United States Patent

Schaller

[15] **3,685,212**

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[54] **CENTERLESS GRINDING MACHINE**

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[21] Appl. No.: **29,031**

[52] **U.S. Cl.**.....**51/103 TF,** 51/139, 51/165.88, 51/215 H

[51] **Int. Cl.** **B24b 5/18**

[58] **Field of Search** .51/103 TF, 103 R, 139, 165.87, 51/165.88, 215 H

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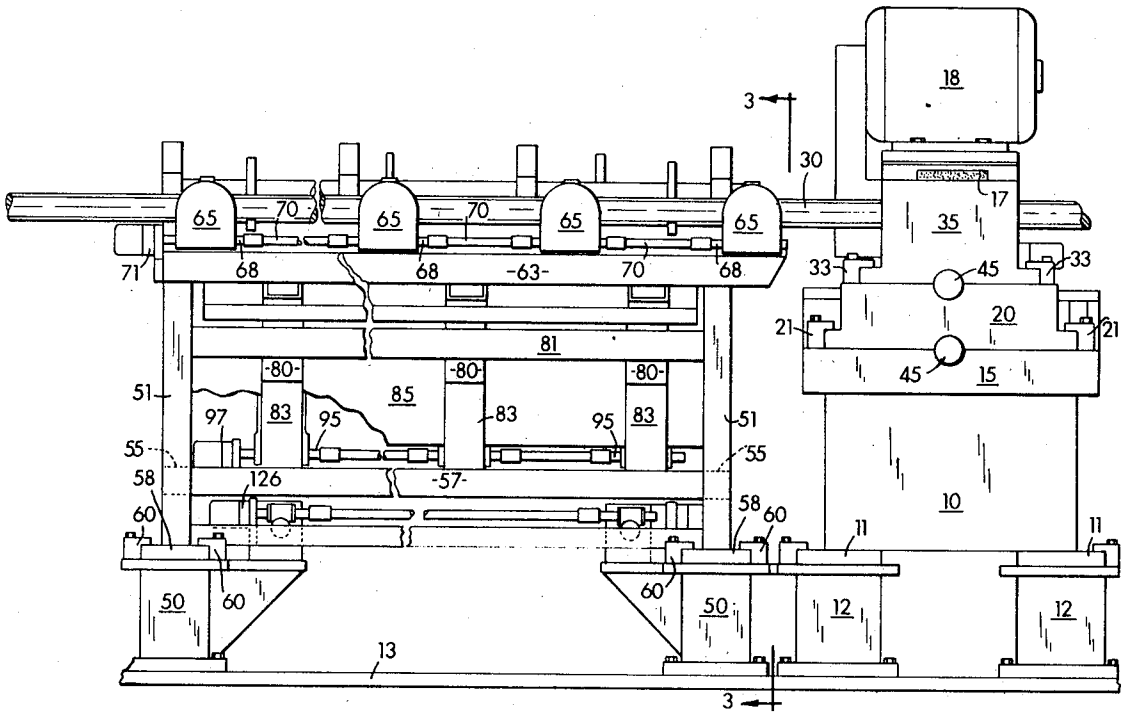
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Attorney—D. Emmett Thompson

[57] **ABSTRACT**

The centerless grinding machine includes a grinding head in fixed position. The infeed and outfeed bar roll assemblies and the regulating wheel and bar rest assembly are movable toward and from the grinding element in the grinding head. An in-process grinding wheel guaging device is provided for continuously gauging the diameter of the wheel. As the wheel wears, during the grinding operation, the gauge signals the amount of wear to a numerical control system which effects movement of the roll assemblies, and the regulating wheel and rest assembly toward the grinding wheel to compensate for the wheel wear. The bar loading assembly may also be moved under the control of the wheel gauge.

7 Claims, 4 Drawing Figures



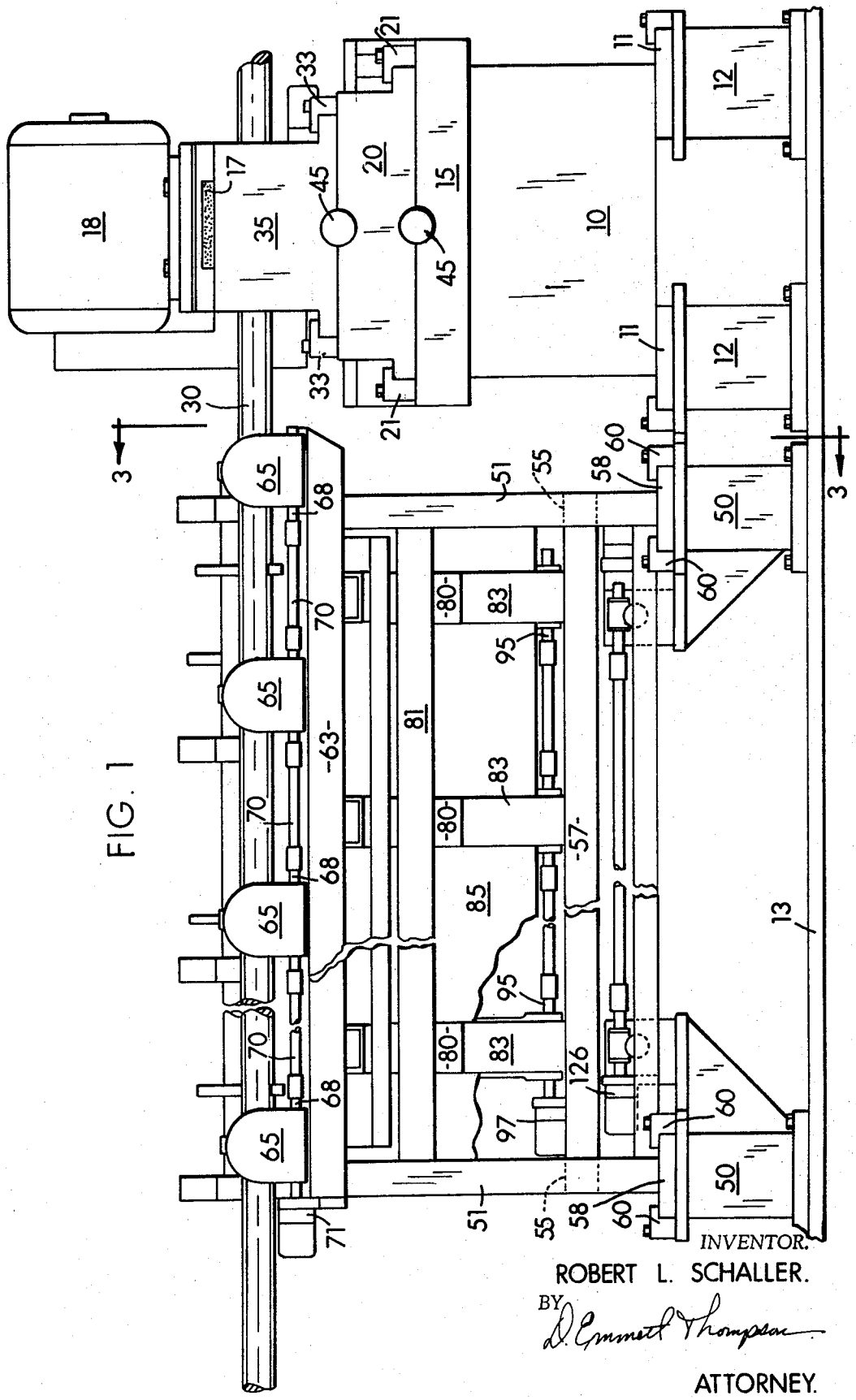


FIG. 1

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FIG. 4

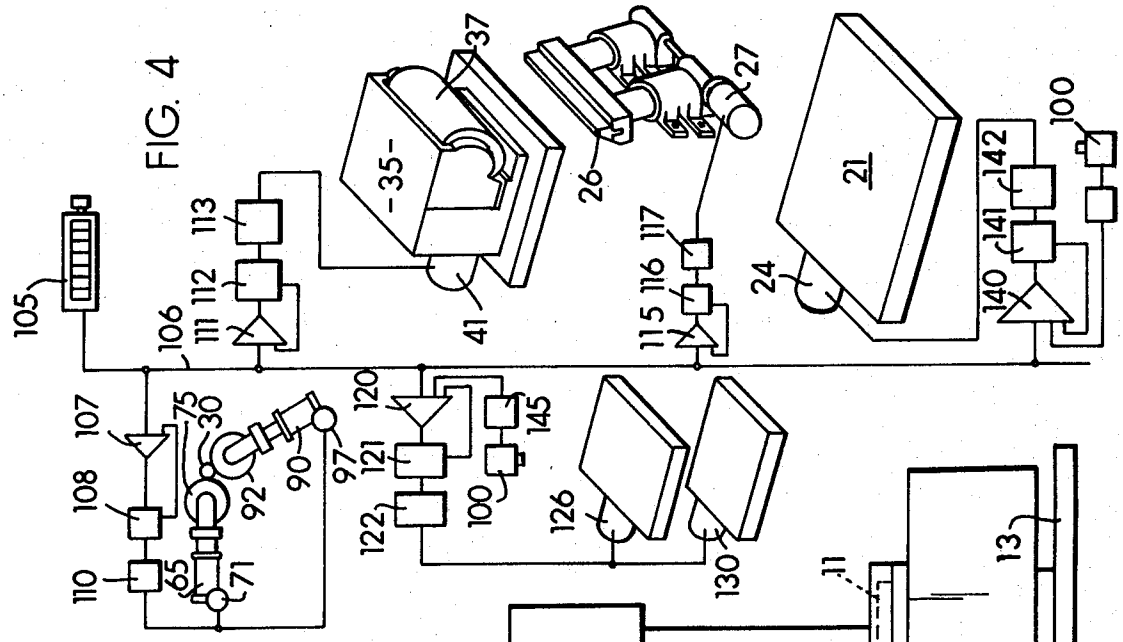
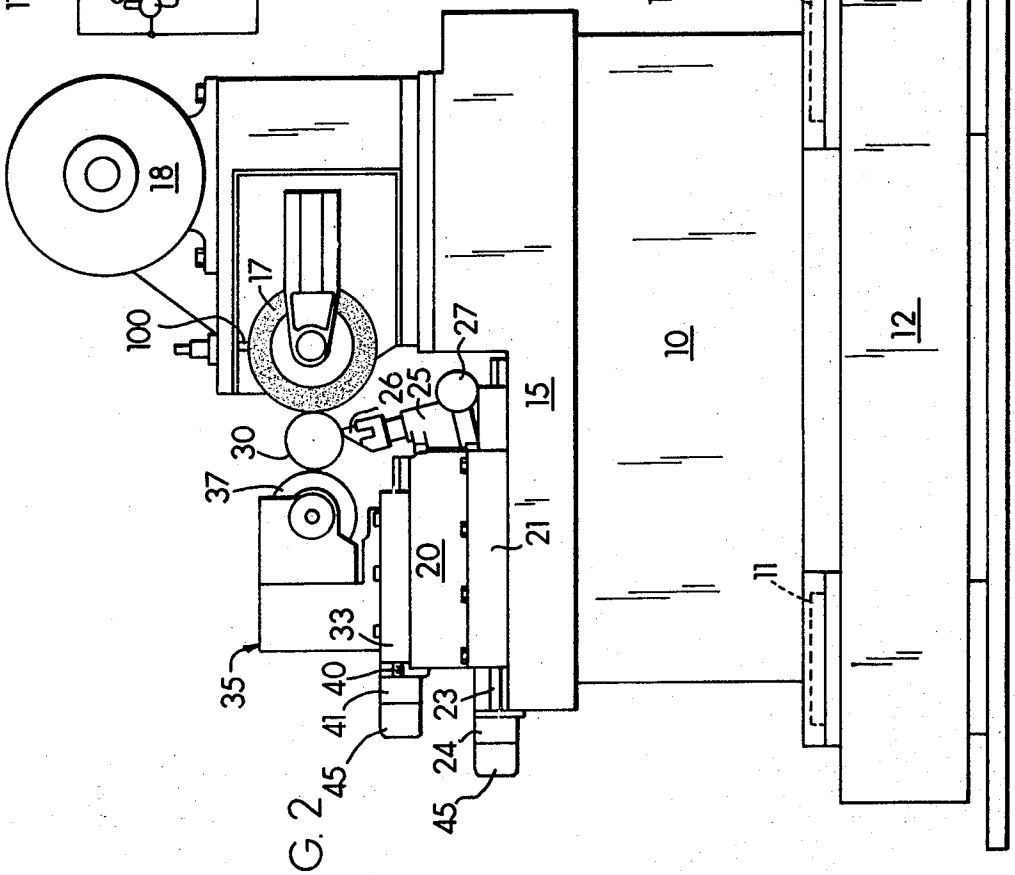


FIG. 2

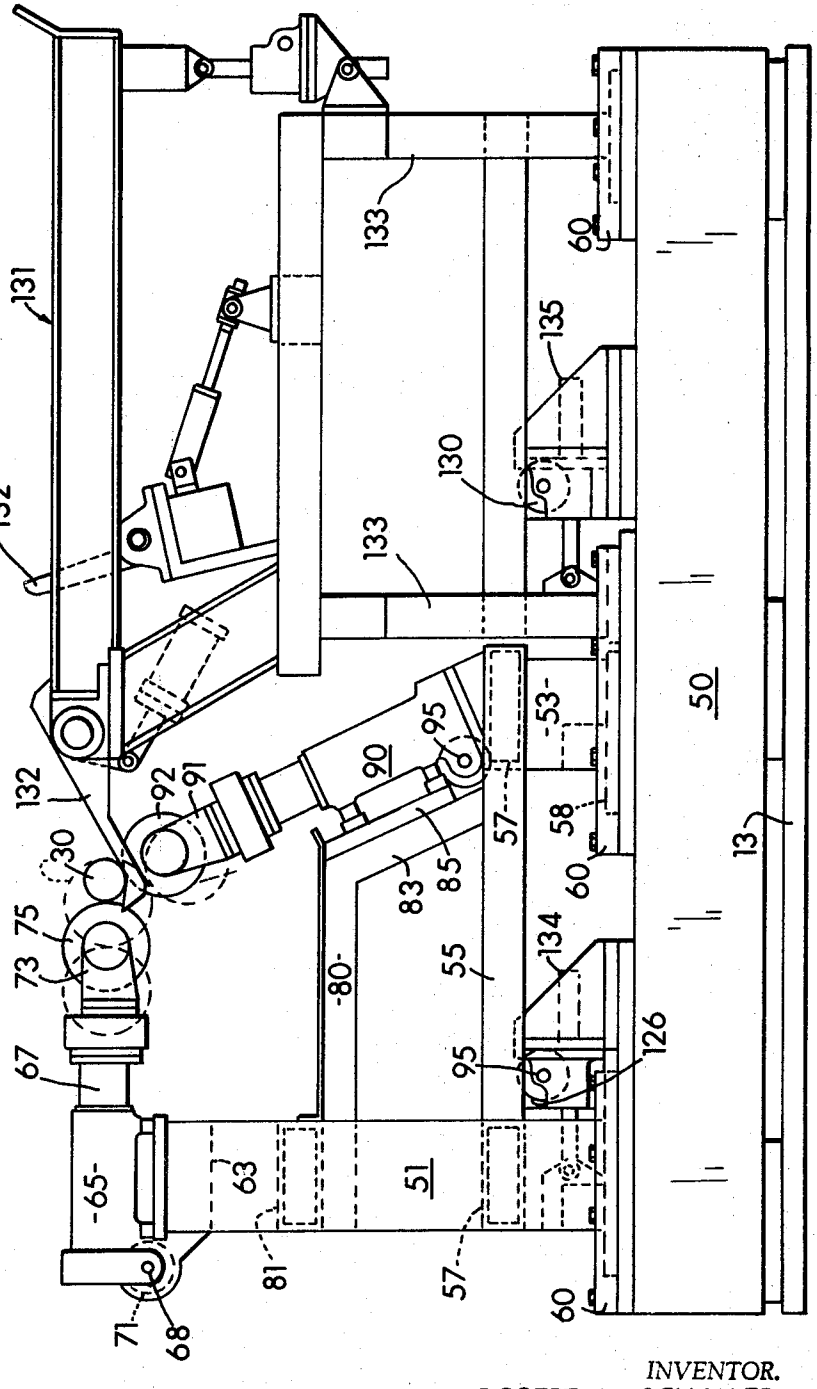


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FIG. 3



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CENTERLESS GRINDING MACHINE

BACKGROUND OF THE INVENTION

Centerless grinding machines have been provided with means for dressing the grinding wheel, and with means for moving the regulating wheel toward the grinding wheel to compensate for the reduction in diameter of the grinding wheel due to the dressing operation. While this arrangement establishes a predetermined spacing between the grinding wheel and the regulating wheel for the intended purpose of grinding bars uniformly to a desired diameter, the arrangement is not satisfactory to maintain the desired bar diameter within close tolerances. Such an arrangement does not automatically and continuously effect a comparable adjustment of the feed rolls supporting the bar during its axial movement into and through the throat of the machine, nor does such an arrangement effect automatic adjustment of the work rest.

BRIEF SUMMARY OF THE INVENTION

This invention has as an object a centerless grinding machine wherein the diameter of the grinding wheel is continuously gauged. The various components of the machine having to do with the positioning of the bar, such as the in-feed rolls, work rest and regulating wheel are initially zeroed from a signal produced by the wheel gauge and thereafter, all of these components are adjusted in unison, as by numerical control, for the grinding of a bar of specified diameter to effect uniform grinding of the bar to a pre-selected precise diameter.

The invention includes an arrangement whereby the various components of the machine are adjusted during the grinding of the bar to compensate for wheel wear, all whereby the specified bar diameter is constantly maintained.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a front elevational view illustrating a machine embodying my invention.

FIG. **2** is an end elevational view looking to the left, FIG. **1**.

FIG. **3** is a view taken on line **3—3**, FIG. **1**.

FIG. **4** is a schematic diagram of the circuity for controlling the various components of the machine.

DETAILED DESCRIPTION

The grinding machine proper is shown in the right portion of FIG. **1** and in FIG. **2**. It consists of a boxlike substructure **10** provided with pads **11** mounted on supporting members **12** fixed to base plates **13**. The member **10** is provided with a top structure **15** on which is fixedly mounted a grinding wheel head assembly including a grinding element which may be in the form of a hard wheel **17**, or other well known and conventional part, driven by a motor **18**. A slide **20** is mounted on the top structure **15** for sliding movement toward and from the grinding element **17**. The slide is guided by ways **21**. The movement of the slide **20** may be effected by a lead screw **23** driven by a servo motor **24**.

Fixedly mounted on the inner end of the slide is a work rest supporting structure **25** in which a work rest **26** is mounted for vertical adjustment. The support **25** may contain screw jack structure operated by a servo motor **27** to effect vertical adjustment of the work rest **26** toward and from the axis of the bar **30**. Such a work rest adjusting structure is disclosed in U.S. Pat. No. 3,466,810, issued Sept. 16, 1969.

The slide **20** is provided with ways **33** in which a regulating wheel mechanism **35** is mounted for sliding movement toward and from the work rest **26**. The regulating wheel mechanism includes a power driven regulating wheel **37**, FIG. **2**. Sliding movement to and from the work rest **26** is imparted to the regulating wheel **35** by a screw **40** operated by a servo motor **41**. The motors **24**, **41**, may be provided with read-out devices **45**. While the regulating wheel mechanism **35** is adjustable by motor **41**, and the rest **26** is adjusted by motor **27**, it will be apparent both the regulating wheel and the rest are adjusted as an assembly by motor **24** actuating the slide **20**.

Referring to FIGS. **1** and **3**, the in-feed roll assembly includes base beams **50** secured to the plate **13**. The structure includes columns **51** of substantial height, and short columns **53** spaced rearwardly of the columns **51** are positioned on beams **50**. The columns **51**, **53**, are connected by members **55** and **57**. Pads **58** are secured to the lower ends of the columns **51**, **53**, and are arranged in gibs **60** for sliding movement on the beams **50** for movement in a direction transverse to the axis of the bar **30** being ground. A cross beam **63** is fixed to the upper ends of the columns **51**, and serves to support a plurality of housings **65**. A ram **67** is slidably mounted in each of the housings **65**, sliding movement being imparted to the rams through a worm gear transmission mounted in each housing and actuated by a shaft **68**. The shafts **68** are connected by shafts **70** driven by a servo motor **71**.

A bifurcated yoke member **73** is fixed to each of the rams **67**, and a feed roll **75** is journalled in each of the yokes **73**. The rams **67** and the feed rolls **75** carried thereby are moved in a horizontal plane toward and from the axis of the bar being ground by the motor **71**.

Beams **80** are fixed to the beam **81** extending between the upright posts **51**. The beams **80** extend rearwardly to inclined beams **83**, FIG. **3**, which are supported by the beams **57**. A plate **85** is fixed to the inclined beams **83**. Screw jack structures **90** are mounted on the plate **85** and arranged in registration with the housings **65**. The units **90** are of the same structural arrangement as the units **65**, including the yokes **91**, in each of which is journalled a roll **92**. The shafts **95** of the jack structures in the housings **90** are operated by a servo motor **97**, FIG. **1**. Rotation of the shafts **95** effects movement of the rolls **92** toward and from the axis of the bar **30**. Simultaneous operation of the shafts **68**, **95**, effects movement of the rolls **75**, **92**, to accept work bars **30** of different diameters. The numerical control system connected to the motors **71**, **97**, effects movement of the rolls **75**, **92**, to maintain work bars of different diameters with their axes positioned on the same pass line.

Initially, in operation, the numerical control system functions to adjust the regulating wheel **37**, the work rest **26**, and the in-feed rolls **75**, **92**, to accept a work bar **30** of a selected diameter and position the bar on a preselected axis to effect grinding of the work bar to a desired diameter.

During the operation of the machine, it will be appreciated that the grinding element **17** wears away and accordingly, is reduced in diameter, thereby increasing the spacing between the grinding wheel and the regulating wheel **37**. In order to maintain the desired finished diameter of the work bar, the regulating wheel **37** is moved inwardly toward the grinding wheel **17** a distance to compensate for the reduction of the diameter of the grinding wheel.

The diameter of the grinding wheel is constantly gauged by a gauging element **100** fixedly mounted on the grinding head for continuous contact with the periphery of the grinding wheel.

A position setter **105**, FIG. **4**, is operated according to the diameter of the finished ground bar. The position setter **105** transmits a signal over line **106** to an amplifier **107**, the output of which is transmitted to a position read-out device **108**, and from there to an actuator device **110**, the output from which is transmitted to the servo motors **71, 97**, to effect movement of the in-feed rolls **75, 92**, to correctly position the bar of the selected diameter. The signal from line **106** is transmitted to an amplifier **111** having an output extending through a position read-out **112** and an actuator **113**, to provide actuating power to the motor **41** to effect movement of the regulating wheel **37** to the proper position for the selected bar.

In like manner, the signal from line **106** is fed to an amplifier **115**, the output being connected through a position read-out **116**, to an actuator **117** connected to the motor **27** which functions to properly position the rest **26**. The signal from line **106** is also fed to an amplifier **120**, the output of which is transmitted through the position read-out **121** and actuator **122** to the servo motors **126, 130**.

The bars are automatically transferred from a load rack **131**, FIG. **3**, by mechanism including a series of bar transfer arms **132**. The loading rack **131** is supported on columns **133** which, like the columns **51, 53**, are slidably mounted on the beams **50**. The infeed wheel assembly is moved in a direction lengthwise of the beams **50** - that is, transversely to the axis of the bar **30**, by screw jack mechanism **134**, FIG. **3**, actuated by the servo motor **126**, FIG. **1**. Also in the arrangement shown, the bar supporting rack is moved by a screw jack mechanism **135** powered by the servo motor **130**.

The signal from line **106** is fed through an amplifier **140**, position read-out **141**, actuator **142**, to motor **24**. It will be recalled that motor **24** effects movement of slide **20** which carries the regulating wheel and rest assembly. The signal from the wheel gauging device **100** is fed through a power amplifier **145** to the amplifier **120**. Also, the gauging signal is fed to the amplifier **140**. Accordingly, when the position setter **105** is dialed for a bar of given diameter, the in-feed rolls **75, 92**, the regulating wheel **37** and the bar rest **26**, are individually moved to position the bar on the pass line. Also, the regulating wheel and the rest assembly is positioned in respect to the then diameter of the grinding wheel **17**. Also the in-feed roll assembly and the loading rack are positioned in respect to the grinding wheel diameter. While the signal from line **106** is effective to operate motors **24, 126, 130**, to move the above assemblies to a theoretically correct position for the bar diameter dialed in, the signal from line **106** is modified by the signal from the wheel gauge **100** to accurately position the assemblies in respect to the then diameter of the wheel **17**. The signal from line **106** is constantly modified by the wheel gauging device to move the in-feed roll assembly, the regulating wheel, rest assembly, and the bar loader, in proportion to the wheel wear.

What I claim is:

1. A centerless bar grinding machine comprising a base, a grinding head fixedly mounted on said base and having a rotatable power driven generally cylindrical grinding element having an axis of rotation, a diameter and a periphery, a slide mounted on said base for movement toward and from the axis of said grinding element, a bar rest mounted on said slide, a regulating wheel assembly mounted on said slide for movement independently thereof toward and from the axis of rotation of said grinding element to accommodate generally cylindrical bars of different diameters, each having an axis of rotation, means mounting said rest on said slide intermediate said head and regulating wheel assembly for adjustment toward and from the axis of rotation of the bar being ground, an in-feed roll structure including a frame mounted on said base for movement toward and from the axis of said grinding element, a linear series of feed roll assemblies mounted on said frame for adjustment to accommodate bars of different diameters, gauging means mounted in juxtaposition to the periphery of said grinding element, said gauging means being operable to continuously sense the diameter of said grinding element and transmit a signal indicative thereof, servo mechanism operable upon receipt of a signal from said gauging means indicative of a reduction of diameter of said grinding element to effect proportional movement of said frame and said slide toward the axis of said grinding element.

2. A centerless bar grinding machine as set forth in claim **1**, wherein said servo mechanism is operable upon receipt of said signal from said gauging means to effect simultaneous proportional movement of said frame and said slide.

3. A centerless bar grinding machine comprising a base, a grinding head fixedly mounted on said base and having a rotatable power driven generally cylindrical grinding element having an axis of rotation, a diameter and a periphery, a slide mounted on said base for movement toward and from the axis of said grinding element, a bar rest mounted on said slide, a regulating wheel assembly mounted on said slide for movement independently thereof toward and from the axis of rotation of said grinding element to accommodate generally cylindrical bars of different diameters each having an axis of rotation, said rest being disposed intermediate said head and regulating wheel assembly and being adjustable toward and from the axis of rotation of the bar being ground, an in-feed roll structure including a first frame mounted on said base for movement toward and from the axis of said grinding element, a linear series of feed roll assemblies mounted on said first frame and being adjustable to accommodate bars of different diameters, a second frame mounted on said base for movement toward and from the axis of said grinding element, a bar supply rack carried by said second frame, a bar loading mechanism mounted on said second frame and operable to transfer bars successively from said supply rack to said feed roll assemblies,

gauging means fixedly mounted in juxtaposition to the periphery of said grinding element, said gauging means being operable to continuously sense the diameter of said grinding element and transmit a signal indicative thereof, servo mechanism operable upon receipt of a signal from said gauging means indicative of a reduction of diameter of said grinding element to effect proportional movement of said first frame, said second frame and said slide toward the axis of said grinding element.

4. A centerless bar grinding machine as set forth in claim 3, wherein said second frame is mounted on said base at the opposite side of the axis of said grinding element on which said first frame is mounted.

5. A centerless bar grinding machine comprising a base, a grinding head mounted on said base and having a rotatable power driven generally cylindrical grinding element having an axis of rotation, a diameter and a periphery, a slide mounted on said base for movement toward and away from the axis of said grinding element, a bar rest mounted on said slide, a regulating wheel assembly mounted on said slide for holding generally cylindrical bars against the grinding element, each bar having an axis of rotation, an in-feed roll structure including a first frame mounted on said base at one side of the axis of a bar in work position for movement toward and away from the axis of rotation of the grinding element and a linear series of feed roll assemblies mounted on said frame for advancing bars toward the grinding wheel, a second frame mounted on said base at the opposite side of the axis of rotation of a bar in work position for movement toward and away from the axis of said grinding element, including a bar supply mechanism associated with the feed roll assemblies, gauging means mounted adjacent the periphery of the grinding element to continuously sense the diameter of the grinding element and transmit a signal indicative thereof, and servo mechanism operable upon receipt of a signal from said gauging means indicative of a reduction of the diameter of said grinding element to effect compensating adjustment of said slide, said first frame and said second frame relative to the axis of said grinding element.

6. A centerless bar grinding machine as defined in claim 5 wherein said second frame includes a bar supply rack and a bar loading mechanism operable to transfer bars successively from said bar supply rack to said feed roll assemblies.

7. A centerless bar grinding machine as defined in claim 5 including means mounting said bar rest on said slide intermediate said head and regulating wheel assembly for adjustment toward and away from the axis of rotation of a bar in work position, means mounting said regulating wheel assembly on said slide for movement independently thereof toward and away from the axis of said grinding element to accommodate bars of different diameters, and means mounting said feed roll assemblies on said first frame for adjustment toward and away from the axis of a bar in work position to accommodate bars of different diameters.

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