Dec. 28, 1948. L. L. HERCIK 2,457,468

METHOD OF AND APPARATUS FOR CORRECTING DEVIATIONS IN CROSS-RAILS OF MACHINE TOOLS

Filed Dec. 31, 1945 4 Sheets-Sheet 1

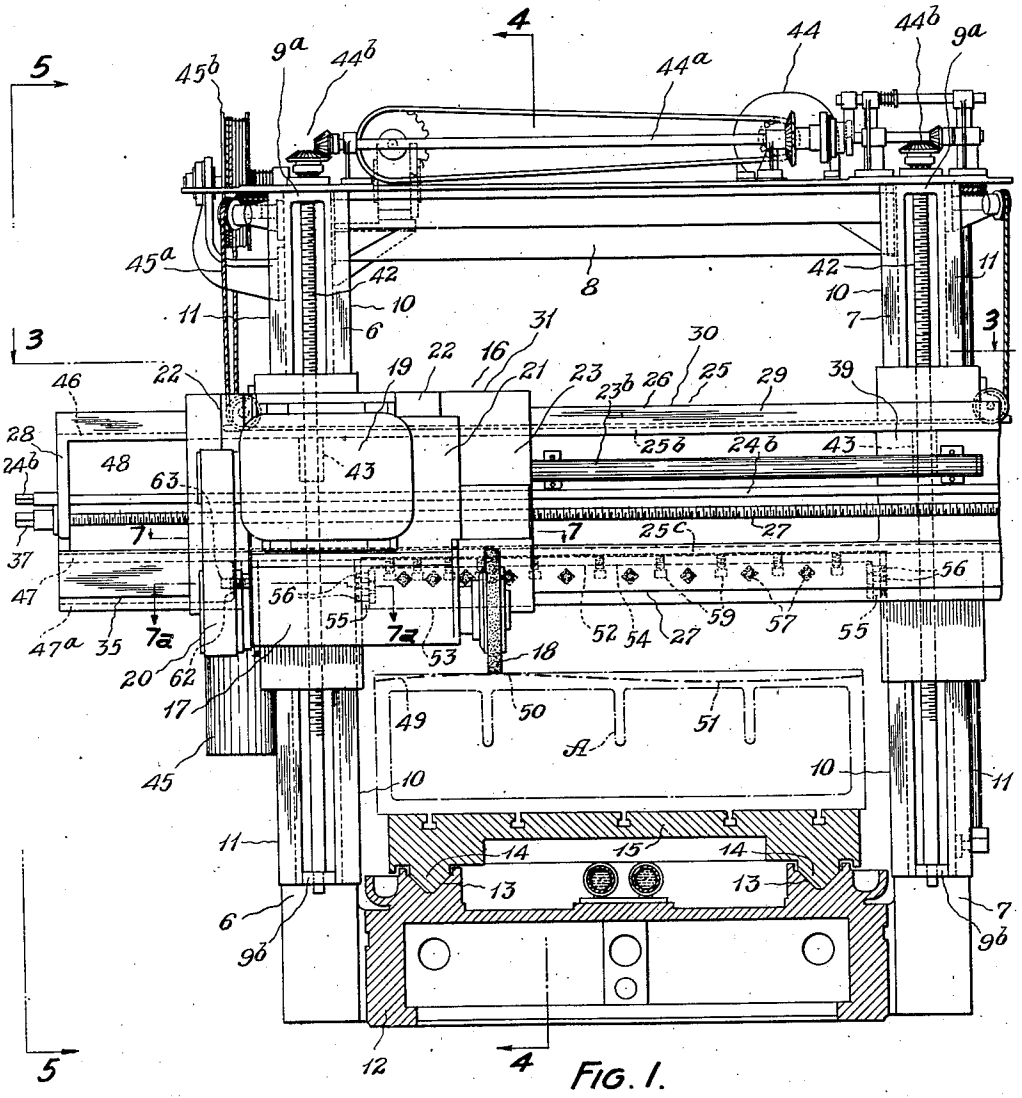


FIG. 1.

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Filed Dec. 31, 1945 4 Sheets-Sheet 2

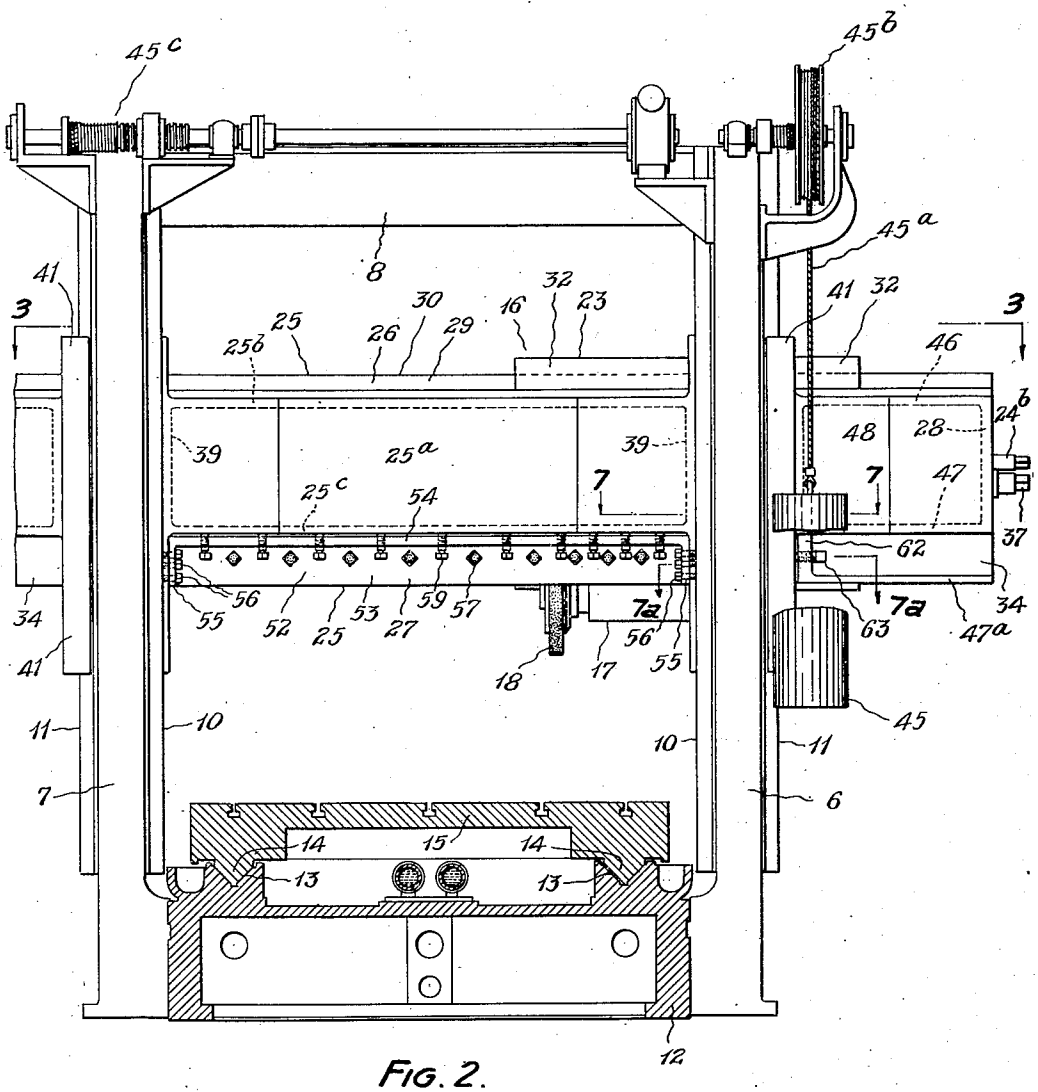


FIG. 2.

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METHOD OF AND APPARATUS FOR CORRECTING DEVIATIONS IN CROSS-RAILS OF MACHINE TOOLS

Filed Dec. 31, 1945 4 Sheets-Sheet 3

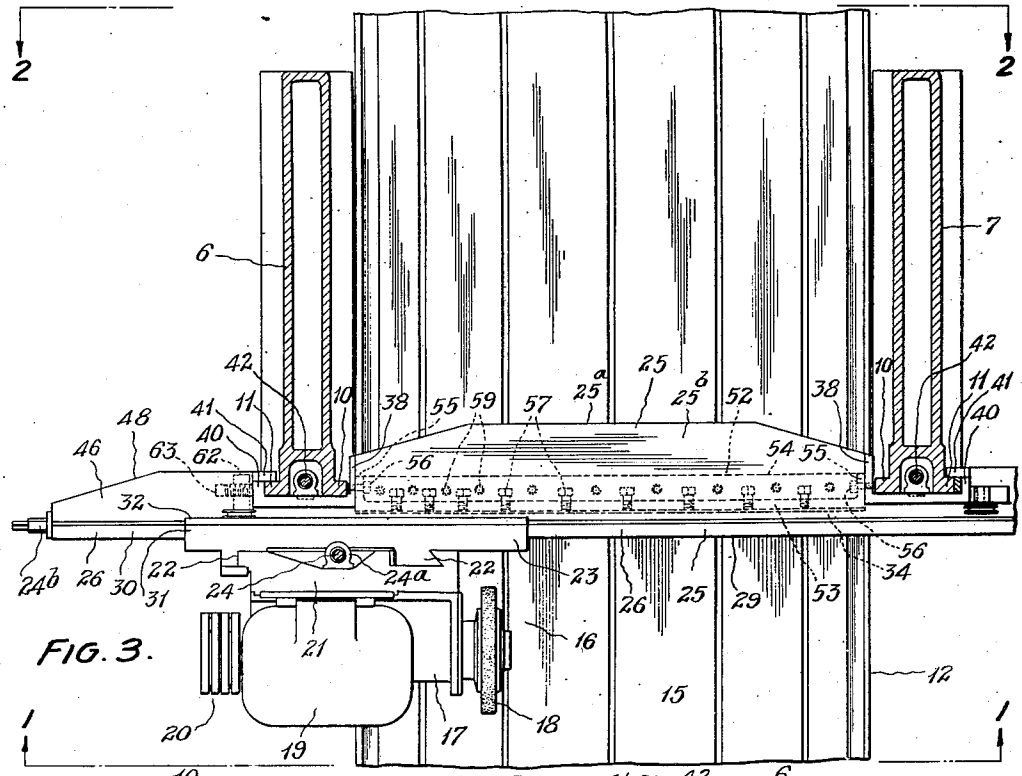


FIG. 3.

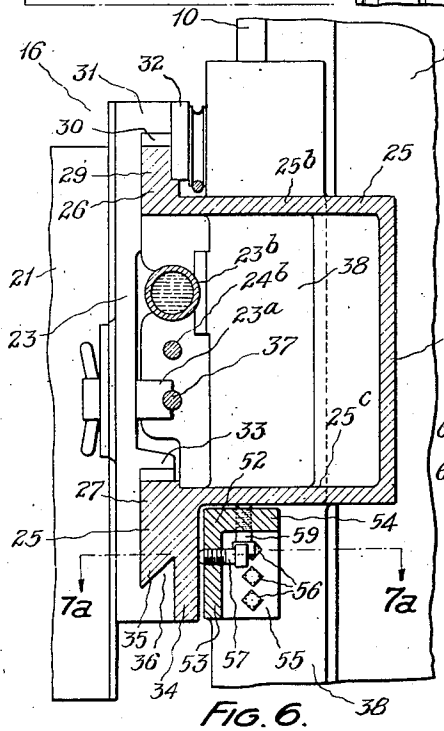


FIG. 6.

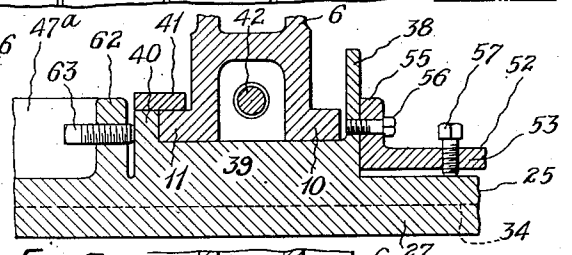


FIG. 7a.

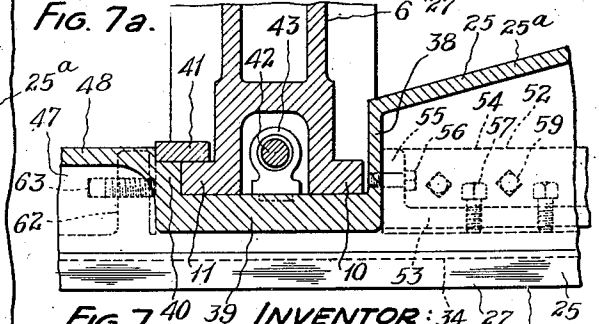


FIG. 7.

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Dec. 28, 1948. L. L. HERCIK 2,457,468

METHOD OF AND APPARATUS FOR CORRECTING DEVIATIONS IN CROSS-RAILS OF MACHINE TOOLS

Filed Dec. 31, 1945 4 Sheets-Sheet 4

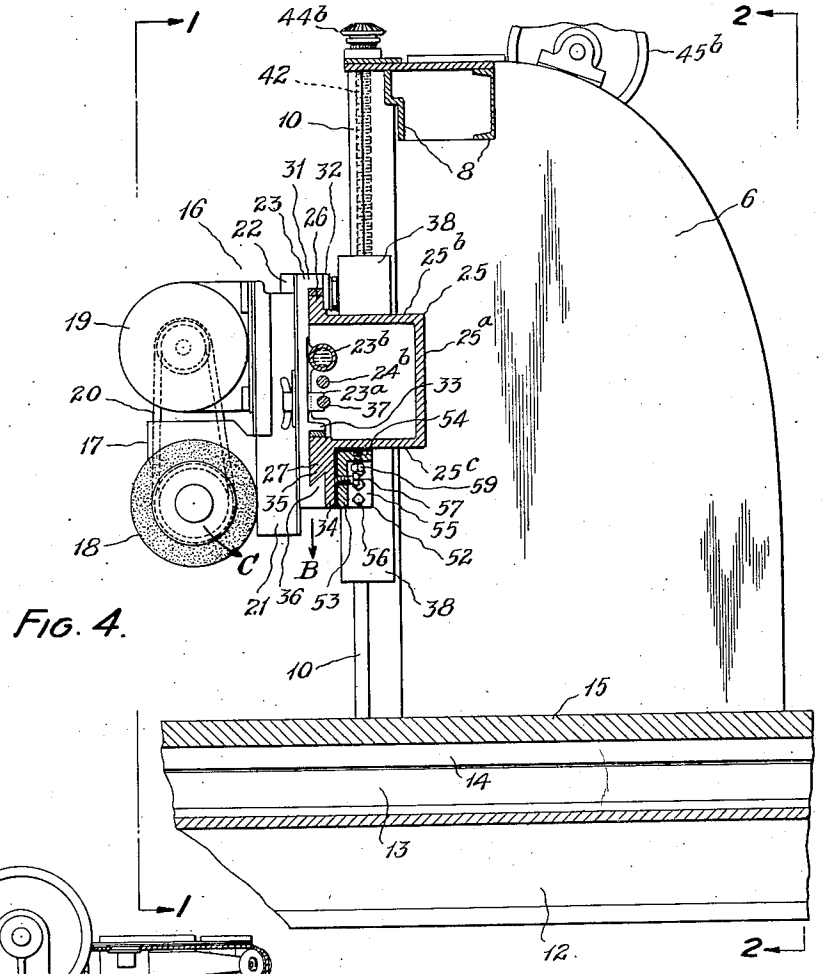


FIG. 4.

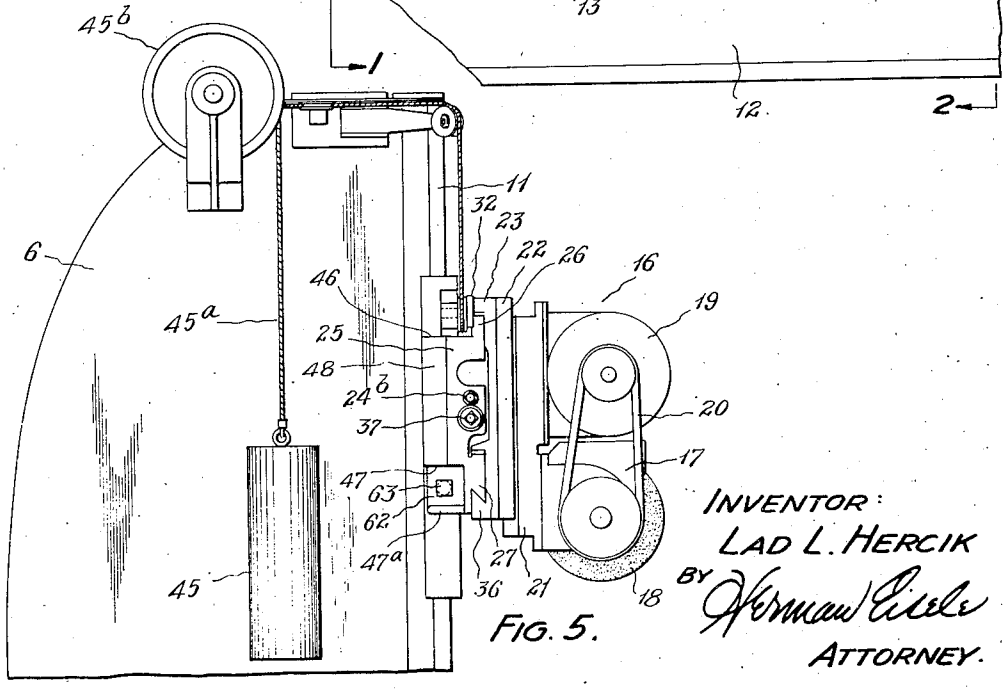


FIG. 5.

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Patented Dec. 28, 1948

2,457,468

UNITED STATES PATENT OFFICE

2,457,468

METHOD OF AND APPARATUS FOR CORRECTING DEVIATIONS IN CROSSRAILS OF MACHINE TOOLS

Lad L. Hercik, Lakewood, Ohio

Application December 31, 1945, Serial No. 638,530

15 Claims. (Cl. 51—166)

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This invention relates generally to machine tools, and more particularly to apparatus for and methods of correcting deviations from a rectilinear form which occur in rails or ways of machine tools which are traversed by tool carriages during the finishing operations on the work by finishing tools.

While the herein disclosed invention is adapted for use with many types of machine tools, its advantages are most clearly apparent when it is embodied in surface grinding machines of the type which are adapted for grinding relatively wide surfaces, and accordingly the invention is illustrated and described in connection with a grinding machine of this character.

Machines of this type usually comprise a travelling work support such as a platen or table, and supporting columns or uprights, located on each side thereof, and widely spaced apart, upon which columns are mounted cross-rails or ways which extend between and beyond the columns. These cross-rails or ways carry a travelling tool head carriage and its related parts, including a grinding wheel, its mounting, and a driving motor. All parts of the machine are of heavy construction, and the tool head and its related parts likewise proportionately heavy in most types of machines, necessarily project to one side on the cross-rails or ways, resulting in an overhanging or overbalanced condition. This overhanging tool head carriage imposes twisting or deflecting strains upon the rails or ways, causing deviations from the intended rectilinear form of the rails and corresponding deviations from the intended straight line travel of the tool head and particularly of the periphery of the grinding wheel as the tool head travels from one side of the machine to the other. These deviations are transmitted as inaccuracies to the finished work and appear as corresponding deviations from the desired and intended rectilinear surface finish in the work. In existing machines, deviations or variations from straight line travel of the tool, caused by these twisting or deflecting stresses, have been found to be as much or more than ten thousandths of an inch, and when transmitted to the work render the same unsatisfactory or unfit for the purpose intended.

It might appear that an increase in the cross sectional areas of the metal in the cross-rails or ways would eliminate the difficulties, but experiments have shown that even in much heavier metal sections, there is sufficient deflection or twisting to cause deviations of considerable extent, and hence solution of the problem evidently

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does not lie in this direction, even if the greater expense and excessive weights involved, are overlooked.

An object of the present invention, therefore is to provide an economical and efficient method and apparatus for rectifying deviations from straight line travel of a tool head, as of a grinding machine, with reference to the work or work support, and thus eliminate transmission of such deviations to the finished work.

Another object of the invention is to provide a method and apparatus for adjustably correcting deviations in the travel of a tool head, which may be caused by imposition of twisting or deflecting load stresses upon the cross-rails or ways along which the tool head travels.

Still another object of the invention is to provide a method and apparatus for predetermining the amount and location of such deviations, and adjustably correcting the same to insure straight line travel of the tool head with respect to the work support.

A further object of this invention is to provide a method and apparatus for correcting deviations in straight line travel of a tool head, both between and beyond the supports for the cross-rails or ways along which the tool head travels.

A still further object of the invention is to provide a method and apparatus for correcting deviations in the travel of a tool head, wherein one adjustment suffices to condition the machine for extensive operation without readjustment.

A further understanding of the construction and operation and of the manner in which the novel features of this invention effect the above and further objects, will become apparent from the following detailed description and the annexed drawings, which set forth means embodying this invention, such disclosed means constituting, however, but one of the forms in which the principle of this invention may be applied.

Referring to the annexed drawings:

Figure 1 is a front elevational, part sectional view of a double housing horizontal surface grinding machine embodying this invention, this view being taken transversely thru the bed of the machine facing the front of the uprights of the housing on the plane substantially indicated by lines 1, 1 in Figures 3 and 4, a portion of the view being broken away to better accommodate the same to the sheet.

Figure 2 is a rear elevational, part sectional view of said surface grinding machine, this view being taken transversely thru the machine facing

the rear of the uprights, on the plane substantially indicated by lines 2, 2 in Figures 3 and 4.

Figure 3 is a plan sectional view of this surface grinding machine, said view being taken on the plane indicated by the lines 3, 3 in Figures 1 and 2.

Figure 4 is a partial vertical longitudinal sectional view of this surface grinding machine taken on the plane substantially indicated by the lines 4, 4 in Figure 1.

Figure 5 is an elevational view of the left side of this surface grinding machine, partly broken away, this view being taken from the plane indicated by lines 5, 5 in Figure 1.

Figure 6 is an enlarged view of a portion of Figure 4 comprising a fragmentary vertical sectional view thru the cross-rail of the grinding machine and showing associated parts of the cross-rail rectifying device.

Figure 7 is an enlarged fragmentary plan sectional view illustrating the relation between one upright of the housing of the grinding machine and the cross-rail and its associated rectifying devices, this view being taken on the plane indicated by lines 7, 7 in Figures 1 and 2.

Figure 7*a* is a similarly enlarged fragmentary plan sectional view illustrating the relation between one upright of the housing of the grinding machine and the cross-rail and its rectifying devices, this view being taken on a plane indicated by lines 7*a*, 7*a* in Figures 1, 2 and 6, this plane being slightly below the plane of Figure 7.

As shown in the drawings, the surface grinding machine in which this invention is embodied comprises a pair of widely spaced heavy columns or uprights 6 and 7, relatively deep fore and aft, hollow in cross section, and connected at their tops by cross members or tie pieces 8. The forward edge of each of the columns 6 and 7 is of channel shaped conformation in transverse section, closed at top and bottom by walls 9*a*, 9*b*, respectively, and having inwardly and outwardly turned vertically extending flanges 10 and 11 at the forward edges of the legs of the channel conformation, all for a purpose presently to appear.

Arranged between the lower ends of the columns 6 and 7, is an elongated base casting 12, having longitudinally extending spaced V-grooves or ways 13, adapted for the reception of slide tongues 14, V-shaped in cross-section and forming part of a work carrying table or platen 15. The table 15 is adapted to be longitudinally reciprocated by any suitable mechanism, not shown in detail, hydraulically actuated means of a well known type usually being employed for this purpose. While many types of work may be processed on this surface grinder, a machine base casting A is shown, for purposes of illustration, in dot and dash lines, supported upon the table 15.

Mounted to reciprocate transversely across and above the table 15 and the work A, is a tool head carriage 16. The tool head carriage 16 includes a tool head 17, a grinding wheel 18, the latter being driven by a motor 19, thru a belt 20, these and related parts being carried by a slide or support 21. The slide 21 is mounted for vertical adjustment on slide ways 22 which slidably engage the slide 21 with a tool head saddle 23. Vertical adjustment of the tool head 17 with reference to the tool head saddle 23 is effected thru manipulation of a vertical worm shaft 24 engaging a nut 24*a*, which vertical shaft is, in turn, actuated by a horizontal shaft 24*b*, the interconnection of these tool head adjusting

elements not being shown in detail, as they do not form part of the present invention.

The saddle 23 is mounted for horizontal reciprocation upon a cross-rail or transverse track member 25. The rail member 25 may be in the form of a skeleton or hollow casting, which has upper and lower spaced rails or ways 26 and 27, connected intermediate their ends adjacent and forwardly of the columns 6 and 7 by web members 39 and at their ends by integrally formed webs, one of which is shown at 28. The rails 26 and 27, as best shown in Figure 1, extend between the columns 6 and 7, and considerably beyond said columns especially on the left side of the machine, as viewed in Figure 1. The upper rail 26 is preferably formed as an upwardly directed flange 29, providing a slideway 30, upon which an inwardly directed angular flange 31 of the saddle 23 is adapted to bear, an adjustable liner strip or gib adapted to compensate for wear, being interposed between the bearing surfaces, and a retaining piece 32 extending behind the flange 29. The lower rail 27 provides a slideway upon which bears an adjustable gib supporting a shoulder 33 formed at the inner side of the saddle 23, and below the slideway the rail 27 is provided with a downwardly directed flange 34, of considerably greater depth than the flange 29, the front face of which is formed to provide an undercut or dove tailed beveled slideway 35, for the reception of a correspondingly shaped shoulder 36 formed along the inner side of the saddle 23. For the manual transverse adjustment of the saddle and tool head, a worm shaft 37 is provided extending longitudinally thru the cross-rail casting 25 and engaging a disconnectable nut portion 23*a* mounted on the saddle 23, each end of the shaft 37 being formed with a square so that it may be engaged by a suitable crank handle wrench whereby the shaft may be manually rotated. This manual rotation of the shaft 37 effects sliding reciprocation of the tool head saddle 23 along the rails or slideways 26 and 27. The progressive lateral reciprocation of the tool saddle in both directions during the regular production grinding operation of the machine is effected by hydraulic means including a cylinder 23*b* shown in Figures 1, 4 and 6, this hydraulic actuating means being well known in this type of machine tool and forming, per se, no part of this invention, need not be further described in detail. When the tool carriage is hydraulically actuated the worm shaft engaging nut 23*a* is disengaged from the shaft.

As best shown in Figures 4 and 6, the cross-rail member 25, between the columns 5 and 7, is channel or U-shaped in cross-section, and comprises a rear vertical web section 25*a* and upper and lower flange sections 25*b* and 25*c* integrally connected at their front edges with the rails 26 and 27, respectively. The ends of the channel formation terminate in vertically extended walls 38, 38. Each wall 38 is integrally connected with a web portion 39 adapted to bear upon the faces of the flanges 10, 11 of the columns 6 and 7. Each web portion 39 is connected with a flange 40, Figures 1 and 3, to provide a vertically extending channel formation which slidably fits over the forward edge of each of the columns, the flanges 40 bearing upon the outer flanges 11, 11 of the columns 6 and 7, and in each case a retaining piece 41 is provided behind the related flange 11. The cross-rail member 25 is thus mounted for vertical adjust-

ment, and is adapted to be vertically adjusted thru the medium of vertical adjusting screws or worm shafts 42, engaging nut pieces 43 mounted on the web portion 39, the shafts 42 being adapted to be driven in unison by a motor 44, thru shafting 44a and gearing indicated generally at 44b. Mechanism for counter-balancing the weight of the cross-rail and associated parts is additionally provided in order to reduce the power required to raise the cross-rail and associated parts. This counterbalancing mechanism includes a counterweight 45, cable 45a, force multiplying drum 45b and compensating cable take up mechanism indicated generally at 45c. This motor 44 and associated drive parts and the counterweight 45 and associated mechanism, forming no part of this invention, per se, need not be here described in detail. This drive and counterbalancing mechanism are, however, described in complete detail in my co-pending application Serial No. 638,529, entitled Counterbalancing mechanism for machine tools, and filed December 31, 1945, now Patent No. 2,434,613, issued January 13, 1948.

Laterally outwardly beyond the flanges 40, Figures 1, 2 and 7, top and bottom walls 46 and 47, shown horizontally alined with the walls 25b and 25c, continue toward and merge with the end walls 28. This outwardly extending section is also channel shaped in vertical cross-section, the horizontal walls 46 and 47 being connected by a vertical web 48. An additional wall extension or flange 47a is formed at the extreme bottom of this outwardly extending section of the cross-rail member, this flange being below and spaced from the wall 47, and connected with the outwardly extending portion of the flange 34.

Assuming the use of the finest materials, precision prepared cross-rail surfaces and general excellence of construction, operation of the mechanism thus far described results in imparting to the upper surface of the finished work, such as shown at A, a contour, exaggerated for the purposes of illustration, conforming to the curved broken line shown at 49, 50, and 51 in Figure 1. This contour results from forces set up generally along the lines indicated by the arrows B and C as shown in Figure 4, due to the weight and overbalanced condition of the tool carriage and its related parts. When the tool saddle 23, in its traverse of the work, travels on the extreme left, Figure 1, of the cross-rail member 25, some downward sag and twist or deflection occurs in the portion of the ways 26 and 27 of the cross-rail extending laterally outwardly beyond the column 6 because of the weight and overbalanced position of the tool carriage just referred to, producing a contour in the finished surface of the work of the character indicated at 49. When the tool carriage passes the column 6, the supporting effect of the column on the ways 26 and 27 of the cross-rail 25 reduces or eliminates the sag or deflection of the rail and produces a slight relative rise in the contour of the finish on the work, of the character indicated at 50. When the tool carriage travels on the ways 26 and 27 of that portion of the cross-rail member 25 between the columns 6 and 7, greater sag or deflection again progressively occurs as the carriage travels along the ways, resulting in a contour on the surface of the finished work, of the character indicated at 51. These deviations in travel of the tool head and grinding wheel or other tool, although their effect is exaggerated in the drawing, nevertheless are sometimes in excess of ten one-thousandths of an inch, and occur to an appreciable extent regardless of how heavy or rigid the construction of the cross-rail may be. This is particularly true when the tool consists of a large grinding wheel driven by a high powered motor which is necessarily of substantial size and weight.

For counteracting and rectifying this condition, I employ an expedient which includes the application of adjustable forces counter to the forces which cause the flexures resulting in the deviations in the path of travel of the tool, which enables me to rectify and direct the travel of the tool to a path substantially exactly parallel to the plane of the work table top.

Since the deviations occur between the columns 6 and 7 and laterally outwardly of the column 6, particular and separate means are employed to meet this condition in these two areas of the cross-rail.

These means, for correcting the deviations between the columns 6 and 7, include an angle bar 52 arranged beneath the cross-rail member 25, the angle bar 52 comprising flanges 53 and 54, connected at their opposite ends by integrally formed end walls 55. The angle bar 52 is of an overall length so as to nicely fit between the vertically extended walls 38, 38 of the cross-rail member 25, and is fixed in place by screw bolts 56 threaded thru the end walls 55 and into the adjacent walls 38, 38.

The angle bar 52, once fixed in position, has its flange 53 disposed parallel to and in the rear of the flange 34 and rail 27 of the cross-rail member 25, and is spaced a slight distance from the flange 34. Extended thru the flange 53 is a series of individual adjusting members, preferably in the form of set screws 57, which are threaded thru the flange 53 at intervals therealong, and in such position that their inner ends are adapted to bear upon the inner faces of the flange 34. The set screws 57 are provided with heads readily accessible for manipulation thru use of a suitable tool. When the screws 57 are turned forwardly they set up forces upon the inner surface of the flange 34, in a direction counter to the forces indicated by the arrow C, Fig. 4, tending to straighten or to counterflex the latter to whatever extent it is deflected from the original or intended rectilinear form, and thus to true or restore the intended rectilinear configuration of the rail flange 34 and rail proper or way 27.

Also threaded thru the flange 54 of the angle bar 52 is a series of set screws 59, arranged at intervals therealong, having their heads accessible for ready manipulation, and having their inner ends bearing upon the adjacent bottom wall 25c of the U-shaped section of the cross-rail member 25. The screws 59 are operable to resist the reaction imposed by the screws 57 upon the flange 53 of the angle bar 52, and to exert vertical forces counter to the forces acting in the direction of the arrow B, thereby straightening or counterflexing the flange 34 and the rail 27 in a vertical direction.

For counteracting and rectifying sag or deviation in that portion of the cross-rail member 25 extending outwardly to the left beyond the column 6, as viewed in Figure 1, the cross-rail member 25 is provided between the horizontal wall 47 and the horizontal flange 47a, with an ear 62, this ear being located adjacently juxtaposed to, but slightly spaced from the flange 40, and integrally formed with the way 27, as best shown in Figures

2, 3, 5, 6 and 7. A set screw **63** is threaded thru the ear **62**, the inner end of which set screw is adapted to bear upon the adjacent flange **40** of the cross rail member **25**. By reason of the location of the set screw **63**, turning the same forwardly against the flange **40** serves to tilt the lower portion of the cross-rail member **25** extending beyond the column **6** and particularly the lower rail **27** thereof in a forward direction, thus serving to tilt the entire overhanging portion slightly so as to counteract forces operating in the direction of the arrow C and effect the necessary counter-flexure in this portion of the cross-rail member **25**, in order to produce the intended path of travel of the face of the tool **18**.

In truing up the cross-rail member **25**, with reference to the table **15**, and the work carried thereby, trial runs of the tool carriage over a work piece are made, and deviations are noted with the use of suitable tools, and then the appropriate set screws **57** in line with such deviations are adjusted primarily to correct deviations occurring because of twisting or deflecting forces in the direction of the arrow C, while the set screws **59** are adjusted primarily to correct deviations caused by forces acting in the direction of the arrow B, the set screws **57** and **59**, however, having a cooperative relation, and aiding one another in the truing operation against a composite pattern of the distorting forces described. Likewise, during these trial runs, the set screw **63** is adjusted to correct the deviations occurring on the portion of the cross-rail extending outwardly beyond the supporting column **6** as a result of the twisting or deflecting forces caused by the weight of the tool carriage and indicated by the arrows B and C. It has been found that in practice, one screw is ample to produce the desired correction in this extending portion of the cross-rail. It will be clear that, by the method outlined the cross-rail may be restored to and maintained in its original rectilinear state, that is, in its intended rectilinear form, when it is subjected to the distorting and deviating stresses resulting from the unbalanced loads of the tool carriage.

It will be understood, from the above that the form of the ways **26** and **27** of the cross-rail, when the cross-rail is not subjected to the distorting and deviating stresses imposed by the tool carriage, may not be, and usually is not, straight and rectilinear, the cross rail having been preflexed from the rectilinear form to such an extent that the cross-rail will assume a substantially rectilinear form when the portion of the cross-rail in question is subjected to the load of the stresses of the carriage.

In its broader concept, the rectifying means described are not limited to counteracting the deviating forces imposed upon the cross-rail. This rectifying means may, as will be understood, effectively be used to correct such distortion as occurs in long generally rectilinear members as a result of temperature changes, aging or release of initial strains in such members.

It will be apparent that thru the use of the adjusting screw **57**, the adjusting screws **59** and the adjusting screw **63**, sagging, deviation or deflection along the cross-rail members **25** and the rails thereof, and with respect to the work table, may be accurately corrected so as to provide rails or ways for the tool head carriage which will insure rectilinear travel of the tool in a plane substantially exactly parallel with the face of the work table and the work carried thereby, and thus eliminate inaccuracies in the contour of the work such as those indicated at **49**, **50** and **51** in Figure 1.

It is to be understood that variations and modifications of the particular embodiment of the invention herein shown and described for purposes of illustration, may be made without departing from the spirit of the invention.

It is to be noted that certain details disclosed in this application but not claimed herein are claimed in my copending application Serial No. 638,529, filed December 31, 1945, entitled Counterbalancing mechanism for machine tools, now Patent No. 2,434,613, issued January 13, 1948.

What I claim is:

1. Apparatus of the character described, comprising: elongated continuous suspended cross-rail means having supporting means restricted to a localized area along its length, and having also an unsupported portion extending beyond said supporting means, a carriage movable on said unsupported portion and subjecting the same to deviation under load stresses from the intended rectilinear form of said cross rail means, and a rectifying device carried by said cross-rail means and including means operable to exert a flexing force upon said unsupported portion of said cross-rail means, said flexing force being exerted counter to said load stresses, thus to flex the unsupported portion of the cross-rail means to its intended rectilinear form when subjected to said load stresses.

2. Apparatus of the character described, comprising: elongated continuous suspended cross-rail means having supporting means at a localized area along its length, and having also an unsupported portion extending beyond said supporting means, a carriage movable on said unsupported portion and subjecting the same to deviations under load stresses from the intended rectilinear state of said cross-rail means; and a rectifying device having a plurality of means selectively operable to exert, upon predetermined parts of the unsupported portion of said cross-rail means, flexing forces to correct said deviations in said cross-rail means and thus restore the same to its intended rectilinear state when subjected to said load stresses.

3. Apparatus of the character described, comprising: suspended metallic cross-rail means having supporting means at a localized area along its length, and having also an unsupported portion extending beyond said supporting means, a carriage movable on said unsupported portion and subjecting the same to progressively varying flexures under load stresses from the intended rectilinear form of said cross-rail means; and a device carried by said cross-rail means having a plurality of force exerting means independently operable to exert upon said unsupported portion of said cross-rail means at the points of flexure, selectively variable forces for flexing the same in a counter direction sufficient to compensate for the imposed flexures when said unsupported portions are subjected to said load stresses.

4. In a machine of the character described, a vertically extending supporting column, cross-rail means supported by said column and having a portion extending beyond said column and formed with spaced ways adapted to slidably support a tool head carriage, said carriage exerting a turning influence on said extending portion of the cross-rail about a longitudinal axis thereof, and screw means associated with said cross-rail means adapted to angularly flex one of said ways with respect to the other.

5. In a machine of the character described, spaced vertically extending supporting colums; cross rail means supported by said columns, and extending between and beyond said columns, and adapted to be traversed by a tool head carriage, said cross-rail means being susceptible, under the load of said carriage, to progressively variable sagging at various points along its length; and means for truing the said cross-rail means to remove said sagging therefrom, said truing means including a plurality of elements independently operable to variably flex said cross-rail means at the various points to adjustably counteract those forces causing sagging at the various points along said cross-rail means.

6. In a machine of the character described spaced vertically extending supporting columns; elongated cross-rail means supported by said columns, and extending between and beyond said columns; a tool head carriage mounted upon said said cross-rail means, projecting to one side there of, and exerting a turning influence upon said cross-rail means about a longitudinal axis thereof; and rectifying means operable to exert a force counteractive to the turning influence upon said cross-rail means.

7. In a machine of the character described, spaced vertically extending supports; elongated cross-rail means extending between said supports; a tool head carriage adapted to traverse said cross-rail means, and projecting to one side thereof; said carriage in its traverse of said cross-rail means exerting a downward influence upon said cross-rail means and also a turning influence about a longitudinal axis thereof; and a corrective device associated with said cross-rail means, and including a first power means operable for resisting said downward influence, and a second power means for resisting the turning influence upon said cross-rail means.

8. In a machine of the character described, spaced vertically extending supports; elongated cross-rail means extending between said supports; a tool head carriage adapted to traverse said cross-rail means, and projecting to one side thereof, said carriage in its traverse of said cross-rail means exerting a downward influence upon said cross-rail means and also a turning influence about a longitudinal axis thereof; and a corrective device associated with said cross-rail means, and including a first power means having a plurality of selectively operable elements for resisting said downward influence, and a second power means having a plurality of elements selectively operable to resist the turning influence upon said cross-rail means.

9. In a machine of the character described, cross-rail means having means by which the same may be supported at spaced points therealong, said cross-rail means comprising a body portion carrying the rail means proper; and a truing device carried by the said cross-rail means and extending the supporting means thereof, and having means for exerting forces upon said cross-rail means to counteract forces tending to cause deviation in the intended configuration of said cross-rail means proper, when the latter is under load, said truing device including an angle bar having its end portions secured to said cross-rail means adjacent to the supporting means thereof, and having a plurality of adjusting members threaded at intervals thru each leg of said angle bar and adapted to bear upon selected portions of said rail means.

10. In a machine of the character described,

vertically extending supporting column means, cross-rail means supported for vertical travel upon said column means, the cross-rail means being formed with a flange engaging at least one side of said column means and also formed with horizontally disposed vertically spaced generally rectilinear ways adapted to be traversed by a tool carriage, said ways extending laterally outwardly beyond the flange, and force applying means associated with the flange and one of the laterally outwardly extending ways, adapted to flex said one laterally extending way out of rectilinear alinement with the remainder of said ways.

11. In a machine of the character described, spaced vertically extending supporting columns, a horizontally disposed cross-rail having front, rear, top and bottom portions and carrying channel shaped formations extending vertically across its rear portion and adapted to slidably engage the front and at least one side of the supporting columns, said cross-rail member also having spaced horizontally extending top and bottom ways adjacent the front thereof, said ways extending longitudinally between and laterally outwardly of said channel-shaped formations and adapted to be traversed by a tool head carriage, and force applying means positioned adjacent to and rearwardly of one of said ways and between one of said channel shaped formations and one outwardly extending end of said cross-rail member, said force applying means being operable to adjust the angular position of said one way with respect to the adjacent channel shaped formation.

12. In a machine of the character described, spaced vertically extending supporting columns, a horizontally disposed cross-rail having front, rear, top and bottom portions and carrying vertically extending columns engaging means across its rear portion including a rearwardly extending flange, said means and flange being adapted to slidably engage the front and at least one side of one of the supporting columns, said cross-rail member also having spaced horizontally extending top and bottom ways adjacent the front thereof, said ways extending longitudinally between and laterally outwardly of said column engaging means and adapted to be traversed by a tool head carriage, a rearwardly disposed extension fixed to one of said ways at a point intermediate the flange and the outer end of one of the outwardly extending ways of the cross-rail, and juxtaposed to said flange, and force applying means, associated with said flange and said extension, said force applying means being operable to adjust the angular position of said one way with respect to the flange.

13. The method of truing a continuous metallic tool carrying cross-rail of a machine tool, comprising: mounting the tool on the cross-rail, locating a plurality of localized areas of deviations from the intended configuration of said cross-rail caused by the tool and applying a separate force directly to the cross-rail in each of the areas of deviation to flex the said cross-rail in a direction to restore its intended configuration.

14. The method of truing a metallic tool carrying cross-rail of a machine tool, which is supported at a localized area along its length and subject to torsional flexure from a rectilinear form at points spaced from the localized area by the weight of a tool supported on the cross-rail, comprising: mounting the tool on the cross-rail, determining the amount of flexure produced in

the rail by the weight of the tool, and adjustably counterflexing the rail torsionally to return the rail to its rectilinear form.

15. The method of truing a metallic tool carrying cross-rail of a machine tool, which is supported in a substantially horizontal plane at a localized area along its length and which is subject to different kinds of flexures, including torsion and straight vertical sagging from the intended rectilinear form, resulting from the load imposed by the weight of the tool, at points variously spaced from the supporting area, comprising: mounting the tool on the cross-rail ascertaining the extent and kind of flexure produced at the variously spaced points and variably adjustably flexing the cross-rail at said points in a direction counter to the respective torsion and sagging, whereby the cross-rail assumes the intended

rectilinear form at the said points when the tool is supported at these points.

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