part to show the wheel and the energy dissipating means within the hood in section;

FIG. 3 is a fragmentary elevation taken transversely of the machine at one side, showing the guideways for the wheel slide and support to much larger scale and the form of energy dissipater illustrated in FIGS. 1 and 2;

FIG. 4 is a fragmentary elevation corresponding to FIG. 3, showing another form of dissipater;

FIG. 5 is a fragmentary elevation longitudinally of the machine showing the guideways at one side of the machine and another form of dissipater;

FIG. 6 is a fragmentary elevation corresponding to FIG. 3, showing still another form of dissipater;

FIG. 7 is a fragmentary vertical section taken through the hood at right angles to the axis of the wheel, showing a portion of the wheel and a removably attached dissipater similar to that shown in FIGS. 1 and 2, but with its components disposed crosswise;

FIG. 8 is a fragmentary vertical section through the hood, showing a portion of the wheel and a dissipater similar to that shown in FIG. 6, but with its components disposed crosswise;

FIG. 9 is a section through a dissipater having a rigid skeletal-like structure containing internal openings;

FIG. 10 is a section taken on the line 10-10 of FIG. 1, showing a form of dissipater for the inside of the cover;

FIG. 11 is a graph of force versus deflection, illustrating the dissipation of energy by a single tube, a tube within a tube, and an integrated honeycomb structure; and

FIG. 12 is a fragmentary transverse section through the hood showing a modification of the energy dissipater illustrated best in FIG. 2 in which the tubular members are of different diameters.

Referring to the drawings, there is shown a machine support 10 to which there is bolted a bearing block 12 having at its upper side V-shaped and flat ways 14 and 16 for slidably receiving a wheel slide 18. The wheel slide 18 has mounted on it, in suitable bearings, a wheel spindle 20, to one end of which is fixed a grinding or cutting wheel 22 and to the other end of which is fixed a pulley 24. A motor M is mounted on the wheel slide and has fixed to its drive spindle a pulley 26 which is drivably connected to the pulley 24 by belts 28 entrained about the two pulleys.

The bearing block 12 has at its opposite sides, parallel to the ways 14 and 16, horizontally disposed grooves 30-30, so situated as to provide, near the upper edges of the block, horizontally disposed shoulders 32-32. A pair of channels 34-34 are fastened to the opposite sides of the slide 18 by bolts 36 and each channel has a flange 38 at its lower edge which projects into the groove 30 beneath the lower shoulder 32 in spaced relation thereto. The shoulders and channels collectively provide interlap-

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ping guides which normally do not have contact and hence do not interfere with the feeding movement of the slide.

In accordance with this invention, a shock-dissipating device 40 (FIGS. 1, 2 and 3) is placed between each lower shoulder 32 and the flange 38 of the channel. The shock-dissipator is removably secured to the flange 38 by bolts 42 so that after it has served its purpose it may be removed and replaced and normally does not have contact with the shoulder 32 and hence does not interfere with translational movement of the slide on the bearing block. As herein shown, the shock-dissipator is in the form of a tubular member 41 (FIG. 3) comprised of a material which will deform or crush under high pressure without rebound, as shown in dotted lines (FIG. 3). For example, the tubular member may be comprised of metal embodying substantially no elasticity so that the application of high pressure will merely crush it. The function is to dissipate the kinetic energy released by the disintegration or breaking up of a high-speed wheel.

Alternative shock-dissipators 40a, 40b and 40c are shown in FIGS. 4, 5 and 6. The dissipater 40a (FIG. 4) comprises an outer tube 41a and an inner tube 41b fastened to the flange 38 by bolts 42. The effect of such an arrangement is that the initial impact is taken up by the outer tube up to its point of failure whereupon the inner tube takes up the balance of the impact thus providing for dissipating the impact in successive steps. The tubes 41a and 41b are shown as disposed with their long axes extending lengthwise of the way however short tube sections may be disposed transversely thereof with good results. The dissipater 40b (FIG. 5) comprises tubes 41c and 41d of different diameter, disposed in spaced parallel relation to each other so as to act successively to dissipate the energy by crushing of the tubes of larger diameter first and those of smaller diameter thereafter. As shown in FIG. 5 they are arranged crosswise of the guides. The absorber 40c (FIG. 6) is comprised of a plurality of tubes 41e, for example an integrated honeycomb structure disposed with the long axes lengthwise of the way or transversely thereof.

Optionally, a rigid skeletal-like structure 40d (FIG. 9) may be used which contains a plurality of internal openings 41f. Such an element may be made by drilling holes through a solid block or by integrating a powdered metal with a filler which can be burned out or dissolved to leave internal voids.

The wheel is enclosed within a hood 44 (FIGS. 1 and 2) fastened by bolts 46—46 to the wheel slide 18 and comprises spaced parallel side walls 48—48 and a peripheral wall 52. The hood is open at one side and has a cover 54 hinged to the upper end of the opening. In accordance with this invention, a shock-dissipator 58 is disposed within the hood against the inner surface of the peripheral wall 52 about the wheel. The dissipater 58 (FIGS. 1 and 2) comprises a sandwich of metal strips 60 and 62 between which are situated a plurality of tubular members 64 to which the strips 60 and 62 are attached in suitable fashion, for example by welding, brazing or the like. The tubular members 64 are similar to the tubular members 41 employed between the shoulders 32 and flanges 38 on the bearing block of the machine and are adapted to be deformed or crushed by impact. The strip 60 may actually constitute the peripheral wall of the hood. The strip 62 should be of sufficiently hard metal to withstand the impact of flying fragments. The unit is designed to extend all of the way around the hood, that is, from the upper end of the opening, at the forward side, rearwardly about the rear side, to the lower end of the opening.

The dissipater may, as previously described, take various forms and when tubular in make-up may be disposed with the long axes of the tubes peripherally of the wheel within the hood, as shown in FIG. 2, or transversely thereof, as shown in FIG. 7, with tubes 64a welded between the strips 60 and 62 and fastened to the inside of the

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hood by bolts 65. Tubes of different diameter may be employed to provide for taking up the impact in successive steps, as previously mentioned, by disposing them lengthwise or crosswise of the inside of the hood, as shown in FIG. 12.

In FIG. 8 there is shown a dissipater 68a in the form of a honeycomb of integrated tubes 69a disposed with their axes extending crosswise of the hood. The honeycomb structure could be used lengthwise of the hood in the same fashion as used with the guides (FIG. 6).

Optionally, a skeletal-like structure (FIG. 9) may be employed comprising, for example, a block 40d containing a plurality of openings 41f through it or a sintered body of high porosity.

Correspondingly constructed dissipaters 58a are applied to the inner side of the cover 54. Thus, as shown in FIGS. 1 and 10, tubes 64b are welded between metal strips 60b and 62b. Obviously, these tubes could be placed lengthwise or crosswise of the cover and any one of the structures related above could be substituted therefor.

The shock-dissipators function by taking up the kinetic energy developed by the breaking wheel in such a manner as not to redirect the energy in any other direction. The dissipaters are designed, in particular, to absorb the components of the forces of impact which are perpendicular to the slide and which thereby tend to lift the slide off the bearing block and those which are radial and which tend to destroy the hood. By use of the dissipaters, as described, the impact transmitted to the inner side of the hood and through it to the slide is cushioned both in the hood and on the slide by deformation or collapse of the material of which the dissipaters are compounded. FIG. 11 shows three curves x, y and z which, respectively, illustrate the dissipation of energy by means of a single tube, tubes of different diameter, and a honeycomb of tubes respectively. The curves are plotted with abscissa as force and ordinate as deflection with reference to the maximum allowable force represented by the line a.

It is evident that when the longitudinal axes of the tubular members or structure are placed peripherally of the wheel within the hood they provide added resistance to impact due to the fact that energy is used both in stretching the members as well as crushing them.

The present disclosure is for the purpose of illustration only and, in particular, illustrates the broad principle of dissipating kinetic energy developed by explosion of a high-speed grinding or cutting wheel by deformation of one or more deformable elements and, more particularly, to the use of deformable elements which are deformable in compression. The use of deformable elements for dissipating kinetic energy deformable in tension are disclosed in my copending application Serial No. 128,077, filed July 3, 1961.

I claim:

1. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support and a cushion element disposed between the parallel portions of the guides, yieldable under pressure in response to forces tending to lift the slide from its ways.

2. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and deformable elements disposed between the interlapping portions of the guides deformable by forces tending to lift the slide relative to its ways.

3. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping

guides on the wheel slide and support and energy dissipating elements disposed between the interlapping portions of the guides operable to resist lifting of the slide relative to the ways.

4. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and tubular elements disposed between the interlapping portions of the guides, said elements being adapted to collapse at a pressure sufficient to lift the slide from its ways.

5. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of tubes disposed between said parallel portions of the guides deformable successively by forces tending to lift the slide from its ways.

6. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of tubes of different diameter disposed between the parallel portions of the guides deformable successively by forces tending to lift the slide away from its ways.

7. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and tubes of different diameter situated one within the other disposed between the parallel portions of the guide deformable successively by forces tending to lift the slide relative to its ways.

8. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and hollow elongate members disposed between the parallel portions of the guides with their axes lengthwise thereof, said members being deformable by forces tending to lift the slide relative to its ways.

9. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and hollow elongate members disposed between said parallel portions of the guides with their axes crosswise thereof, said members being deformable by forces tending to lift the slide relative to its ways.

10. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of hollow elongate members disposed between the guides with their axes crosswise thereof, said hollow members being deformable successively under pressure tending to lift the slide away from its ways.

11. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, a plurality of hollow members disposed between the guides with their axes lengthwise of the ways operable collectively, by deformation, to dissipate the energy of impact.

12. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational move-

ment relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of integrated hollow members disposed between the parallel portions of the guide operable collectively, by deformation, to dissipate the energy of impact.

13. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of integrated hollow members disposed between the interlapping portions of the guide with their axes lengthwise thereof, operable collectively, by deformation, to oppose lifting of the slide away from its ways.

14. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and a plurality of integrated hollow members disposed between the parallel portions of the guides crosswise thereof which collectively operate, by deformation, to oppose lifting of the slide away from its ways.

15. In a grinding machine, a support, a wheel slide mounting a wheel and a hood therefor, ways on the support supporting the wheel slide for translational movement relative to the work, spaced parallel interlapping guides on the wheel slide and support, and energy dissipating means disposed between the interlapping portions of the guides comprising a sandwich of a pair of strips and a plurality of tubular members disposed between them and attached thereto.

16. In a grinding machine, a support having horizontally disposed ways and subjacent thereto horizontally disposed shoulders, a wheel slide mounting a wheel and a hood, resting on the ways, anchoring elements fixed to the slide having portions underlying the shoulders, and energy dissipating means disposed between the shoulders and the portions of the anchoring elements underlying the shoulders.

17. In a grinding machine, a support having horizontally disposed ways and subjacent thereto horizontally disposed recesses providing undercut shoulders paralleling the ways, an anchoring element fastened to the slide at each side, each anchoring element having a flange projecting into the groove at that side beneath the shoulder, but being spaced downwardly therefrom, and cushion elements disposed in the spaces between the flanges and shoulders, said cushion elements being fastened to the flanges.

18. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work, said hood enclosing the wheel, and a plurality of elongated hollow permanently deformable members of different diameters disposed about the inside of the hood with their axes disposed circumferentially of the wheel sequentially effective by permanent deformation thereof to dissipate energy released when a wheel breaks.

19. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, and an integrated plurality of elongated hollow permanently deformable members disposed about the inside of the hood with their axes disposed crosswise of the periphery of the wheel effective by permanent deformation thereof to dissipate energy released when a wheel breaks.

20. An expendable energy dissipater comprising a plurality of hollow tubular members of different diameters all open to the atmosphere and disposed side-by-side in spaced parallel relation between a pair of flat strips and secured thereto, operable by permanent deformation of the tubular members in response to high impact force components normal to the flat strips.

21. An expendable energy dissipater for a machine tool having a high speed cutting tool comprising a composite permanently deformable skeletal structure partially enclosing a plurality of internal air spaces and shaped to be disposed between spaced relatively movable elements of a machine tool without restricting the relative movement of the spaced machine tool elements under normal operating conditions, and releasable means for securing said skeletal structure to one of the spaced machine tool elements so that relative movement of one machine tool element toward the other machine tool element in the event of cutting tool failure is cushioned by permanent deformation of said skeletal structure.

22. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, and an elongated energy dissipating element disposed around the circumference of the wheel and secured fixedly to the inner surface of the hood, said energy dissipating element including permanently deformable tubular elements everywhere adjacent to the inner surface of the hood, and a continuous liner disposed against the inner sides of the tubular elements for receiving the impact of the fragments of a broken wheel and for dissipating the energy of impact by permanent deformation of the tubular elements.

23. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, and an energy dissipating element disposed peripherally of the wheel within the hood, said energy dissipating element comprising a plurality of permanently deformable tubular elements fixedly secured to the inner surface of the hood, and a continuous liner strip attached to the inner sides of the tubular elements.

24. In a grinding machine, a wheel slide mounting a wheel and a circular hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, a circularly curved sandwich member disposed within the hood against its inner surface peripherally of the wheel, said member being comprised of two strips of sheet metal attached to the opposite sides of a plurality of permanently deformable metal tubes disposed therebetween, and means fixedly securing said member to said hood.

25. In a grinding machine, a wheel slide mounting a wheel and a rigid hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood having a front opening giving access to the wheel and a rigid hinged cover partially closing the upper part of the opening, and a permanently deformable energy dissipating device substantially coextensive with and fastened to the inside surface of the cover.

26. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, ways supporting the wheel slide for translational movement relative to the work to be ground, said hood enclosing the grinding wheel to constrain wheel fragments released if the grinding wheel breaks, and including solid deformable means fixedly secured to the inside surface of the hood operable, by permanent deformation of said means due to the impact of the wheel fragments against said means constrained by the hood, to dissipate the energy of the impact.

27. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, ways supporting the wheel slide for translational movement relative to the work to be ground, said hood enclosing the grinding wheel to constrain wheel fragments released if the grinding wheel breaks and including a plurality of solid deformable means fixedly secured against the inside surface of the hood and operable successively, by permanent deformation of said means due to the impact of the frag-

ments against said means constrained by the inside surface of the hood, to dissipate the energy of the impact.

28. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, ways supporting the wheel slide for translational movement relative to the work to be ground, said hood enclosing the grinding wheel to constrain wheel fragments released if the grinding wheel breaks and including a plurality of solid deformable means fixedly secured to the inside surface of said hood operable collectively, by permanent deformation due to the impact of wheel fragments against said means constrained by the inside surface of the hood, to dissipate the energy of impact.

29. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, ways supporting the wheel slide for translational movement relative to the work to be ground, said hood enclosing the grinding wheel and being adapted to constrain wheel fragments released in the event the grinding wheel breaks, the impact of some of which impart forces which tend to lift the wheel slide from its ways, and solid deformable means fixedly secured to the inside of said hood operable by permanent deformation of said means in response to such impact forces to dissipate said energy of impact tending to lift the wheel slide from its ways.

30. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, said slide supporting the grinding wheel for translational movement relative to the work, said hood enclosing the grinding wheel, and a plurality of elongated hollow permanently deformable members fixedly secured to the inside of the hood with their axes disposed circumferentially of the grinding wheel effective in combination with the hood by permanent deformation of said members to dissipate energy released when the grinding wheel breaks.

31. In a grinding machine, a wheel slide mounting a grinding wheel and a hood therefor, said slide supporting the grinding wheel for translational movement relative to the work, said hood enclosing the grinding wheel, and a plurality of elongated hollow permanently deformable members fixedly secured to the inside of the hood with their axes disposed transversely of the periphery of the grinding wheel effective in combination with the hood by permanent deformation of said members to dissipate energy released when a grinding wheel breaks.

32. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, and a plurality of elongated hollow permanently deformable members of different diameters fixedly secured to the inside of the hood with their axes disposed crosswise of the periphery of the wheel sequentially effective by permanent deformation of said members to dissipate energy released when a wheel breaks.

33. In a grinding machine, a wheel slide mounting a wheel and a hood therefor, said slide supporting the wheel for translational movement relative to the work and said hood enclosing the wheel, and an integrated plurality of elongated hollow permanently deformable members fixedly secured to the inside of the hood with their axes disposed circumferentially of the wheel effective by permanent deformation of said members to dissipate energy released when a wheel breaks.

34. An expendable emergency energy dissipater for a machine tool having a high speed cutting tool comprising a hollow skeletal structure made of solid material resistant to permanent deformation and shaped to fit between and fixedly secured in engagement with the surface of one of opposed spaced relatively more rigid elements of a machine tool subject to abrupt mutual engagement in the event of cutting tool breakage so that energy released by cutting tool breakage is dissipated by permanent deformation of said skeletal structure.

35. An expendable emergency energy dissipater for a

machine tool having a high speed cutting tool comprising a hollow skeletal structure made of solid material resistant to permanent deformation and shaped to fit between spaced elements of a machine tool subject to abrupt mutual engagement in the event of cutting tool breakage, said hollow skeletal structure being provided with elongated internal openings therethrough disposed generally parallel to the surface of at least one of the machine tool elements adjoining said skeletal structure, so that energy released by cutting tool breakage is dissipated by permanent deformation of said skeletal structure.

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