April 26, 1966 R. W. ANDERSON 3,247,623

PROTECTIVE DEVICE FOR GRINDING MACHINES

Filed July 5, 1963

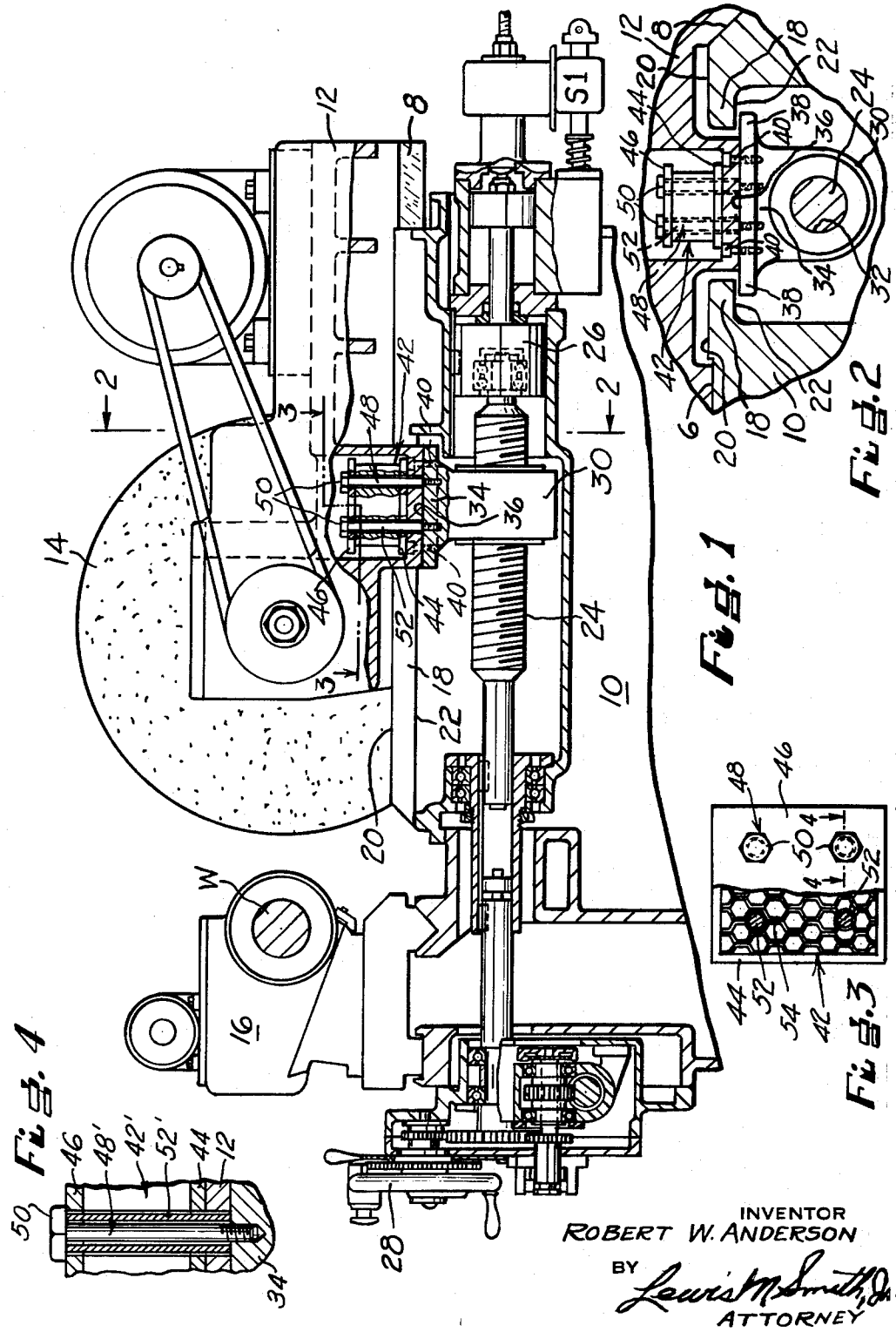


Fig. 1

Fig. 2

Fig. 3

Fig. 4

United States Patent Office 3,247,623 Patented Apr. 26, 1966

3,247,623

PROTECTIVE DEVICE FOR GRINDING MACHINES

Robert W. Anderson, Tacoma, Wash., assignor to Norton Company, Worcester, Mass., a corporation of Massachusetts

Filed July 5, 1963, Ser. No. 292,942
16 Claims. (Cl. 51—166)

This invention relates to grinding machines and has for its principal object, in common with pending applications Serial No. 128,077, filed July 31, 1961 now Patent No. 3,129,538 and Serial No. 127,956, filed July 31, 1961, now Patent No. 3,129,537, granted April 21, 1964, improvements in construction which will dissipate destructive stresses which would be harmful to the wheel slide, the supporting ways and/or the wheel feed mechanism, for example abnormal stresses produced as the result of a grinding wheel failure which develops extremely high kinetic forces. Other objects are to provide stress-absorbing structure which can be incorporated in the frame of the machine without appreciable modification thereof; to provide a structure which can be readily replaced once it has served its purpose; to provide a structure which is of simple make-up; and to provide a structure comprised of components which are readily available. It is to be understood that a further object of the invention is to provide a structure which has general utility apart from grinding machines for the protection of fabricated structures from abnormal stresses by dissipating such stresses in a replaceable connecting structure and hence preserving the permanent component parts intact.

In its broadest aspect the invention resides in the combination with a composite structure, of shock-absorbing means securing the components of the structure to each other designed to operate successively by distortion in tension and compression respectively, to dissipate destructive stresses developed in the structure, the shock-absorbing means embodying tension-resisting elements which takeup the initial shock and a compression-resisting element which absorbs the kinetic energy released following failure of the tension-resisting elements. More especially, the invention resides in the combination with a grinding machine having a base, a wheel slide mounting a wheel on the base for traversing movement, and a keeper for slidably retaining the wheel slide on the base; of first elongated fastening means securing the keeper to the wheel slide designed to fail in tension at a predetermined load, and of second elongate fastening means secured at one end to the keeper, passing loosely through the slide, and secured at the other end to a compression-resisting element disposed between said other end and the slide. As illustrated, the keeper constitutes a feed nut mounted on a feed screw located within the base and beneath the slide and has shoulders underlying and spaced close to the underside of the slotted upper surface of the base whereby the shock-absorbing means protect, in addition to the wheel slide and ways, the feed mechanism and particularly the feed screw.

As herein illustrated, the compression-resisting element comprises a honeycomb structure and the fastening means are bolts which pass loosely through holes in the element, loosely through the slide, and are screwed into the feed nut.

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

FIG. 1 is a fragmentary vertical section through a typical grinding machine embodying the subject matter of the invention, illustrating the application of the invention to an arrangement for securing the wheel slide to the wheel feeding mechanism by means of a full nut;

FIG. 2 is an enlarged fragmentary vertical section taken substantially on the line 2—2 of FIG. 1;

FIG. 3 is a horizontal section of the compression-resisting element, taken on line 3—3 of FIG. 1 to show its honeycomb construction, and;

FIG. 4 is a section taken on line 4—4 of FIG. 3 of an alternate configuration of the spacer means used to control the pre-load conditions of the compression-resisting material.

The apparatus embodying the invention, as herein illustrated, is a grinding machine having a base **10** and a wheel slide **12** mounting a grinding wheel **14** for rotation about a horizontal axis and for movement relative to a work support **16** fixedly secured to the base **10**. As illustrated in FIG. 2, the wheel slide **12** is supported slidably on the base **10** by means of a flat way **6** and a spaced V-way **8** in the manner well known in the art. However, the instant invention is also applicable to a wheel slide supported on a base by means of a pair of spaced flat ways and a horizontally extending guide constraining the wheel slide for sliding movement along the flat ways.

A feed screw **24** is mounted in the base below the slide and is supported at its ends in suitable bearings for movement axially and in rotation about its axis to provide for rapid feed of the wheel slide from a retracted position up to a work piece mounted on a work support **16** and thence on the base and for slow feed during the actual cutting operation. Rapid feed may be provided by a fluid-operated piston, connected to one end of the screw, by means of which the screw is moved axially, and fine feed may be provided either by a fluid-operated piston or by a hand wheel both operably connected to the opposite end of the feed screw by means of either one of which the feed screw is rotated. For the details of the feed mechanism, reference may be had to Patent No. 2,522,485, issued September 12, 1950.

The translational movement of the wheel slide **12** along the base **10** relative to the work support **16** is effected by a feed nut **30** containing a threaded opening **32** for receiving the feed screw **24**. The feed nut has an enlarged head **34** of substantially rectangular cross-section and a flat upper surface **36** for engagement with the underside of the slide **12** to which it is secured as will appear herein after. The head **34** is provided at opposite sides with laterally projecting shoulders **38—38**. The shoulders **38—38** are so disposed that their respective upper surfaces are preferably disposed in a common horizontal plane. The shoulders **38** are provided to limit the vertical displacement of the wheel slide **12** in response to abnormal forces applied thereto, for example, when a grinding wheel **14** breaks while rotating at high speed, to isolate feed screw **24** from any substantial abnormal displacement. This constraint is provided by engagement of the respective shoulders **38** with an opposed pair of lips or shoulders **18** formed integrally with the base **10** and adjoining the conventional slot through the upper surface of the base **10**, provided to accommodate the nut **30** as it is moved along the base **10** by the feed screw **24**. As illustrated in FIGS. 1 and 2, the shoulders **18** are provided with horizontal lower surfaces **22** also disposed in a common horizontal plane. In order to accommodate the normal movement of the feed nut **30** lengthwise of the feed screw **24** without interference with the base **10**,

the upper surfaces of the shoulders 38 are spaced from the lower surfaces 22 of the shoulders 18 by a distance large enough to provide clearance, but small enough to preclude vertical displacement of the feed nut 30 sufficient to damage the feed mechanism.

Under normal conditions of operation, the weight of the wheel slide and wheel will hold the slide securely in place on the horizontal ways. In the event of abnormal stresses however, for example failure of a wheel rotating at high speed with the release of tremendous kinetic energy, forces may be set up which tend to lift the wheel slide off of the ways exposing the wheel slide, the ways and the feed screw to damage. It is the purpose of this invention to dissipate the shock and kinetic energy developed by such wheel failure or for that matter abnormal shock set up in any manner which tends to separate the respective parts, so that damage to the parts will not be entailed. To this end screw bolts 40, four of which are illustrated herein, are inserted through suitable holes provided in the bottom of the wheel slide 12 and screwed into the feed nut. These screw bolts 40 are designed so as collectively to fail in tension at a predetermined stress in excess of that encountered under normal loads. Additionally, a compression-resisting element 42 mounted between rigid plates 44 and 46 is placed on the wheel slide 12 above the feed nut 30 and is secured to the feed nut by screw bolts 48, four of which are illustrated herein. The heads 50 of the bolts engage the upper plate 46, the enlarged shanks 52 extend loosely through the plates 44 and 46, the compression-resisting element 42 and the wheel slide 12 and the ends are screwed into the feed nut 30.

The compression element 42 may, for example, be a honeycomb block (FIG. 4) comprised of a plurality of multi-sided elongate tubular members 54 disposed in rigidly associated relation with each other. An integrated honeycomb structure of this kind is disclosed in the aforementioned pending application Ser. No. 127,956, now Patent No. 3,129,537, and may be used in whatever form illustrated therein for the present application. Such a structure is characterized in that it crushes without elastically returning to its original shape and is sufficiently resistant to such crushing to absorb tremendous amounts of kinetic energy thus to dissipate such energy.

The honeycomb material may conveniently consist of the type commercially available which, as illustrated in FIG. 3 of the drawings, consists of multiple sheets of corrugated material bonded together along abutting surfaces to form a plurality of interfitting elongated hexagonal tubular portions. In addition, the energy absorbing characteristics of the honeycomb material used for the purpose described in this application may be enhanced by orienting the honeycomb material of the compression-resisting element 42 so that the axes of the passages through this material extend parallel to the longitudinal axes of the screw bolts 48 passing through the honeycomb material. In addition, the energy absorbing characteristics relied upon in the application of such material described herein can be further enhanced by developing a carefully determined pre-load condition in the compression-resisting material 42 by the provision of any suitable spacer means for this purpose such as the enlarged shanks 52 of the screw bolts 48 of the precise length necessary in relation to the thickness of the plates 44 and 46, the thickness of the compression-resisting material 42 and the lower surface of the wheel slide 12 so that the proper pre-load is developed when the screw bolts 48 are tightened until the shoulders at the lower ends of the shanks 52 are bottomed against the upper surface of the head 38 of the feed nut 30. The same result can of course be obtained with straight screw bolts 48' encircled by sleeves 52' extending between the underside of the heads 50 on screw bolts 48 and the upper surface of the head 34 of the feed nut 30 as shown in FIG. 4 to a scale larger than the corresponding showing in FIG. 2.

For the sake of clarity, the spacing between the bolts 48' and the sleeve 52' and the spacing between the sleeve 52' and the surrounding elements is somewhat exaggerated. For the same reason, FIG. 4 includes a simplified representation of the compression-resisting material 42.

It will be evident that failure of the wheel 14 at a high rotative speed will release a tremendous amount of kinetic energy which will be transferred to the wheel slide 12 when portions of the wheel strike the wheel guard secured to the wheel slide 12. This transfer of kinetic energy to the wheel slide will result in abnormal stresses tending to lift the wheel slide 12 from the base 10 so that the upper surfaces of the shoulders 38 are brought into engagement with the lower surfaces 22 of the shoulders 18 to preclude further displacement of the feed nut 30 radially relative to the feed screw 24 in order to avoid damage to the precision parts of the wheel feed mechanism. The abnormal stresses tending to separate the wheel slide 12 from the base 10 are thereafter absorbed first by the screw bolts 40 elongated under tension until they break under a predetermined load after absorbing a portion of the kinetic energy released by failure of the grinding wheel 14. The remainder of the energy so released is then absorbed by the compression-resisting element 42 as it is compressed by the tendency of the wheel slide 12 to move upwardly away from the feed nut 30, thus forcing the plate 44 at the lower end of the compression-resisting element 42 upwardly toward the plate 46 at the upper end of the compression-resisting element 42, the plate 46 being constrained against movement relative to the feed nut 30 and hence the base 10 by the heads 50 of the screw bolts 48 which pass through the plates 44 and 46 and the element 42 and are threadably engaged in the feed nut 30.

By its operation in the sequence described above, the instant invention is effective first to preclude abnormal displacement of the element of the wheel feed mechanism of a grinding machine, and then to absorb the kinetic energy tending to separate the wheel slide from the base of the grinding machine, when grinding machine is subjected to abnormal stresses as the result of the failure of the grinding wheel.

The instant invention offers the further advantage that it may be incorporated readily in existing machines by relatively simple modification of the existing grinding machines and feed nut and by the introduction of other elements of the inventive structure into already existing unoccupied space within the wheel slide.

Recalling that the upper surfaces of the shoulders 38 and the lower surfaces 22 of the shoulders 18 are spaced a small distance apart in the embodiment of the instant invention described above and illustrated in the accompanying drawings, it should be noted that the abutting surfaces of the overlapping pairs of opposed shoulders 18 and 38 may be finished with a high degree of precision so that the respective surfaces may be so disposed that they are maintained continuously substantially in mutual contact without interfering with the normal operation of the wheel feed mechanism and the resultant displacement of the wheel slide 12. However, the degree of precision required to permit such juxtaposition of the respective shoulders should not ordinarily be necessary to provide adequate protection for the wheel feed mechanism.

The instant invention is particularly useful in connection with a wheel feed mechanism including a full nut as described in the illustrative embodiment. However, it may also be employed in the same manner in connection with a wheel feed mechanism including a conventional half-nut secured to and dependent from the wheel slide 12 in order to avoid violent and uncontrolled displacement of the half-nut relative to the feed screw.

While the invention is illustrated herein as having particular utility as a means for minimizing damage to the component parts of grinding machines in the event of grinding wheel failure at a high rotative speed, it is to be understood that it may be applied to other structures comprised of components interconnected by connecting means effective under normal loads to maintain a predetermined spatial relationship between the respective components, and also operable under abnormal stresses tending to separate the respective components to absorb the abnormal stresses first through means operable in tension and then through means operable in compression, and also effective to limit relative displacement of the respective components.

It should be understood that the embodiment of the instant invention described herein is illustrative only, and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. In a structure comprised of interconnected components, a connecting structure for such components arranged to withstand normal operating stresses and also effective to constrain the interconnected components against mutual separation in response to an abnormal shock load exceeding the normal operating stresses, said connecting structure including first shock-absorbing component connecting means arranged to rupture in tension after absorbing a portion of the abnormal shock load tending to produce mutual separation of the interconnected components, and second shock-absorbing component connecting means operable after rupture in tension of the first shock-absorbing component connecting means including means permanently deformable in compression under the abnormal shock load tending to produce mutual separation of the interconnected components and thereby absorb the remainder of the abnormal shock load tending to produce mutual separation of the interconnected components.

2. In a structure comprised of components designed to be adjustably interconnected so as to withstand predetermined normal operating stresses, a connecting structure consisting of interconnected relatively movable elements supported by and constrained against abnormal movement relative to one of said components, coupling means interconnecting the other of said components and an element of said connecting structure, said coupling means including shock-absorbing means effective to constrain the components interconnected by said connecting structure and said coupling means against mutual separation in response to an abnormal shock load exceeding the normal operating stresses, said shock-absorbing means comprising first attachment means arranged to rupture in tension after absorbing a portion of an abnormal load tending to produce mutual separation of the components interconnected by said coupling means and said connecting structure and second attachment means, effective after rupture of the first attachment means, including means deformable in compression under an abnormal load tending to separate the interconnected components and thereby operable to absorb the remainder of an abnormal shock load tending to produce mutual separation of the interconnected components.

3. In a machine comprising structural parts interconnected so as to withstand loads generated under normal operating conditions, connecting structure for such structural parts including first and second shock-absorbing connecting means, said first shock-absorbing connecting means including a tension resisting portion arranged to break in tension under an abnormal load tending to separate the structural parts, and said second shock-absorbing connecting means including a compression-resisting portion permanently deformable in compression under the abnormal load tending to separate the structural parts and which operates after said first shock-absorbing connecting means has broken in tension, whereby said first and said second shock-absorbing connecting means operate successively to dissipate the abnormal load tending to separate the structural parts.

4. In a machine having two structural parts adjustably interconnected so as to withstand loads generated under normal operating conditions, adjustable connecting structure for such structural parts including relatively adjustable interconnected elements constrained against abnormal displacement relative to one of the structural parts, fastening means for attaching the other structural part to an element of said connecting structure including first and second connecting means, the first connecting means having portions arranged to break in tension under an abnormal load tending to separate the structural parts, and the second connecting means being operable after the first connecting means has broken and having a portion deformable in compression under an abnormal load tending to separate the structural parts, whereby said first and said second connecting means operate successively to dissipate an abnormal load tending to separate the structural parts.

5. Connecting structure for securing a supported member to its support for limited movement away from its support in response to an abnormal load tending to separate the supported member from its support, said connecting structure including shock-absorbing means comprising first connecting means securing the supported member to its support operable to withstand loads imposed under normal operating conditions but arranged to break in tension under a predetermined abnormal load tending to separate the supported member from its support, and an elongate second connecting means passing through the supported member with one end constrained against relative movement toward the supported member by a compression-resisting element and its other end constrained against relative movement away from the support, said compression-resisting element being arranged to be substantially deformed in compression after the first connecting means is broken, whereby any residual abnormal load tending to separate the supported member from its support is absorbed.

6. Adjustable connecting structure for securing a supported member to its support for predetermined sliding movement thereon and for limited movement away from its support in response to an abnormal load tending to separate the supported member from its support, said adjustable connecting structure including interconnected relatively movable elements constrained against abnormal movement relative to the support and a coupling means comprising first shock-absorbing means securing the supported member to one of the relatively movable elements of said adjustable connecting structure operable to withstand loads imposed under normal operating conditions but arranged to break in tension under a predetermined abnormal load tending to separate the supported member from its support, and an elongate second shock-absorbing connecting means with one end constrained against movement relative to the supported member by a compression-resisting element and its other end secured to the same one of the relatively movable elements of said adjustable connecting structure, said compression-resisting element being arranged to be substantially deformed in compression after the first shock-absorbing connecting means is broken, whereby any residual abnormal load tending to separate the supported member from its support is absorbed.

7. Connecting structure for coupling a slide to a support in such fashion as to absorb abnormal shock forces tending to separate the slide from the support, said connecting structure including shock-absorbing means comprising first fastening elements securing the slide to the support, said first fastening elements being arranged to rupture in tension under a predetermined abnormal force tending to separate the slide and the support, and elongated second fastening elements secured at one end to

the support and extending loosely through the slide and having enlarged heads at the other ends and a compressible element disposed between the slide and the heads of said second fastening elements operable by progressive crushing of the compressible element following rupture of said first fastening elements to dissipate abnormal shock forces during limited displacement of the slide relative to the support.

8. The combination with a grinding apparatus having a base, a wheel slide mounting a grinding wheel on the work support for movement along the base, a feed screw supported on the base and a feed nut operably connecting the feed screw to the wheel slide for effecting movement of the wheel slide; of means operable to constrain the feed nut from substantial movement relative to the base in the direction necessary to accommodate displacement of the wheel slide from the base, and shock-absorbing means connecting the wheel slide to the feed nut comprising first elements securing the wheel slide to the feed nut which have sufficient strength to hold the wheel slide in its operative position under normal loads, said first elements being designed to break in tension under a predetermined abnormal load, elongate second elements secured at one end thereof to the feed nut, said second elements passing loosely through the wheel slide and having heads at their other ends, and a compressible element disposed between the wheel slide and the heads of said second elements operable, by progressive resistance of the compressible element to crushing, to retard displacement of the wheel slide away from the work support following breakage of the first elements.

9. In a grinding machine comprising a wheel slide mounting a wheel, a base on which the wheel slide rests for translational movement of the slide on the base, and fastening means securing the wheel slide to the base, said fastening means including at least one first element designed to break in tension under a predetermined abnormal load and at least one second element thereafter deformable in compression to dissipate disruptive stresses developed between the wheel slide and the base.

10. In a grinding machine comprising a wheel slide mounting a wheel, a base including ways supporting the slide for translational movement, and fastening means securing the wheel slide to the base, said fastening means including at least one first element arranged to fracture under a predetermined abnormal tension and at least one second element thereafter deformable in compression to dissipate abnormal stresses developed between and tending to separate the slide and the base.

11. In a grinding machine comprising a wheel slide, a support on which the wheel slide is mounted for movement in translation, a driving element mounted on the support, and a driven element operably connected to the driving element for effecting translational movement of the wheel slide responsive to movement of the driving element; fastening means securing the wheel slide to said driven element, said fastening means including a first portion arranged to rupture in tension under a predetermined abnormal load and a second portion thereafter deformable in compression to dissipate disruptive abnormal stresses developed between said wheel slide and said support and also including means to isolate said driving element from the abnormal stresses.

12. In a grinding machine, a hollow support having a generally flat upper wall including ways, a wheel slide mounted on the support in sliding engagement with the ways, an elongated feed screw mounted parallel to the ways within the support, and a feed nut operatively engaging the feed screw movable axially with the screw and along the screw by rotation of the screw; means on the feed nut coacting with means on the upper wall of the support in response to disruptive stresses developed between the wheel slide and the support to preclude substantial abnormal displacement of the feed nut relative to the support; means connecting the feed nut to the wheel slide by means of which the wheel slide is moved along the support in response to movement of the feed nut, said means comprising first elements arranged to be fractured under a predetermined abnormal tension load and at least one second element including a compression-resisting means arranged to be compressed after the first elements are fractured to dissipate disruptive stresses developed between the wheel slide and the support without substantial abnormal displacement of the feed screw.

13. In a grinding machine, a hollow support with an upper wall including horizontally disposed, spaced parallel ways, a wheel slide mounted on the ways, a feed screw mounted on the support below and parallel to the ways, a feed nut on the screw movable parallel to the ways both with the feed screw and by rotation of the screw, and shoulders on the feed nut in juxtaposition to the underside of the upper wall of the support; fastening means securing the wheel slide to the feed nut, said fastening means including first means arranged to be deformed in tension until such means is fractured and second means arranged to be compressed after said first means is fractured to dissipate abnormal disruptive stresses developed between the wheel slide and the support without substantial abnormal displacement of the feed screw.

14. In a grinding machine, a hollow support with an upper wall including horizontally disposed, spaced parallel ways, a hollow wheel slide including a lower wall mounted on the ways, a feed screw mounted on the support between and parallel to the ways, a feed nut on the feed screw movable parallel to the ways both with the feed screw and by rotation of the feed screw, and shoulders on the feed nut in juxtaposition to the underside of the upper wall of the support; first fastening means securing the wheel slide to the feed nut, said first fastening means comprising screw bolts passing through the lower wall of the wheel slide and fixedly engaged with the feed nut, said screw bolts being designed to fail in tension at a predetermined abnormal stress, means deformable in compression with its lower end situated on the lower wall of the wheel slide, and second fastening means connected at their lower ends to the feed nut, passing loosely through the lower wall of the wheel slide and connected at their upper ends to the upper end of the deformable means.

15. In a grinding machine, a hollow support having an upper wall including horizontally disposed, spaced parallel ways, a hollow wheel slide including a bottom wall and mounted on the ways, a feed screw mounted on the support below and parallel to the ways, a feed nut on the feed screw movable parallel to the ways both with the feed screw and by rotation of the feed screw, and shoulders on the feed nut in juxtaposition to the underside of the upper wall of said support; fastening means securing the wheel slide fixedly to the feed nut during normal operation, comprising first screw bolts having heads engaging the wheel slide and threaded portions engaging the feed nut, said first screw bolts being designed to fail in tension at a predetermined abnormal disruptive stress, a compressible element supported at its lower end on the bottom wall of the wheel slide above the feed nut, a rigid plate resting upon the upper end of the compressible element, and second screw bolts screwed into the feed nut with their heads engaged with the rigid plate on the upper end of the compressible element and with their shanks extending loosely through the rigid plate, the compressible element, and the wheel slide.

16. A device as described in claim 15, including spacer means operatively associated with said second screw bolts effective to limit the displacement of the heads of said second screw bolts relative to the feed nut so that said compressible element may be subjected to a predetermined compressive pre-load.

(References on following page)

References Cited by the Examiner

UNITED STATES PATENTS

1,549,665	8/1925	Hill et al.	220—89
1,970,718	8/1934	Tryon et al.	220—89
2,291,360	7/1942	Unger	220—89
2,665,128	1/1954	Guffey	64—28 X
2,802,580	8/1957	Larsson	213—45
2,966,200	12/1960	Freedhold	188—1

2,968,458	1/1961	Moeller	248—19
3,081,725	3/1963	Treer	113—38
3,129,537	4/1964	Backer	51—269 X
3,129,538	4/1964	Backer	51—269 X

ROBERT C. RIORDON, *Primary Examiner.*

LESTER M. SWINGLE, *Examiner.*