

[54] SAFETY GUARDS FOR GRINDING WHEELS

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51/238 R; 144/251

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[57]

ABSTRACT

A safety guard for grinding wheels comprising a solid outer shield provided upon its inner periphery with resiliently deformable segments and an inner shield adapted to close over the grinding wheel provided upon its outer periphery also with resiliently deformable segments. The inner closing shield is rotatably seated within the solid outer shield and the deformable segments and are arranged alternatively, one by one, in pairs to provide slidable supports for maintaining the shields in radial spaced relationship.

9 Claims, 4 Drawing Figures

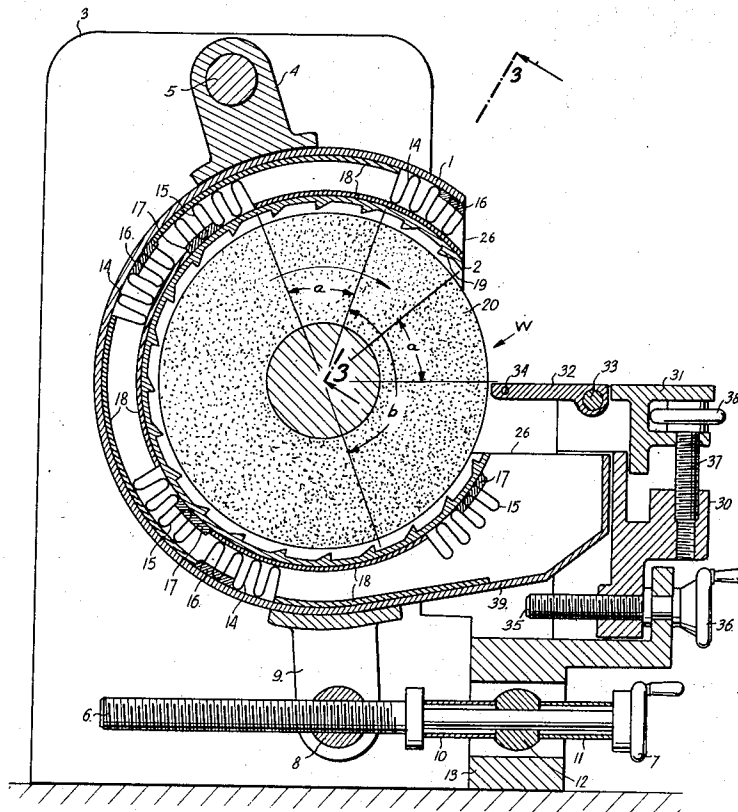


Fig. 1

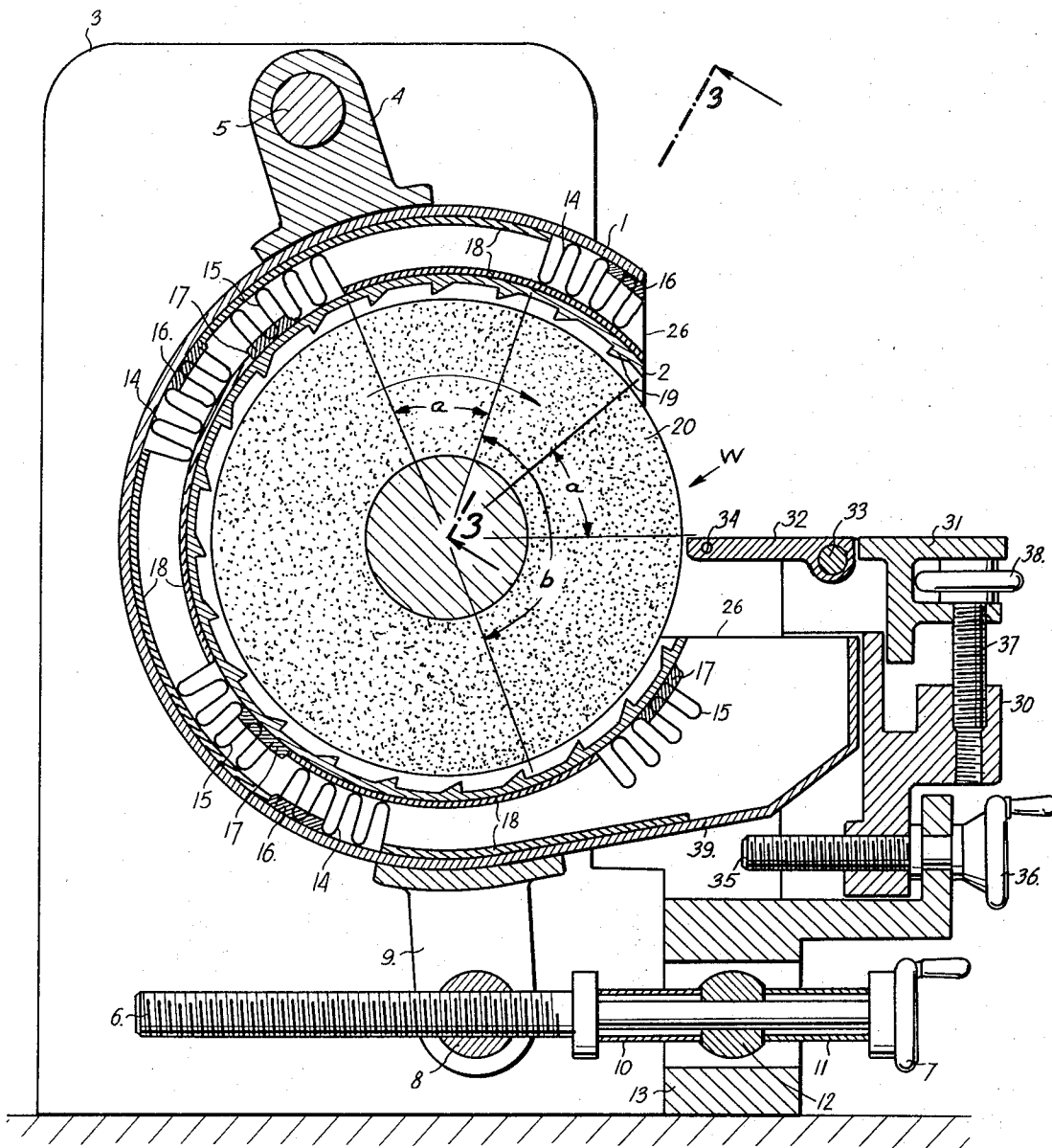
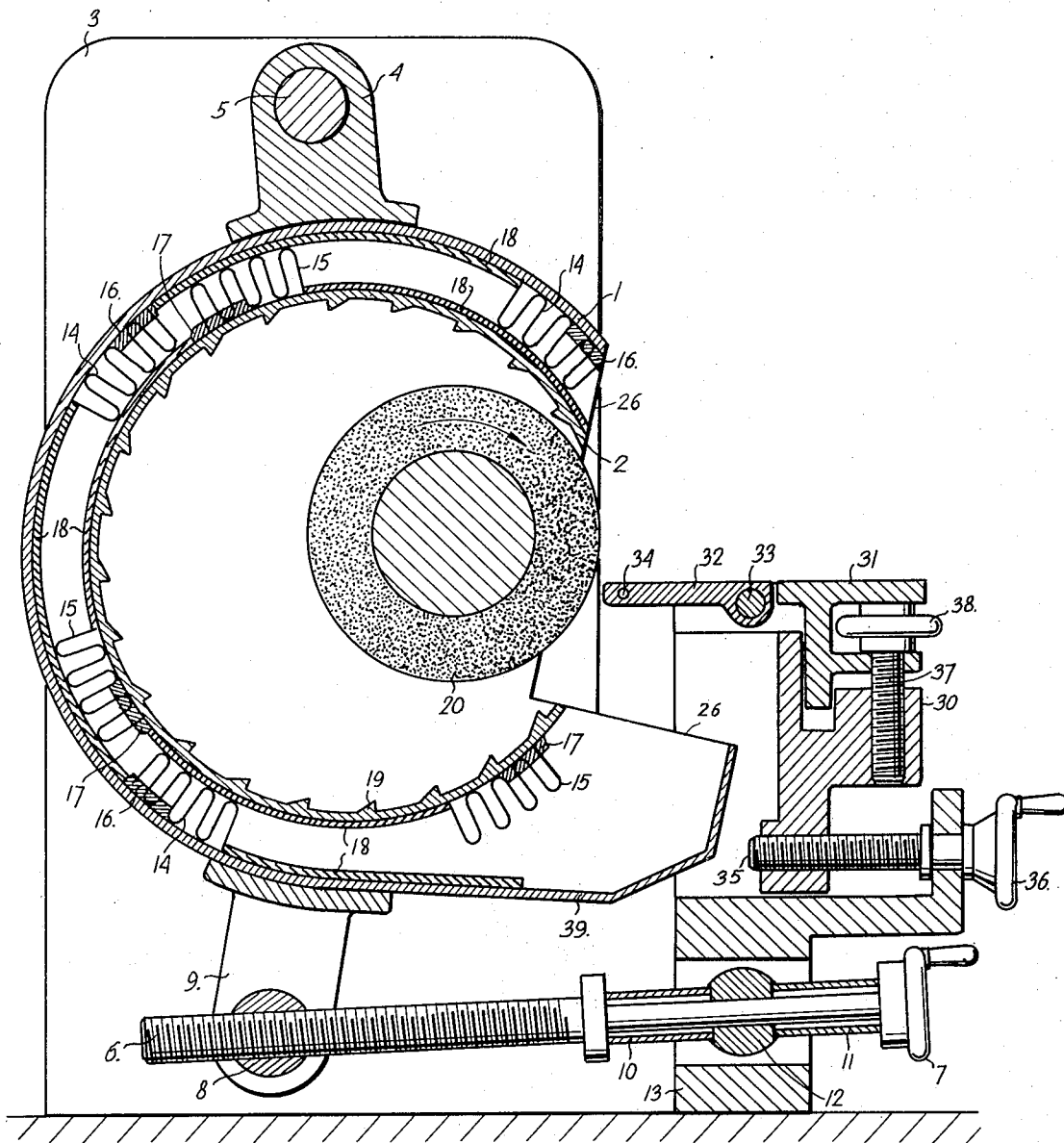
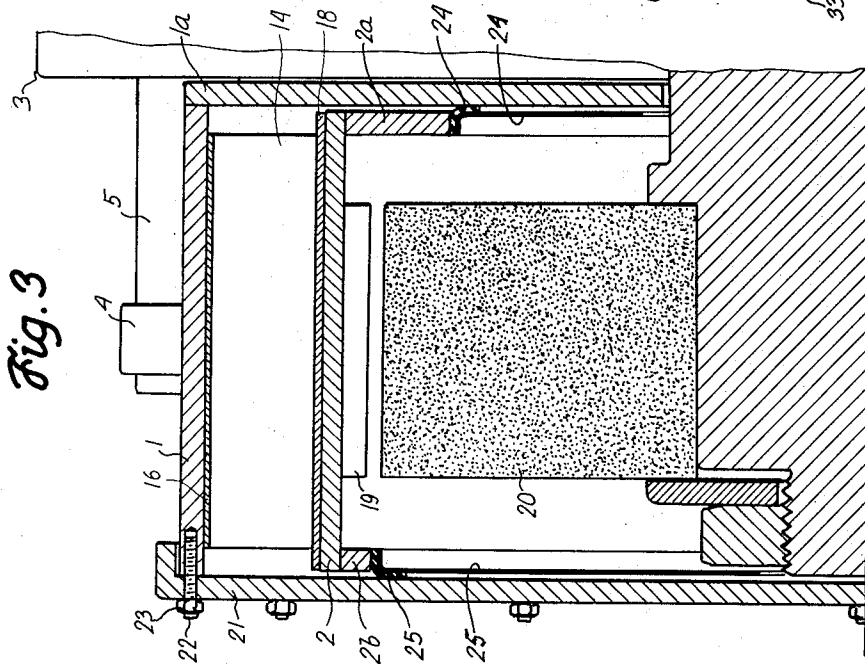
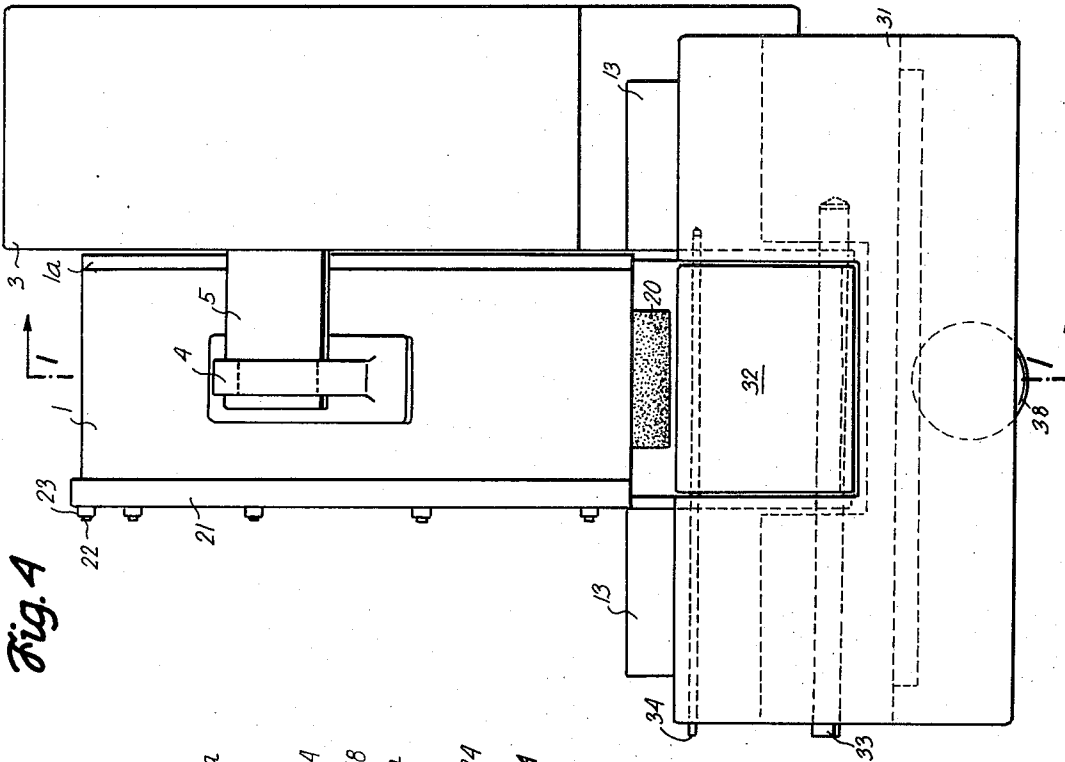


Fig. 2





SAFETY GUARDS FOR GRINDING WHEELS

BACKGROUND OF INVENTION

This invention relates to apparatus for safeguarding machine tools and particularly to a safety guard for grinding machines.

The development of high speed grinding and the like has brought a number of technological and economic advantages to the machine tool art. This is particularly true in the development of high speed grinding machines. The development, however, requires that a number of safety measures be taken for the protection of the operator and of the machine itself, since the kinetic energy of a rotating grinding wheel, as well as the danger of its breaking, substantially increases with the increase in speed. The conventional safety guards for such machines are not suitable for high speed grinding machines since the angle of the guard opening (into which the workpiece is inserted) is too great (up to 65°) and, furthermore, they are relatively rigid and stiff. The large angle of guard opening enables grinding and wheel fragments to be freely cast out of the machine, resulting in great and often deadly injury to the operator. The rigidity and stiffness of the conventional guards prevent the absorption of kinetic energy so that if the grinding wheel is ever broken, total damage and destruction of means for holding the safety guard occurs, resulting in the breaking of the guard itself and possible damage to the machine and operator. On the other hand, the force may be transferred onto the head stock of the machine damaging it or the workpiece feed mechanism.

Recently, attempts have been made to overcome the above disadvantages by totally covering the wheel in order that any fragment of the broken grinding wheel could not be cast out. In order that the huge kinetic energy of the broken wheel could be absorbed, such guards were also provided on their inner surfaces with deformable means and layers (for example, of corrugated steel sheet, tubular members, plastic layers etc.) by which the impact of broken fragments onto the guard could be absorbed. This concept, however, was only useful with such arrangements where hand-manipulation of a workpiece was not required. In pedestal type grinding machines, for example, a hand grinding or manipulation cannot be omitted and the rotating grinding wheel cannot be fully covered by a safety guard.

Safety guards having automatic inner closing members, automatically movable on impact of fragments to close the machine have been tried. Guards of this type, however, are disadvantageous mainly in the fact that they are constructed as stiff bodies and do not absorb the kinetic energy of the broken grinding wheel. The inner closing shield encircles the grinding wheel only round a small part of its periphery and the efficiency of automatic closing and, consequently, the safety of the whole guard, are relatively small. Furthermore, guards of this type do not readily entrap the first fragments cast off from the broken wheel since such fragments are, at the moment of breaking up of the wheel, within the open area of the guard and thus freely fly out of the guard in a tangential direction. This fact is very important especially with pedestal type grinding machines which, moreover, must be constructed with an open workpiece rest, positioned in front of the grinding

wheel at the distance of 3mm. The known workpiece rests are of rigid construction and if they are positioned in front of the grinding wheel, the flying fragments of the broken grinding wheel can be deflected by it against the operator. The workpiece rest also prevents the guard from being closed. The known guards of this latter type are disadvantageous also in the fact that it is impossible to adjust the guard during the grinding process to close the opening according to wear of the grinding wheel and to compensate for the decreasing size of the wheel. Thus, its functional efficiency is also decreased.

It is an object of the present invention to provide a safety guard for grinding which the disadvantages of the known arrangements are overcome.

Additional objects and advantages will be seen in the following disclosure.

SUMMARY OF THE INVENTION

According to the present invention, the safety guard comprises a solid outer shield provided upon its inner periphery with resiliently deformable segments and an inner shield adapted to close over the grinding wheel provided upon its outer periphery also with resiliently deformable segments. The inner closing shield is rotatably seated within the solid outer shield and the deformable segments are arranged alternatively, one by one, in pairs to provide slidable supports for maintaining the shields in radial spaced relationship.

Preferably, the deformable segments are sheet steel bent into an accordion form having a plurality of U-shaped bends to provide both radial and tangential deforming means. The outer solid shield is pivotally mounted at its upper surface to the grinding machine body and at its lower part is provided with means permitting it to be swung relatively to the surfaces of the grinding wheel. The outer shield has at its lower ending part a projecting pocket to receive waste fragments. The machine is provided with a solid working rest plate having a tilting portion positioned against a grinding wheel, which may be broken on impact.

The nature of the invention will be more easily understood from the details given by way of example in the following description in which reference is made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side elevation in cross section of a safety guard according to the present invention in which the grinding wheel is of maximum diameter,

FIG. 2 is a view similar to FIG. 1 showing the grinding wheel worn to a minimum diameter,

FIG. 3 is a partial cross sectional longitudinal view of a safety guard showing the outer resiliently deformable segments, and

FIG. 4 is a plan view of the workpiece rest in association with the guard.

DESCRIPTION OF THE INVENTION

As is shown in the accompanying drawings, the safety guard according to the present invention surrounds a conventional grinding wheel 20 mounted on a pedestal, and rotated at high speeds in the conventional and common manner about an axis O. The guard comprises a solid outer shield 1 enclosing a substantial concentric and radially spaced inner shield 2. The inner shield is

slidably seated within and is rotatable relative to the solid outer shield 1 to close the work space W (See arrow in FIG. 1). The solid outer shield 1 is substantially round being circularly shaped to follow the shape of a grinding wheel 20 about its entire periphery and flat to axially cover the axial width of the wheel. The outer shield is provided at its lower end with an open pocket 39 projecting forwardly beneath the working space W. The solid outer shield 1 is stiffened by means of a flat annular side wall 1a on one side and closed by a cover 21 on its other side. In order to increase its stiffness in the area of the projecting pocket 39 the outer shield 21 is stiffened by side walls arranged on both sides. These walls are shaped in such a manner as not to prevent the exchange of grinding wheels or the opening at the top for entry of waste material. The inner shield 2 is also arranged in a circular shape corresponding with the shape of the grinding wheel except that it does not have the projecting pocket and is more of a complete circle. In order to provide the shield 2 with a sufficient stiffness it is reinforced from the side of the outer right wall 1a by means of welded circular ring 2a and from the side of the cover 21 by means of welded circular ring 2b (FIG. 3).

The solid outer shield 1 is mounted to the grinding machine head stock 3 by means of a lever 4 to which it is welded or otherwise fastened to it. The lever 4 is secured about a pivot pin 5 journaled in the head stock and about which the whole guard can be turned. The turning of the guard is provided by means of an adjusting screw 6 which extends through a threaded swivel pin 8 onto a lever 9 which is fixed to the solid outer shield 1. The adjusting screw 6 is swingably connected to the grinding wheel head body 3 by means of deformable telescoping tubes 10 and 11, swivel pin 12 and a fixed carrier block 13.

The slidable seating of the inner shield 2 within the outer shield 1 is provided by means of several spaced cooperating outer resiliently deformable support segments 14 and similar inner resiliently deformable support segments 15. The outer segments 14, made in the present embodiment of corrugated steel sheet, folded into a series of U-shaped bends, are fixed to the solid outer shield 1 by means of weldments 16 which are provided only on the part of the contact surfaces between the outer segments 14 and the outer shield. The inner segments 15 made also of corrugated sheet of a similar bend, are fixed to the closing inner shield 2 by means of weldments 17 which are also provided on only part of the contact surface segments 15 and the inner shield 2. The weldments 16 which fix the outer segments 14 and outer shield 1 are positioned at the end series of bends in each considered from the direction of closing of the space W, i.e., the upper end of the shield, as seen in FIG. 2. The weldments 17 are positioned on the other hand, at the end of the bends of the inner segments considered from the opposite or counter direction of closing. Thus, each segment is secured at only one end and thus can be resiliently folded or deformed in accordion fashion from the other end.

The segments 14 and 15 are positioned on the periphery of the respective outer and inner shields 1 and 2 in such a manner that, when the inner shield 2 is set within the solid outer shield 1, the opposing segments are alternatively adjacent each other and make couples or pairs consisting, always, of one outer segment and one inner segment and the shields may move freely rel-

atively to each other, through an arc angle α . The exact number of the couples is a consequence of geometric conditions and are influenced by the working conditions of a grinding process as well as the size of the machine. In the embodiments shown segments 14 and 15 are each three in number and are spaced apart so that an arc α having a central angle of 40° is left between each of them. The outer segments 14 are arranged so that one is at the forward edge of the shield above the work space, while one of the inner segments 15 is at the forward edge of the inner shield below the work space. The spacing between each of the accordion like segments 14 and 15 permits the inner shield to rotate freely and conform with the angle of the opening W which is also approximately 40° so that the work space W can be easily closed without the segments deforming. Both the solid outer shield 1 and the closing inner shield 2 are provided on their opposing surfaces with inserted layers 18 of low friction material over which the segments 14 and 15 slide. The layers 18 may be made of, for example, plastic, such as "Teflon" or "Nylon."

Longitudinal or axial ribs 19 are provided on the inner surface of the inner shield 2 in order to present barbs or edges against which fragments may impinge to obtain a more perfect transfer of the tangential dynamic force from the waste or broken grinding wheel fragments.

The cover 21 is hingedly mounted to the solid outer shield 1 and is secured in closed position by means of a screw 22 and bolt 23 with the screw 22 fixed in the solid outer shield 1. The slidable surfaces between the solid outer shield 1 and the closing inner shield 2 are sealed by means of seal rings or packing 24 and 25 (FIG. 3) and, also, by means of upper end plate covers 26 (FIG. 1).

The solid carrier block 13, serving to hold the adjusting mechanism for the shields is provided upon its upper surface with a guide slot for seating a workpiece rest body 30 traversable by means of a feed screw 35 and hand control wheel 36 towards and away from the axis of the wheel 20. The feed screw 35 is rotatably mounted and axially fixed within the front part of the solid carrier 13. The carrier block 13 facing the grinding wheel 20 is cut out to provide a chamber for the projecting pocket 39 which, in the initial stages of operation, blocks the workpiece rest body 30 (FIG. 1). During a grinding operation and as the grinding wheel wears and becomes smaller (FIG. 2), the pocket 39 (and the guard as a whole) is turned downwards by means of the adjusting screw 6 so that the workpiece rest body 30 is gradually exposed and more and more defines the front wall of the entrapping space for the flying fragments and takes over the function of the pocket projection 39. As the wheel diminishes in size the shields are pivoted from a position concentric to the axis of rotation, to a position in back of it so that the upper edge of the shield remains as close as possible to the surface of the wheel (FIG. 2).

The workpiece rest body 30 is also provided with a vertical guide groove in which a lift screw 37 having hand control wheel 38 is provided feeding, up or down, a solid yoke or U-shaped working plate 31. The working surface of the workpiece rest consists of this solid U-shape working plate 31 and a pivotal member 32 which is swingably mounted to the solid working plate 31 by means of fixed pin 33 and with a shear pin 34

provided at the end near to the grinding wheel by which the front tip of the plate 32 may be easily sheared. The thus pivoted working plate 32 is consequently pivotal upwardly about pin 33 to expose the projecting pocket 39, and forcibly pivotal downwardly into the pocket projection after cutting off of the shear pin 34. Preferably, the width of the plate 32 is at least the same as the width of the inner shield 1 and the shear pin 34 is designed with such a shearing strength so that the pivoting working plate 32 would be safely secured during normal grinding operation but should breaking of the grinding wheel occur then the shear pin 34 would be cut due to the tangential force of the impinging fragments.

In operation, the employment of the present safety guard does not require major restructuring of or redesigning of the conventional grinding machine. The outer shield with its attached annular side wall 1a is mounted on the body, over the wheel shaft, before the wheel itself is mounted. Thereafter, the inner shield 2 is set in place. From this point the inner and the outer shield need not be removed, even to replace a broken wheel. After the grinding wheel 20 is set on from the open side of the outer shield, the cover 21 is secured in the closed position. During the grinding operation, the diameter of the grinding wheel slowly decreases and a gap between the grinding wheel 20 and the upper edge of closing inner shield 2 is created. As this gap must be maintained within the range required to prevent waste etc., from flying to the face of the operator, the entire safety guard must be consequently shifted towards the diminishing grinding wheel 20. This is enabled by the hand wheel 7 which by revolving the adjusting screw 6 swings pin 8 and levers 9 and 4 causing the entire guard to swing round the pin 5. Since the safety guard turns round the pivoting pin 5 as a whole, the position of the guard relative to the axis of the grinding wheel also changes. For this reason the place at which the pivotal mounting of the safety guard upon the machine body 3 must be determined precisely, in order to ensure the maximum functional efficiency at whatever state of its wear or size of wheel. Simultaneously with this, it is necessary also to adjust the workpiece rest at its distance from the grinding wheel, which during operation also changes. This shifting is carried out by means of the traverse guide and vertical guide of the workpiece rest body 30. The determination of these positions and relationships is not difficult, being merely an exercise in geometry and well within the knowledge of those skilled in this art.

Generally, when grinding wheel breaks, it breaks into from 4 to 10 pieces of various sizes. At the moment of the breaking, the individual fragments are moving at tangential directions at the given peripheral speed of the wheel. The direction is tangent to the circle passing through the individual centers of gravity of each fragment. The most important fragment from the point of loading and deformation of the safety guard is the fragment having a central angle of about 134° with the horizontal work surface and a maximum translating energy. This energy in conventional grinding wheels, having the peripheral speed of from 60 to 80 mps, reaches a value of several thousands of kilopondmeters. That means that in order to absorb this energy within the trajectory of several millimeters, as is the case of the conventional rigid safety guards, such a guard would have to withstand the loading of several millions kiloponds. If, of

course, the deforming trajectory is increased the magnitude of these forces is accordingly decreased. It is, then, necessary to maintain these deforming forces within such a range of magnitude that only the deformation of the designed deforming elements occurs and that no deformation of the guard itself or its connecting parts occurs. The present invention satisfies these conditions by providing the described accordion segments 14 and 15, as well and, further, the deformable telescoping tubes 10 and 11.

With the present apparatus, the fragments of the broken grinding wheel move tangentially from the center and successively strike against the longitudinal ribs 19 of the closing inner shield 2. As the fragments strike against the inner shield 2 under the small angle formed by their relative positions the resulting dynamic loading forces are mostly tangential, and the action of these dynamic tangential forces turns the inner shield 2 within the solid outer shield 1 clockwise over the angle α . The inner shield 2 at first moves freely to close the work space W until the free end parts of the corresponding outer and inner accordion segments 14 and 15 are moved into mutual contact. At this moment, the closing of work space W, by the guard itself according to the invention, is finished without the guard absorbing any of the kinetic deforming energy. From then on, the accordion segments 14 and 15 are pressed and are folded together with their free ends deforming and resiliently collapsing. The segments thus deform radially and tangential simultaneously and dynamically with the absorption of the kinetic energy. The inner shield 2, thereafter, catches all the fragments of the broken grinding wheel absorbing their energy by the continuing resiliency of the segments.

It is possible that one or two fragments which are moving at the moment of the breaking of the wheel exactly along the tangent line passing through the point of the upper inner ending edge of the closing inner shield 2, will escape out of the space W. These fragments will, however, fly away and strike into the shearable workpiece plate 32. The force of such fragments will cut off the shear pin 34 and cause the plate 34 to tilt and fall down about the solid pin 33 coming to rest against the inner wall of the pocket projection 39, or against the workpiece rest body 30. The space thus opened into the pocket 39 catches the flying fragments of the broken grinding wheel. Simultaneously, the closing inner shield 2 is closing down and passes through the gap between the arms of the fixed work plate 31 left by the falling down of the plate 32.

After final pressing of the deforming segments 14 and 15 takes place, the safety guard is fully closed and no other escape of fragments can occur. The telescoping tubes 10 and 11 serve at this final moment for absorbing any excess or remaining kinetic energy of the broken grinding wheel, by being axially extensible one within the other. The tubes may be spring loaded external or internal to provide the necessary resiliency. Other spring dampening means may be used.

The object of the invention to produce a safety guard for a grinding wheel having a high safety and functional reliability during normal and abnormal operation is fully met. The closing inner shield encircles the rotating grinding substantially round its total periphery and it is seated within the solid outer shield upon slidable layers with small coefficient of friction so as to be freely movable. It is also provided with perfect sealing of these

slidable surfaces so that the waste of the grinding process cannot penetrate between these functional slidable surfaces. The pock projecting at the lower end part of the solid outer shield catches the grinding wheel waste and also the first fragments of the wheel upon its breaking even before closing of the guard itself.

An advantage of a safety guard according to the present invention is that it is capable of absorbing nearly all the kinetic energy of the broken rotating grinding wheel. Construction of a safety guard, according to the invention, also enables the entire guard to turn easily round the upper fixed pin to permit adjustment of the guard according to the wearing of the grinding wheel. A workpiece rest is constructed so that it does not prevent the inner shield from being closed upon breaking of the wheel since the tilting working plate member itself falls out of the way permitting the inner shield to easily close on the first impact of any fragment.

The safety grinding wheel guard according to the present invention can be used for pedestal type grinding machines. It may also be used for other types of grinding machines with only minor constructional modification to make them suitable for the purpose. When used with center grinding machines or other grinding machines where the workpiece rest is omitted, the entrapping space is formed only by means of the pocket projection 39 and the workpiece rest body 30 omitted entirely.

Various modifications and embodiments will of course be evident to those skilled in this art. Accordingly, the foregoing disclosure is to be taken as illustrative only, and not limiting of the scope of the present invention.

What is claimed:

1. A safety guard for covering the rotating wheel of a grinding machine comprising, a pair of substantially concentric arcuate shields having facing surfaces arranged about said wheel, the inner shield being rotatable relative to the outer shield and cooperating therewith to encircle said grinding wheel, a plurality of radially and tangentially deformable supports spaced along and between the periphery of each of the respective facing surfaces of said shields to maintain said shields in radial spaced relationship, said supports being fixed alternatively on each of said shields and arranged in pairs to permit rotation of said inner shield in a pre-

defined arc relative to said outer shield.

2. The guard according to claim 1 wherein the grinding wheel is rotatably mounted on a machine head, and said outer shield is pivotally mounted at its upper portion of said head and provided with means for adjusting the position of said shield relative thereto.

3. The guard according to claim 1 wherein each of said support means comprise a sheet of metal bent to form an accordion shaped series of folds resilient in a radial, tangential and axial direction.

4. The guard according to claim 1 wherein said shield is mounted on an open grinding wheel having a space for the entry of a workpiece and said segments are spaced from each other to permit rotation in an arc substantially equivalent to the workpiece opening space.

5. The guard according to claim 1, wherein some of the support segments are fixed to the inner surface of the solid outer shield only at the end of their mutual contact considered from the point of the direction of closing and some of the support segments are fixed to the outer surface of the inner shield only at the end of their mutual contact considered from the point of the counter direction of closing.

6. The guard according to claim 1 wherein the outer shield is provided at its lower part with a projecting pocket surrounded with side wall and front walls, said pocket extending below the working face of said wheel.

7. The guard according to claim 6 including a supporting body mounted adjacent said grinding wheel, and a workpiece work rest mounted thereon, said rest comprising a fixed plate having a pivotal member arranged opposite to said grinding wheel and mounted about a fixed pin located at its rear in said plate and a shear pin located at its front within said plate, the width of said pivotal member being at least the same as the width of said inner shield.

8. The guard according to claim 7, wherein the projecting pocket, the supporting body and the pivotal member are arranged as an entrapment space for catching fragments escaping from said wheel.

9. The guard according to claim 1 including a plurality of longitudinal ribs secured on the inner surface of the inner shield.

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