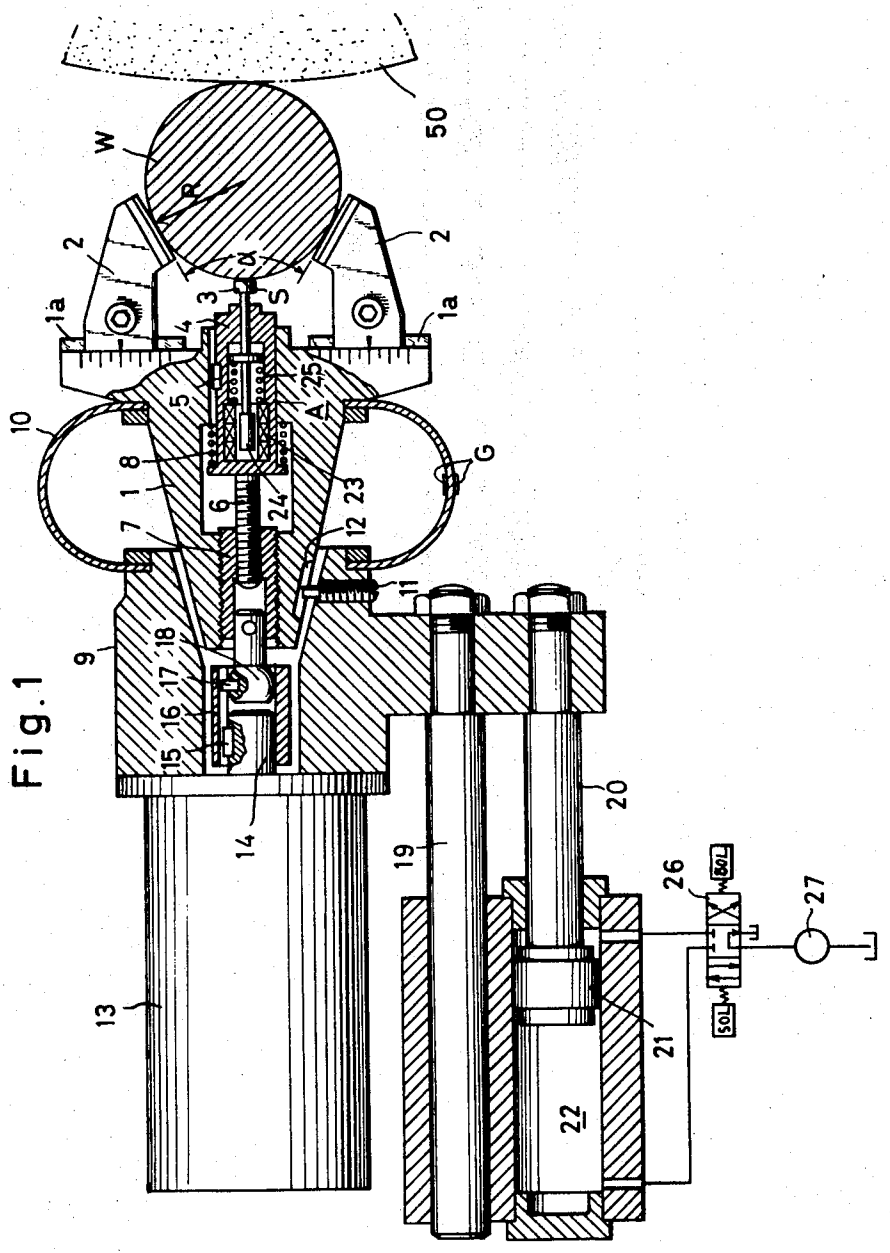
March 9, 1971 HIROAKI ASANO ET AL 3,568,372

SIZING DEVICE FOR EFFECTING SIZING OVER A WIDE RANGE

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Fig. 1



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SIZING DEVICE FOR EFFECTING SIZING OVER A WIDE RANGE

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Fig. 4

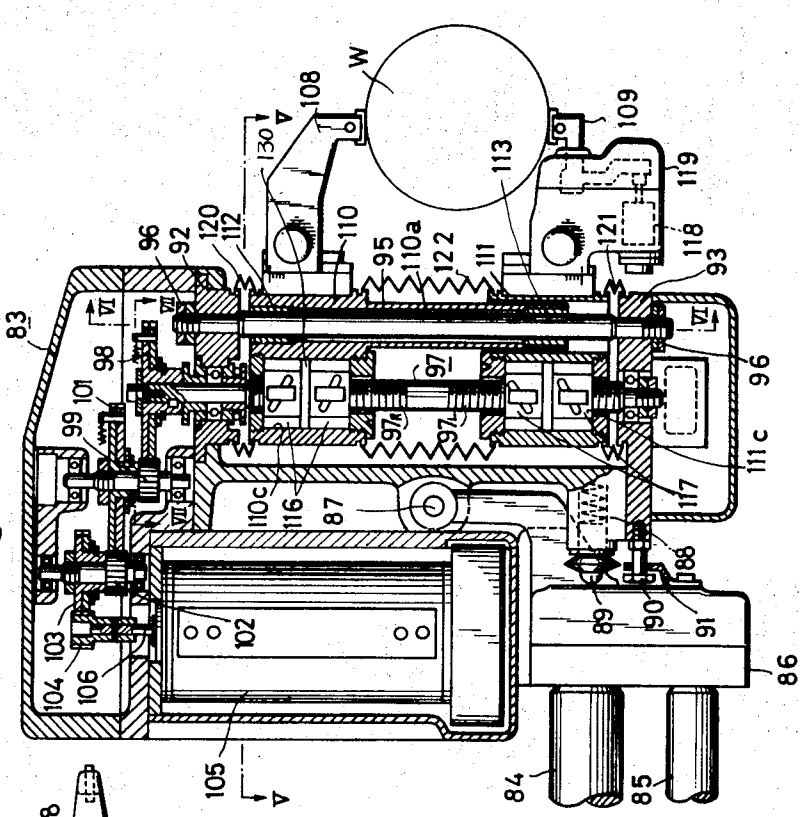


Fig. 5

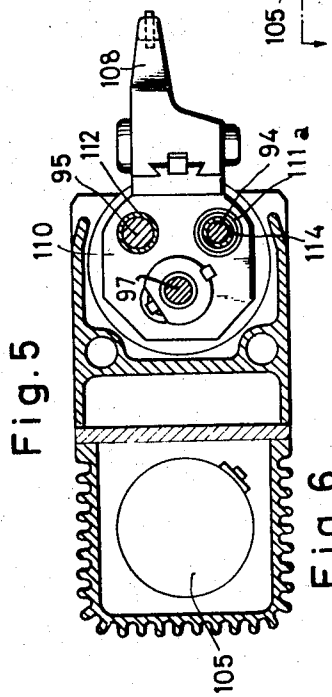


Fig. 7

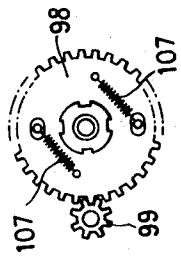
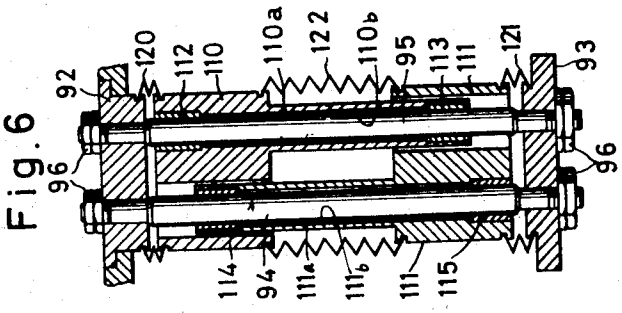


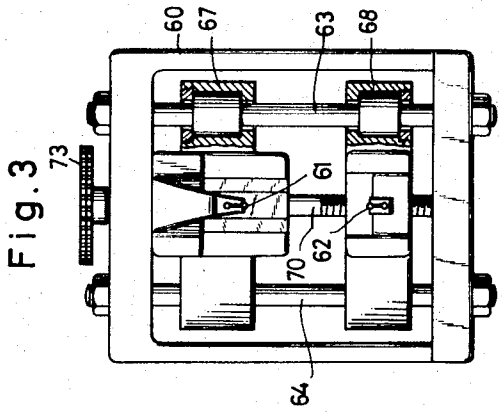
Fig. 6

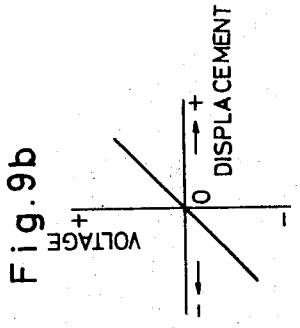


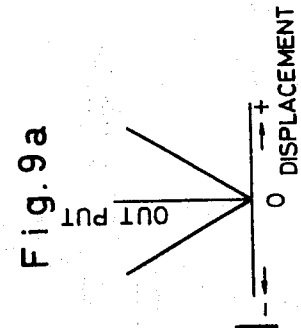
March 9, 1971 HIROAKI ASANO ET AL 3,568,372

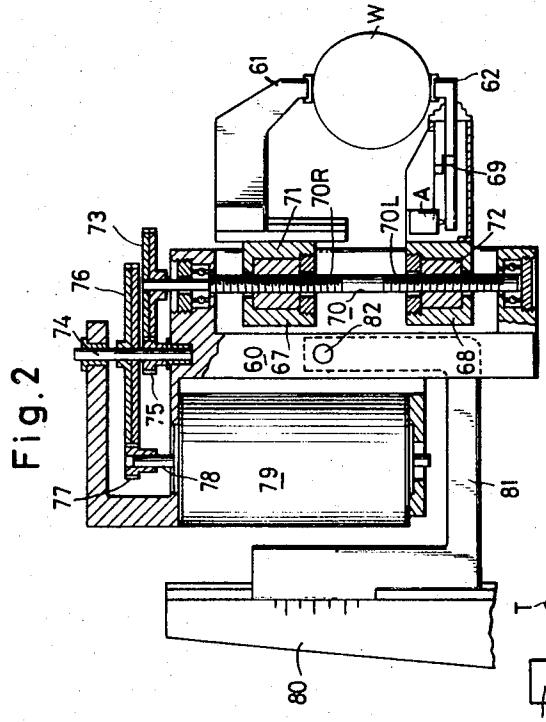
SIZING DEVICE FOR EFFECTING SIZING OVER A WIDE RANGE

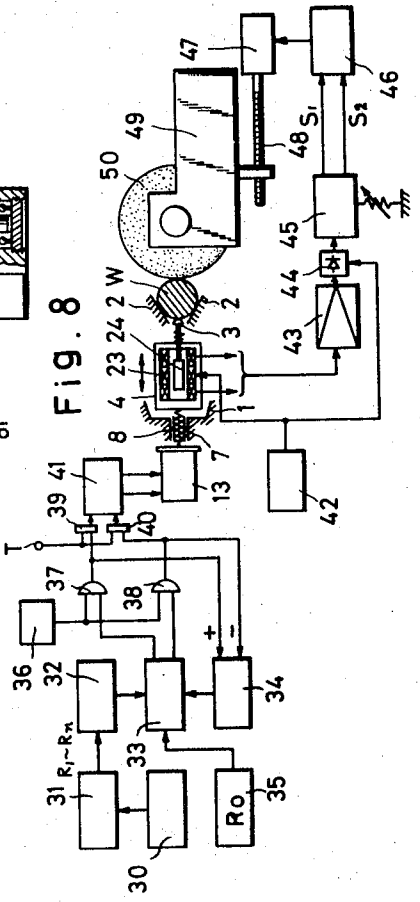
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United States Patent Office

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SIZING DEVICE FOR EFFECTING SIZING OVER A WIDE RANGE

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Int. Cl. B24b 49/04
U.S. Cl. 51—165 12 Claims

ABSTRACT OF THE DISCLOSURE

A sizing device for grinders or the like which uses a feeler or feelers mounted on a sizing head for contacting a workpiece, and a displacement detector for sensing the displacement of the feeler or feelers caused by a change in the outer circumferential dimension of the workpiece so as to control the feed of wheel slide. The displacement detector is moved in accordance with numerical data previously stored, so that the point of generation of a sizing signal by the displacement detector can be moved. The sizing device measures the diameter of a workpiece accurately and over a wide range by eliminating master setting.

BACKGROUND OF THE INVENTION

The present invention relates to sizing devices in general, and in particular the invention is concerned with a sizing device for grinders and the like which permits control of the feed motion of a wheel slide by measuring the diameter of a workpiece.

Sizing devices of the prior art can effect very high precision sizing. However, as their range of sizing is determined, a so-called master setting is essential for effecting adjustments of the position of feelers or adjustments of the operation point of a sizing signal in conformity with the diameter of the workpiece. The sizing device in which a master setting is once effected cannot handle workpieces of other dimensional values than a predetermined value set for a particular workpiece. Therefore, it has hitherto been required to effect master setting of a sizing device each time different workpieces are handled or to use a plurality of sizing devices which are each set to handle a workpiece of a particular diameter. Effecting master setting is a very complicated process involving a certain degree of skill and a prolonged operation time. Moreover, it is required to prepare masters of various dimensions previously finished to have predetermined values. Thus, the present practice is to employ a sizing device only in cases where a large number of workpieces are ground to the same dimension.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a sizing device for grinders or the like which comprises feeler means mounted on a sizing head pivotally supported by a suspension spring mounted on a main supporting structure for contacting the outer circumference of a workpiece supported by a pair of fixed jaws, said feeler means being adapted to move as the diameter of said workpiece varies, displacement detecting means for sensing the relative displacement of said feeler means, an output circuit for generating an electric switch signal at the point of operation of said displacement detecting means, movable feed control means responding to a given sizing instruction for moving said feeler means and said displacement detecting means with respect to the workpiece, driving means connected to said feed control means, and control means for operating said driving means.

The invention also provides a sizing device for grinders or the like which comprises feeler means including a pair of feelers mounted on a sizing head for movement in accordance with the value of a generated sizing signal, said pair of feelers contacting a workpiece at two points on said workpiece diametrically opposed to each other and one of said pair of feelers being capable of moving pivotally, and displacement detecting means mounted on said pivotally supported feeler and responding to a change in the outer diameter of the workpiece.

The invention also provides a sizing device for grinders or the like which comprises control means for operating feeler means, said control means comprising a tape reader and numerical command means, said numerical command means being operated by instructions from said tape reader for effecting control of ad riving mechanism of the feeler means.

OBJECTS OF THE INVENTION

A principal object of the present invention is to provide a sizing device adapted for effecting sizing over a wide range at high precision by accommodating changes in the outer diameter of a workpiece.

Another object of the invention is to provide a sizing device adapted for effecting sizing over a wide range which relies on numerical control.

Another object of the invention is to provide a sizing device for effecting sizing over a wide range in which predetermined amounts of relative displacements of a feeler or feelers in contact with a workpiece and a displacement detector for sensing a relative displacement of said feeler or feelers are set by numerical data previously stored so that the point of generation of a sizing signal of the displacement detector can be moved.

Still another object of the invention is to provide a sizing device adapted for effecting sizing over a wide range which can accommodate variations over a wider range in the outer diameter of a workpiece to be sized than sizing device of the jaw type, once a master setting is effected.

A further object of this invention is to provide a sizing device adapted for effecting sizing over a wide range including supporting and guiding means which permits sizing accurately and with high precision.

A still further object of the invention is to provide a sizing device adapted for effecting sizing over a wide range in which protective covers are mounted between upper and lower jaws of a sizing head and a pair of supporters and between said supporters themselves so that the sliding portions of said supporters can be protected by said protective covers against coolant or grinding wheel particles during grinding operations.

Additional objects and advantages of the invention will become apparent from consideration of the description set forth below when considered in conjunction with the accompanying drawings.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a sectional view of a first embodiment of the sizing device according to this invention;

FIG. 2 is a longitudinal sectional view of a second embodiment of the sizing device according to this invention;

FIG. 3 is a front view of the second embodiment shown in FIG. 2, with certain parts being broken away;

FIG. 4 is a longitudinal sectional view of a third embodiment of the sizing device according to this invention;

FIG. 5 is a sectional view taken along the line V—V of FIG. 4 and seen in the direction of arrows;

FIG. 6 is a sectional view taken along the line VI—VI of FIG. 4 and seen in the direction of arrows;

FIG. 7 is an end view of the portion taken along the line VII—VII of FIG. 4 and seen in the direction of arrows;

FIG. 8 is a block diagram of a control circuit used when the device according to this invention is applied to a grinder of the numerical control type; and

FIGS. 9*a* and 9*b* show output characteristics of a displacement detector.

DETAILED DESCRIPTION OF THE INVENTION

A first embodiment of this invention will now be explained with reference to FIG. 1. A pair of fixed jaws **2** and **2** are mounted on vertically aligned surfaces **1***a* and **1***a* at the front end of a sizing head **1**. The positions in which said fixed jaws are mounted can be adjusted and varied by conventional position adjusting means. A movable feeler **3** is supported concentrically with supporter means **4** which mounts therein a displacement detector A. The supporter means **4** is supported by the sizing head **1** for axial sliding motion and restrained against rotation by a key **5**. A rod **6** formed with a fine threaded portion thereon projects rearwardly from the rear end of the supporter means **4** for threadable engagement with a differential nut **7**. The differential nut **7** has an externally threaded portion which is in threadable engagement with the sizing head **1**. Rotation of the nut **7** by means subsequently to be described results in displacement of the supporter means **4** by an amount corresponding to a difference in pitch between the internally threaded portion and the externally threaded portion of the nut **7**. A spring **8** for eliminating backlash of the nut is mounted between the supporter means **4** and the sizing head **1**. A suspension spring **10** floatingly mounts the sizing head **1** on a main supporter **9**. A transducer G is mounted on the suspension spring **10** for detecting the deflection of the spring. A stop **11** for restraining the sizing head **1** against rotation is received in a recess **12**. Firmly secured to the main supporter **9** is a pulse motor **13** which has a rotary shaft **14** connected to the differential nut **7** through joint means **15**, **16**, and **18**. Said joint member **18** has one end which is spherical in shape for floatingly accommodating the sizing head **1**. A drive pin **17** is fixed to the joint member **18**. A pilot bar **19** and a piston rod **20** connected to a piston **21** are fixed at one end thereof to the main supporter **9** which is moved horizontally in reciprocating motion by the pressing force of a quantity of fluid supplied under pressure to a cylinder **22** from a fluid source **27**. The foremost advance position of the main supporter **9** is controlled by an output signal of the transducer G mounted on the suspension spring **10**. Upon occurrence of a predetermined amount of deflection in the suspension spring **10**, the output voltage due to the change of resistences of the transducer G exceeds a predetermined voltage level and an electric switch signal is produced. The electric signal thus produced de-energizes a solenoid of a change-over valve **26** and the valve is switched to a neutral position, so that the two ports of the cylinder **22** are closed. Thus, the main supporter **9** is halted in its forward movement. This arrangement is conducive to elimination of errors in the sizing operation stemming from the presence of contact pressure between the supporter means and a workpiece W, because a change in the outer diameter of the workpiece does not cause deflection of the suspension spring **10** over and above a predetermined amount. The displacement detector A in the present invention may be any device available, such as an electric micrometer or pneumatic micrometer. The displacement detector used in the present embodiment is a differential transformer in which a bobbin **23** having a primary coil and a secondary coil wound thereon and a movable iron core **24** are mounted concentrically, said movable iron core **24** being connected to the aforementioned movable feeler **3** which is urged forwardly by a spring **25** for providing contact pressure at all times.

In a sizing device of the jaw type described above, the point of contact between the movable feeler **3** and the workpiece W is displaced by an amount proportional to a change in the outer diameter of the workpiece. The amount of displacement is equal to the amount of change Δr in the radius of the workpiece when the angle α defined by the pair of fixed jaws **2** and **2** is 60 degrees. Thus, when the radius R is increased, the point of contact S is moved forwardly (toward the center of axis of the workpiece); when the radius is reduced, the point of contact is moved rearwardly.

To effect the initial master setting, the supporter means **4** is positioned at a predetermined position and a Schmitt circuit or the like responsive to the output of the displacement detector A is adjusted so as to produce an electric switch signal when a reference master radius R_0 is measured. Simultaneously with the setting of the generation point for obtaining a finished dimension, the generation point of a fine feed signal which lies slightly short of the operation point of the sizing signal is also set by taking a finish allowance into consideration. When it is required to size other values than the reference master radius R_0, the supporter means **4** has only to be moved by a distance corresponding to a change in radius to produce a sizing signal when the feeler **3** and the supporter means come to the predetermined position i.e., the same relative positions as the master setting, since the feeler **3** is moved through contact with the workpiece W by a distance corresponding to the change in radius of the workpiece W. Assuming that the radius of the finished workpiece is R_1 (which is equal to R_0 plus Δr), predetermined input pulses are applied to the pulse motor **13** so as to rotate the differential nut **7** and thus move the supporter means **4** a distance corresponding to Δr. When the workpiece W is ground by the grinding wheel on the wheel slide into a radius with a finish allowance, the Schmitt circuit which responds to the displacement detector A produces a fine feed signal to reduce the feed rate of the wheel slide toward the workpiece W. Upon further reduction of the workpiece radius to the required value R_1, the sizing signal is produced to stop the feed motion of the wheel slide. Thus, the need for effecting a master setting each time the diameter of the workpiece is varied is eliminated, and one has only to apply to the pulse motor **13** input pulses corresponding to a change in the diameter of the workpiece. The accuracy of the sizing signal may vary depending on the accuracy of positioning of the supporter means **4**. However, since it is possible to reduce a cumulative pitch error of a precision screw to within 1μ, it has been found that the present invention allows sizing with an accuracy in the order of microns.

A second embodiment of the invention will now be explained with reference to FIGS. 2 and 3. In this embodiment of the invention, the sizing of workpieces differing from one another in diameter over a wider range than are the case with workpieces handled by a sizing device of the jaw type can be effected once an initial master setting is effected. In FIGS. 2 and 3, a sizing head **60** includes movable supporter members **67** and **68** guided and supported by guide bars **63** and **64** and supporting a pair of feelers **61** and **62**, respectively, which contact

a workpiece W at positions on the workpiece diametrically opposed to each other. One feeler **62** is supported by a cross spring **69** for pivotal displacement. Operably connected at one end of the feeler **62** is a displacement detector A which detects the displacement of the feeler **62** relative to the supporter member **68** which mounts the feeler **62**. A threaded rod **70** extending through the supporter members **67** and **68** and journalled by the sizing head **60** is formed with a right-hand threaded portion **70R** and a left-hand threaded portion **70L** which threadably engage nuts **71** and **72**, respectively, which are fixed to the supporter members **67** and **68** respectively. The threaded rod **70** is connected to a rotary shaft **78** of a pulse motor **79** through the agency of a gear **73** mounted at one end of the threaded rod **70** and in meshing engagement with a gear train consisting of gears **75**, **76** and **77** mounted on an intermediate shaft **74**. The gears **73** and **76** are compound gears and a spring is mounted between the component members of each compound gear so as to eliminate backlash between the gears in meshing engagement with each other. The pulse motor **79** is fixed to the sizing head **60**. When a pulse signal is applied to the pulse motor **79**, the pulse motor rotates the threaded rod **70** through an angle proportional to the number of pulses of the signal applied thereto so as to move said pair of feelers **61** and **62** toward or away from each other. The sizing head **60** is pivotally mounted by a pin **82** on a bracket **81** secured to a main body **80**. The main body **80** is connected to a suitable reciprocating mechanism as is the case with the first embodiment of the invention.

In the sizing device of the type described, the movable supporter members **67** and **68** mounting the pair of feelers **61** and **62** are moved a distance corresponding to the amount of change of the workpiece diameter in the radial direction of the workpiece W, whereby the sizing signal is generated when the pivotable feeler **62** comes to the predetermined position with respect to the displacement detector A, regardless of the workpiece diameter change. This embodiment of the invention operates in the same manner as the first embodiment. However, since the feelers **61** and **62** are moved radially of the workpiece, they never interfere with the operation of a grinding wheel, no matter in what positions the feelers may be disposed. This allows a great increase in the range of possible sizing. Moreover, sizing can be effected in the second embodiment over a wide range once a master setting is first effected.

In the second embodiment of the invention, it is essential to accurately determine the distance between the pair of feelers after they are moved relative to each other, in order to vary the point of operation of the sizing signal. In addition, it is essential to have the movable supporter members accurately guided in sliding motion in the sizing head in order to prevent the forward ends of the feelers from being deflected radially of the workpiece and displaced. A third embodiment shown in FIGS. 4 and 5 include guide means of special construction for the feeler supporters and means for preventing dust collection mounted in the sliding guide portion.

In FIG. 4, a sizing head **83** is pivotally mounted by a pin **87** on a reciprocable bracket **86** connected to a pilot bar **84** and a piston rod **85** of a hydraulic reciprocating power motor (not shown). Mounted at the lower end of the sizing head **83** is a plunger **89** which is urged by a spring **88** to bear against the front surface of the bracket **86** so as to maintain the sizing head balanced at the pivoting pin **87**. A projection **90** adjustably secured to the sizing head **83** which has an enlargement at the left hand end regulates the range of pivotable movement of the sizing head **83** in cooperation with a stop **91** fixed on the bracket **86**.

Mounted in the upper and lower portions of the sizing head **83** on its front surface are jaws **92** and **93** between which two pilot bars **94** and **95** extend, the opposite ends of the pilot bars **94** and **95** being secured by nuts **96**. A feed rod **97** formed with a right-hand threaded portion **97R** and a left-hand threaded portion **97L** thereon is rotatably mounted in a position corresponding to the apex of a triangle having its base on a line connecting the center of axis of the pilot bar **94** with the center of axis of the pilot bar **95**. The feed rod **97** is connected through the agency of a gear **98** mounted at its upper end and meshing with a gear train consisting of gears **99**, **101**, **102**, **103** and **104** to a rotary shaft **106** of a pulse motor **105** fixed to the sizing head **83**. In order to eliminate the backlash of the gears, springs **107** are mounted between the component members of each of the compound gears **98**, **101** and **103** which are in meshing engagement with single gears, **99**, **102** and **104**, respectively. Supporter members **110** and **111** mounting feelers **108** and **109** respectively, are slidably guided by the pilot bars **94** and **95**, respectively. The supporter members **110** and **111** are formed with openings for the pilot bars **94** and **95** and the feed rod **97** to extend therethrough.

A downwardly directed cylindrical extension **110***a* is formed integrally with the supporter member **110**, and guide bushes **112** and **113** are fitted at the upper end and the lower end, respectively, in the bore **110***b* of the supporter member **110** and the cylindrical extension **110***a*. The guide bushes **112** and **113** are snugly and intimately fitted over the guide bar **95** for sliding motion so as to thereby guide the supporter member **110** in its reciprocating motion. An upwardly directed cylindrical extension **111***a* is formed integrally with the supporter member **111**, and guide bushes **114** and **115** are fitted at the upper end and the lower end, respectively, in the bore **111***b* of the supporter member **111** and the cylindrical extension **111***a*. The guide bushes **114** and **115** are snugly and intimately fitted over the guide bar **96** for sliding motion so as to thereby guide the supporter member **96** in its reciprocating motion. The openings formed in the supporter members **110** and **111** for the feed rod **97** to extend therethrough mount thereon internally threaded members **116** and **117** which threadably engage the right-hand threaded portion **97R** and left-hand threaded portion **97L** of the feed rod **97**, respectively. Each of the internally threaded members **116** and **117** consists of a set of two nuts of the circulating ball type.

The two nuts are rendered preloaded through adjustment of the thickness of spacing collars **130** interposed therebetween to thereby eliminate backlash.

A feeler **108** is adjustably mounted by dovetail engagement on the upper supporter member **110**, while a block **119** pivotally mounting a feeler **109** and including a built-in displacement detector **118** is adjustably mounted by dovetail engagement on the lower supporter member **111**. A bellows **120** made of rubber or like material is clamped at its lower end to the periphery of the upper end of the supporter member **110** and at its upper end to the peripheral edge of the jaw **92**. Similarly, a bellows **121** is clamped at its opposite ends to the periphery of the lower end of the supporter member **111** and the peripheral edge of the jaw **93**. A bellows **122** is clamped at its opposite ends to the lower end of the supporter member **110** and the upper end of the supporter member **111**. The provision of bellows **120**, **121** and **122** is conducive to preventing grinding wheel particles and coolant from adhering to the pilot bars and the feed rod by covering and enclosing the same.

The supporter members **110** and **111** carrying the feelers **108** and **109**, respectively, as aforementioned are respectively fitted over the parallel pilot bars **94** and **95** and guided thereby through nearly the entire length. This arrangement eliminates or minimizes the deflection of the feelers **108** and **109** radially of the workpiece when the feelers tend to be spreaded radially of the workpiece in coming into contact with each other. The supporter members **110** and **111** guided by the pilot bars **94** and **95**, respectively, threadably engage the feed rod **97** at posi-

tions spaced apart from the center axes of the pilot bars **94** and **95**, so that the supporter member **110** and **111** are restrained against rotation about their axes by the pilot bars **94** and **95**, and the feelers **108** and **109** are restrained against lateral displacement. This arrangement offers an advantage in that, when a preset pulse signal is applied to the pulse motor **105** to rotate the feed rod **97** through the agency of the gearing so as to thereby effect displacement of the feelers **108** and **109** up and down a desired amount and change the generation point of a sizing signal, the generation point will move accurately to a desired point. Also, deflection of each of the feelers can be minimized because of the fact that there is a clearance between the supporter member and the pilot bar and the feelers are guided for nearly the entire length of the pilot bar. This is conducive to the elimination of sizing errors. Advantages of the sizing device of the third embodiment of the invention are summarized as follows: The sliding portions of the supporter members are covered by bellows or other flexible protective members, so that the invasion of coolant and grinding wheel particles into the sliding portions can be prevented during grinding operations. The inner spaces covered by the protective members maintain communication with one another, so that the relative sliding motion of the supporter members does not cause movement of air between the inner spaces and atmosphere. Thus, no dust floating in the atmosphere will be drawn by suction into the sliding portions. The protection provided to the sliding portions permits the sizing device of this invention to effect sizing at high precision for a prolonged period of time.

As aforementioned, the sizing device according to this invention as exemplified in the various embodiments described permits sizing at high precision and over a wide range. This advantage imparts increased versatility to this sizing device in performing grinding operations by using this sizing device. This sizing device is particularly useful in grinding workpieces having diverse diameters.

Application of the sizing device according to this invention to a grinding operation of the numerical control type will be explained with reference to FIG. 8. In FIG. 8, **30** refers to a tape reader, **31** to a decoder, **32** to a register in which the value in the radius of a finished workpiece is preset, **33** to a comparator, **34** to a counter, **35** to a register in which the value of the radius of a reference master is set, **36** to a pulse generator, **37** and **38** to AND gates, **39** and **40** to gates closed only when initial setting is effected, and **41** to a pulse motor drive unit. The data read off by the tape reader **30** are discriminated by the decoder **31** and only the value of the radius of a finished workpiece is preset in the register **32**. The comparator **33** compares the contents of the counter **34** with those of the register **32** and closes or opens one of the gates **37** and **38**. It is required to set the value of radius (R_0) of the reference master in the counter **34** immediately after the master setting of the sizing device is effected. An initial setting signal is applied to the gates **39** and **40** through an input terminal T so as to close the same. At the same time, the contents of the register **35** in which the radius of the reference master is set and those of the counter **34** are compared and one of the gates **37** and **38** is opened. Pulses are applied to the counter **34** from the pulse generator **36** so that the value of radius (R_0) of the reference master may be preset in the counter **34**. The pulse motor **13** remains inoperative because no pulses are applied to the pulse motor driving unit **41**. In this way, initial presetting of the reference master radius (R_0) is effected in the counter **34**. Thus, the initial setting signal is cancelled. Upon presetting of a first command value (R_1) in the register **32**, command pulses corresponding to a change in radius ($\Delta r=R_1-R_0$) are applied to the pulse motor drive unit **41** by the gates **37** and **39** or the gates **38** and **40** so as to drive the pulse motor **13** and accurately move the supporter means **4** by an amount corresponding to the change in radius (Δr). When a second command value (R_2) is applied, the supporter means **4** is moved by an amount corresponding to a change in radius $\Delta r=R_2-R_1$, because the first command value R_1 is stored in the counter **34**. It will be evident that the supporter means **4** is moved by an amount corresponding to a change in radius or a difference between the value stored in the counter **34** and the new command value applied. The primary coil of the differential transformer is energized by an AC power source **42** and an output signal corresponding to the amount of displacement of the movable iron core **24** is produced by the secondary coil. After being amplified by an amplifier **43**, this output signal is rectified at a synchronizing and rectifying circuit **44** so that it may be taken out as a positive or a negative voltage in accordance with the direction of displacement of the movable iron core as shown in FIG. 9*b*. A jump takes place in a Schmitt circuit **45** when the voltage thus discriminated agrees with a given set voltage. Master setting of the generation point for a sizing signal (S_1) and the generation point for a fine feed signal (S_2) of the circuit is effected beforehand. The fine feed signal and the sizing signal are applied to a feed control circuit **46** for a wheel slide **49** for reducing the rate of a feed motor **47** and shutting off the motor.

After the supporter means **4** has been moved as instructed by an input signal from a tape or the like, the movable iron core of the differential transformer is positioned away from the generation point. In this state, a command is given to move the wheel slide **49** forwardly at high speed, and the feed is switched to a slow feed when a grind wheel **50** is brought into contact with the workpiece W by suitable means, so that grinding can be performed. As the grinding operation progresses, the diameter of the workpiece W is reduced and the movable iron core **24** draws near the operation point. When the grinding operation has progressed to a point where only the finish allowance is left on the workpiece, the fine feed signal is applied and the rate of feed motor **47** is reduced so that precision feed may be effected. A further progress in the grinding operation results in the application of the sizing signal, whereby the feed of the wheel slide **49** is stopped and the wheel slide is moved rearwardly at high speed after spark out of a predetermined time interval. If a new command is given as to the diameter of a workpiece to be worked on, the supporter means **4** is moved by an amount corresponding to a difference in diameter between the old and new workpieces, so that the generation point with respect to the center of the workpiece can be displaced. It will be evident that the sizing device of the present invention can handle workpieces of any diameter in grinding operations after an initial master setting is effected. The invention also makes it possible to effect sizing at high precision.

The control circuit shown in FIG. 8 can also be used in cases where a series of values corresponding to differences between the value of the reference master and the values to be achieved on the workpiece W are stored as an input signal on the tape. In this case, the register **35** in which the value of the radius of a reference master is set can be abolished. Control of pulses to be applied is effected by the counter **34** and comparator **33** as well as by the gates **37** and **38** in such a manner that an input command value read off by the tape reader **30** is stored in the register **32** and a pulse signal equal in number to said input command value can only be applied to the pulse motor **13**. Upon completion of operation, the contents of the counter **34** are reset. Resetting of the counter **34** must be effected in order that a pulse signal equal in number to the next input command value may be applied to the pulse motor.

While the present invention has been shown and described with reference to preferred embodiments, it is to be understood that the invention is not limited to the precise forms of apparatus, and that changes and modifications may be made therein without departing from the scope and spirit of the invention. The appended claims

should, therefore, be interpreted to cover such changes and modifications.

We claim:

1. A sizing device for effecting sizing over a wide range comprising a sizing head, a feeler supported by said sizing head and maintained in contact with a workpiece and adapted to be displaced in conformity with a change in the dimension of the workpiece, a displacement detector responding to a relative change in the position of the feeler, a signal output circuit for generating an electric switch signal at the generation point set by said displacement detector, movable feed control means for moving said feeler and said displacement detector to relative positions which are predetermined with respect to the center of rotation of the workpiece, drive means connected to said feed control means, and control means for applying a control signal for actuating said drive means, such sizing device being characterized in that said control means applies to said drive means a control signal representing said difference between the input command value and the value previously set.

2. A sizing device for effecting sizing over a wide range comprising a sizing head, a pair of feelers supported by said sizing had maintained in contact with a workpiece and adapted to be displaced in conformity with a change in the dimension of a workpiece, a displacement detector responding to a change in the positions of the feeler, a signal output circuit for generating an electric switch signal at a generation point set by said displacement detector, movable feed control means for moving said feelers and said displacement detector to relative positions which are predetermined with respect to the center of rotation of the workpiece, a pulse motor connected to said feed control means, and control means for applying a pulse signal to said pulse motor, such sizing device being characterized in that said control means applies to said pulse motor said pulse signal corresponding in the number of pulses to a difference between the input command value and the value previously set.

3. A sizing device as claimed in claim 2 in which said control means comprises a register for storing the value of said input command signal, a reversible counter for counting the number of pulses of said pulse signal applied to said pulse motor, a comparator for comparing the contents of said register and said reversible counter, and a pulse generator for generating said pulse signal for driving said pulse motor, characterized in that said control means effects control such that said pulse generator generates said pulse signal corresponding in the number of pulses to a difference between the contents of said register and the contents of said reversible counter.

4. A sizing device for effecting sizing over a wide range comprising a main supporter connected to and supported by reciprocable feed means, a sizing head supported by said supporter, supporter means operatively connected through a differential gear to control means mounted on said main supporter and mounted on said sizing head in such a manner that it is restrained against rotation about its axis, a movable feeler concentrically supported by said supporter means, a displacement detector contained in said supporter means, and a fine threaded rod projecting rearwardly from the rear end of the supporter means for threadable engagement with said differential gear.

5. A sizing device as defined in claim 4 in which said sizing head is floatingly mounted on said main supporter by a suspension spring, said suspension spring mounting thereon a transducer for detecting the deflection of the suspension spring, so that the foremost advance position of the main supporter can be controlled by an output signal produced by said transducer.

6. A sizing device for effecting sizing over a wide range in which a pair of feelers are maintained in contact with a workpiece at positions on said workpiece diametrically opposed to each other and supported by a sizing head in such a manner that the positions of contact of said feelers with said workpiece can be moved a predetermined distance in conformity with a value set for sizing, said sizing head mounting therein two vertically oriented parallel pilot bars firmly secured at their upper and lower ends, a rotatable feed rod mounted in parallel relation to said pilot bars, and drive means for driving a pulse motor through a gearing so as to rotate said feed bar through a predetermined angle in conformity with said value set for sizing, said pilot bars mounting thereon supporter members respectively which are disposed in the upper portion and the lower portion of the pilot bars respectively and guided thereby in sliding motion as they are moved by said feed rod relative to each other, one of said supporter members fixedly supporting one of said pair of feelers and the other of said supporter members pivotally supporting the other of said pair of feelers, said pivotally supported feeler mounting therein a displacement detector which responds to a change in the outer diameter of the workpiece with which said pivotally supported feeler is maintained in contact.

7. A sizing device as claimed in claim 6 in which said upper positioned supporter member supported and guided by one of said pilot bars is formed integrally with a downwardly directed cylindrical extension aligned with the axis of said pilot bar and fitted over said pilot bar at the upper end portion and the lower end portion of the supporter member, and said lower positioned supporter member supported and guided by the other of said pilot bars is formed integrally with an upwardly directed cylindrical extension aligned with the axis of said pilot bar and fitted over said pilot bar at the upper end portion and the lower end portion of the supporter member, characterized in that said pair of supporter members are individually guided by different pilot bars in their sliding motion.

8. A sizing device as claimed in claim 7 in which said feed rod mounted in the sizing head for causing said supporter members mounting said feelers to move in sliding motion relative to said two pilot bars disposed in parallel relation to each other for individually support and guiding said supporter members is disposed such that it is positioned at the apex of a triangle having its base on a line connecting the center of axis of said one pilot bar with the center of axis of said outer pilot bar.

9. A sizing device as claimed in claim 6 in which said sizing head is pivotally mounted by a pin on a bracket which can be moved in reciprocating motion by a hydraulic pressure cylinder and a spring-loaded plunger is mounted in the lower end portion of the sizing head so that said plunger may bear against the front side of said bracket so as to thereby balance the sizing head, and a projection disposed in parallel relation to said plunger and formed with an engaging surface at its forward end is attached to the sizing head, said projecting being adapted to engage a stop attached to the front side of the bracket so as to thereby control the range of pivotal motion of the sizing head.

10. A sizing device as claimed in claim 8 in which a protective cover is mounted between upper and lower jaws attached to the sizing head and said pair of supporter members and a protective cover is also mounted between the supporter members whereby sliding portions of said supporter members can be protected.

11. A sizing device for effecting sizing over a wide range comprising a sizing head, a feeler supported by said sizing head and maintained in contact with a workpiece and adapted to be displaced in conformity with a change in the dimension of the workpiece, a displacement detector responding to a change in the position of said feeler, a signal output circuit for producing an electric switch signal at the generation point set by said displacement detector, and means responding to a control signal for sizing to automatically move said feeler and said displacement detector to relative posiitons which are predetermined with respect to the center of rotation of the workpiece, said control signal representing a difference between the input command value and the value previously set.

12. A sizing device for effecting sizing over a wide range comprising a sizing head, a feeler supported by said sizing head and maintained in contact with a workpiece and adapted to be displaced in conformity with a change in the dimension of the workpiece, a displacement detector responding to a relative change in the position of said feeler, a signal output circuit for generating an electric switch signal at the generation point set by said displacement detector, means for automatically moving said feeler and said displacement detector to relative positions which are predetermined with respect to the center of rotation of

the workpiece, and control means for applying a control signal for actuating said moving means, said control signal representing a difference between the input command value and the value previously set.

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