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Suzuki et al.

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[54] **GRINDING MACHINE**

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[51] **Int. Cl.²** **B24B 53/02; B24B 49/18**
[58] **Field of Search** ..... 51/5 D, 110, 112, 165.85, 51/165.87, 165.88, 165.9, 165.91

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[57] **ABSTRACT**

A grinding machine has a grinding wheel mounted on one side of a straight passageway and adapted to grind the end of workpieces, such as coil springs, continuously fed on a carrier. The grinding machine further has a position setting mechanism for setting the position of the grinding wheel relative to the workpiece and a dressing mechanism for dressing the grinding surface of the grinding wheel. A speed reducer equipped reversible motor is employed for moving a position setting element of the position setting mechanism, or a dressing element of the dressing mechanism, in a direction substantially perpendicular to the grinding surface of the grinding wheel, while an air cylinder is employed for moving the position setting element, or the dressing element, in a direction parallel to the grinding surface of the grinding wheel.

5 Claims, 3 Drawing Figures

FIG. 1

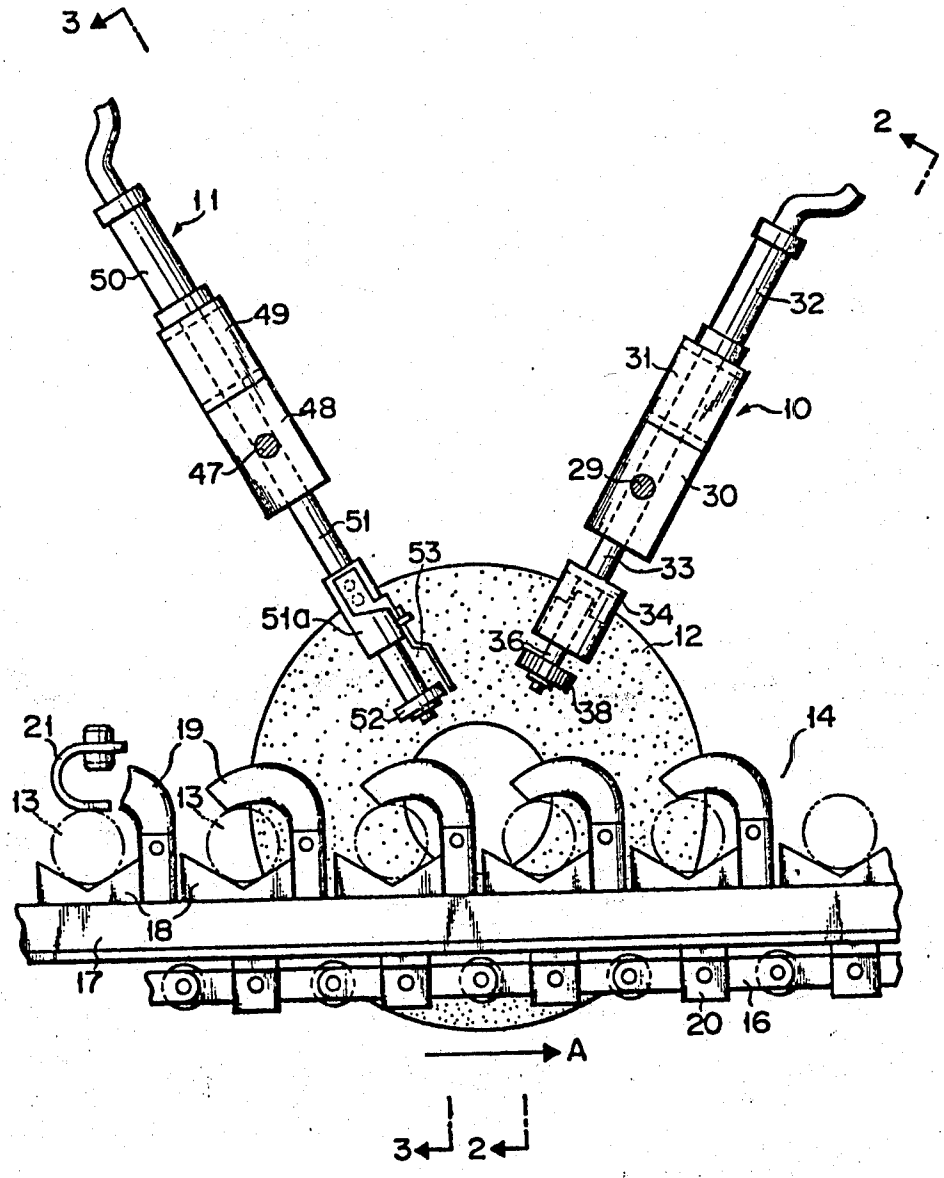
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FIG. 2

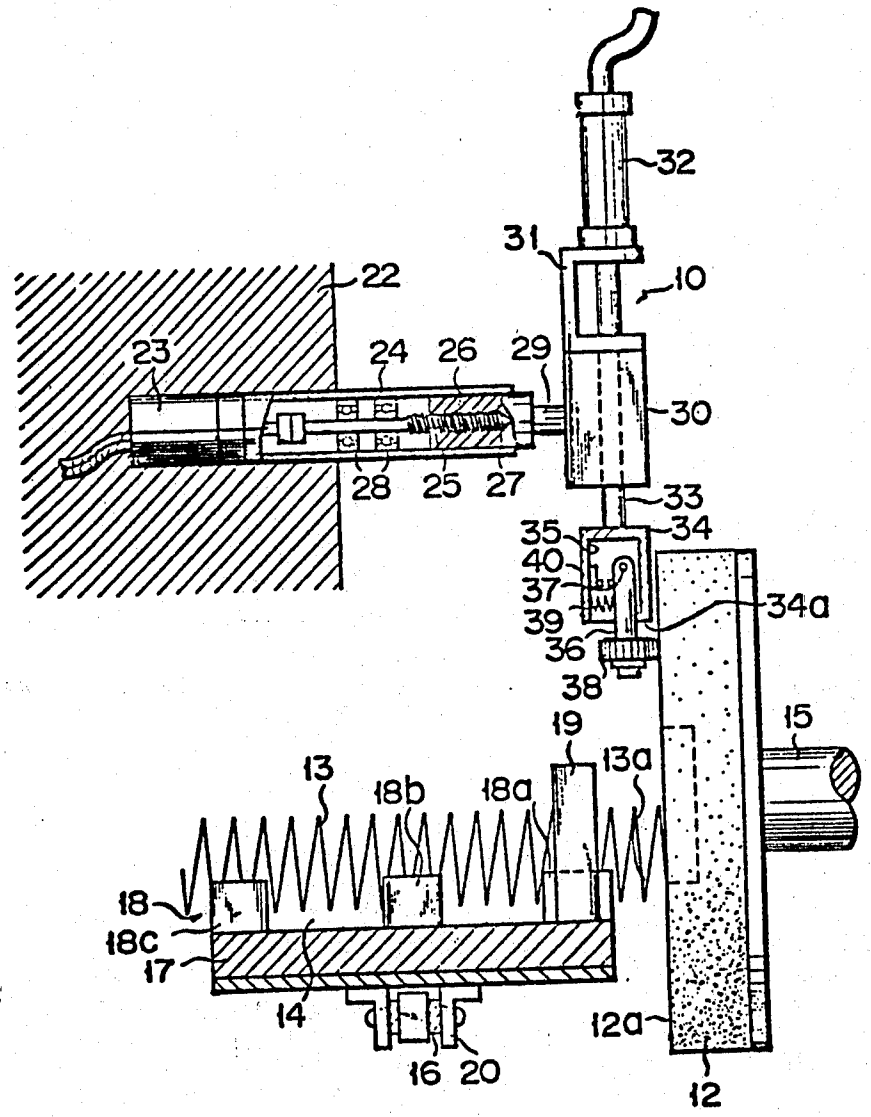
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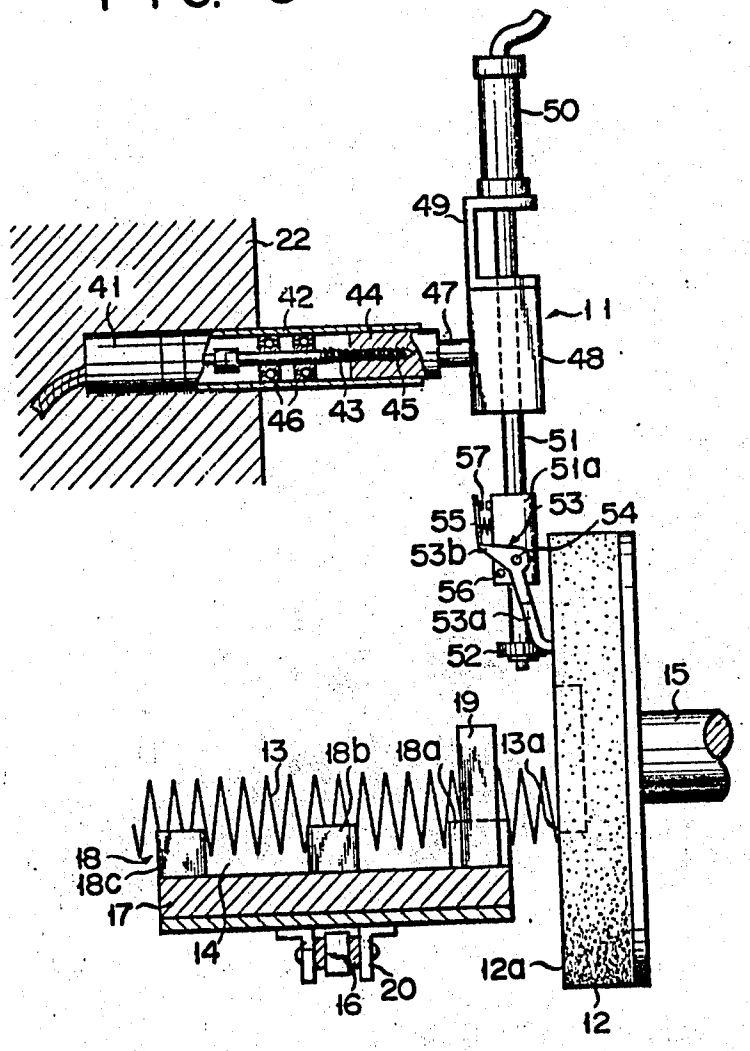
FIG. 3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18b
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18c
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12a
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GRINDING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to a grinding machine for grinding the end of workpieces such as coil springs, and in particular to a grinding machine having a grinding wheel mounted on one side of a passageway and adapted to grind the end of workpieces, such as coil springs, continuously fed while being held on carrier means arranged in a passageway, said grinding machine including a position setting mechanism for setting the position of the grinding wheel relative to the workpiece so as to determine a grinding depth, and a dressing mechanism for periodically dressing the grinding surface of the grinding wheel so as to prevent clogging of the grinding surface of the grinding wheel, while accurately correcting a grinding surface in an attempt to obtain a flat grinding surface.

In such a grinding machine, the grinding surface of a grinding wheel is gradually worn away, resulting in varying the grinding position of the grinding wheel relative to a workpiece. It is therefore necessary to correctly position the grinding surface of the grinding wheel relative to the workpiece each time a predetermined amount of grinding operation is effected. It is also necessary to prevent clogging of the grinding surface of the grinding wheel, while accurately correcting the grinding surface of the grinding wheel in an attempt to obtain a flat grinding surface.

The dressing and position setting of the grinding wheel has heretofore been manually effected in an arbitrary way. It is, therefore, impossible to correctly position the grinding wheel relative to the workpiece, as well as accurately correct the grinding surface of the grinding wheel in an attempt to obtain a flat grinding surface. As a result, an operation efficiency is prominently impaired.

SUMMARY OF THE INVENTION

An object of this invention is to provide a grinding machine capable of accurately positioning a grinding wheel relative to a workpiece and capable of rapidly and positively correcting the grinding surface of the grinding wheel in an attempt to obtain a flat grinding surface as well as preventing clogging of the grinding surface of the grinding wheel.

Another object of this invention is to provide a grinding machine capable of being automatically and periodically setting the position of a grinding wheel relative to a workpiece, as well as capable of being automatically and periodically dressing the grinding surface of the grinding wheel.

One feature of this invention resides in that a dressing element to be contacted direct to the grinding surface of the grinding wheel is movable in a direction substantially perpendicular to the grinding surface of the grinding wheel as well as in a direction substantially parallel to the grinding surface of the grinding wheel. The perpendicular movement of the dressing element is effected by a first mechanism including a reversible motor, a threaded rod driven by the reversible motor and a slide block into which the threaded rod is screwed. The parallel movement of the dressing element is effected by a second mechanism including an air cylinder and a reciprocable plunger member driven by the air cylinder. A second feature of this invention resides in that a position setting element for setting the position of the grinding wheel relative to the workpiece is movable in a direction substantially perpendicular to the grinding surface of the grinding wheel as well as in a direction substantially parallel to the grinding surface of the grinding wheel. The perpendicular movement of the position setting element is effected by a first mechanism similar in arrangement to the abovementioned first mechanism, while the parallel movement of the position setting element is effected by a second mechanism similar in arrangement to the above-mentioned second mechanism.

With the grinding machine according to this invention, the position setting and dressing of the grinding wheel can be respectively effected by the substantially similar and simple mechanism. This makes it possible to simplify the construction of the grinding wheel, leading to a low cost. The position setting and dressing of the grinding wheel can be automatically effected in a periodic way.

In this case, not only can the reduction of labor be attained, but also an increased operational accuracy can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial, side view showing a grinding machine according to this invention which has a position setting mechanism and a dressing mechanism;

FIG. 2 is a partial fragmentary view, taken along line 2—2 of FIG. 1, showing the dressing mechanism incorporated into the grinding machine according to this invention; and

FIG. 3 is a partial fragmentary view, taken along line 3—3 of FIG. 1, showing the position setting mechanism incorporated into the grinding machine according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a grinding machine according to this invention has a dressing mechanism **10** and a position setting mechanism **11** which are arranged in association with a grinding wheel **12**. The grinding wheel 12 is disposed on one side of a passageway **14** on which coil springs **13** as a workpiece are fed. A grinding surface **12***a* of a grinding wheel **12** is arranged at a substantially right angle to the axis of the coil spring **13**, as shown in FIGS. **2** and **3**, which is placed in a direction transverse to the longitudinal direction of the passageway **14**. The grinding wheel **12** is rotated by a shaft **15** and is movable in the axial direction of the shaft **15** by moving mechanism not shown. The coil springs **13** are supported by substantially V-shaped receiving members **18**, respectively, which are successively arranged at a predetermined interval on a base plate **17** driven, in a direction indicated by an arrow A in FIG. **1**, by an endless belt **16**. As will be evident from FIGS. **2** and 3, each receiving member **18** consists of three pieces **18***a*, **18***b* and **18***c* arranged in a direction transverse to the longitudinal direction of the passageway **14**. The pieces **18***a* and **18***c* support the end portions of the spring 13, while the central piece **18***b* supports the central portion of the coil spring **13**. Each coil spring **13** is supported, in the direction transverse to the longitudinal direction of the passageway **14**, by the three pieces on the base plate **17** and one end **13***a* of the coil spring faces the grinding wheel **12**. On the side surface of the piece **18***a* of each receiving member **18** a clamping member 19

stands upright and is adapted to clamp the coil spring 13 in coaction with the V-shaped receiving member 18 so that, during the grinding of the end 13*a* of the coil spring 13, the coil spring is neither displaced nor dislocated from the receiving member 18. The endless chain 16 is secured to the undersurface of the base plate 17 through connecting members 20 which are disposed at a predetermined interval on the undersurface of the base plate 17.

At a suitable position of the passageway 14 a contact element 21 is provided. The contact element 21 is adpated to be contacted with the coil spring passing therethrough. The contact element 21 is connected to an electrical counting mechanism, not shown, and makes the counting mechanism count the number of times the contact element is contacted with the coil spring 13. Thus, the number of the coil springs 13 passing through the contact element 21 can be counted. When a predetermined number of coil springs 13 are sensed by the contact element 21, a dressing operation starting signal is delivered from the counting mechanism and when the other predetermined number of coil springs 13 are sensed by the contact element 21, a position setting operation starting signal is delivered from the counting mechanism.

The dressing mechanism 10 as will be described later more in detail is operated by the dressing operation starting signal and the position setting mechanism 11 as will be described later more in detail is operated by the position setting operation starting signal.

With the dressing mechanism 10 shown in FIG. 2 a speed reducer equipped reversible motor 23 is secured to a machine frame 22. A cylindrical casing 24 is mounted on the machine frame 22 and extends from the machine frame 22. Within the cylindrical casing 24 a threaded rod 25 is arranged to be driven by the motor 23. The threaded rod 25 is coupled at one end to a motor shaft of the motor 23 through a coupling and at the other end screwed into an internal thread 27 which is formed in a sliding block 26. The central portion of the shank of the threaded rod 25 is rotatably supported by bearings 28 which are fitted into the casing 24. The sliding block 26 is slidably moved outwardly of the casing 24 by rotating the threaded rod 25 in one direction and is slidably retracted into the casing 24 by rotating the threaded rod 25 in the other direction. In this way, the sliding block 26 is slidably guided along the inner surface of the casing 24.

A stub shaft 29 fixed to the outer end of the slide block 26 is secured to a block member 30. To the block member 30 an air cylinder 32 is mounted through a bracket 31. A plunger member 33 of the air cylinder 32 passes through the block member 30 and extends below the block member 30 in a state parallel to the grinding surface 12*a* of the grinding wheel 12. To the free end of the plunger member 33 a box 34 is fixed. Within a chamber 35 of the box 34 one end of a swingable arm 36 is pivoted by a pivot 37 to the box 34. At the other end of the arm 36 a dressing element 38 is rotatably supported. The arm 36 is biased counterclockwise, as shown in FIG. 2, by a compression spring 39 disposed within the chamber 35, and is held, against the biasing force of the compression spring 39, normally in abutment with an abutment portion 34*a* formed on the box 34. A limit switch 40 is disposed within the chamber 35 and adapted to be closed when the arm 36 is swung through a predetermined angle from an original position shown.

When a dressing operation starting signal is delivered from the counting mechanism connected to the contact element 21, the motor 23 and air cylinder 32 are operated. The operation of the motor 23 causes the threaded rod 25 to be rotated in one direction to permit the sliding block 26 to be advanced. This causes the block member 30 to be moved in a direction substantially perpendicular to the grinding surface 12*a* of the grinding wheel 12 to permit the dressing element 28 to be abutted against the grinding surface 12*a* of the grinding wheel 12. When, after abutment, the block member 30 is further slightly moved, the arm 36 is swung clockwise against the biasing force of the spring 39 to cause the limit switch 40 to be closed. As a result, the motor 23 is stopped and the movement of the block member 30 is stopped. An electrical connection between the switch 40 and the motor 23 is omitted. In this way, the dressing element 38 is held, under the action of the spring 39, in a state in which it is elastically urged toward the grinding surface 12*a* of grinding wheel 12. In this state, the air cylinder 32 causes the plunger member 33 to be reciprocably moved while being maintained in a state parallel to the grinding surface 12*a* of the grinding wheel 12. By this reciprocating movement of the plunger member 33 the dressing element 38 is reciprocably moved, while being urged against the grinding surface 12*a* of the grinding wheel 12, substantially radially of the grinding wheel 12 and in a direction substantially parallel to the grinding surface 12*a* of the grinding wheel 12. During this period, the grinding wheel 12 continues to be rotated and the dressing element 38 effects a good uniform dressing over the whole grinding surface 12*a* of the grinding wheel 12, preventing clogging of the grinding surface 12*a* of the grinding wheel 12 while accurately correcting the grinding surface of the grinding wheel in an attempt to obtain a flat grinding surface.

After the dressing operation continues for a predetermined time period, the motor 23 and thus the threaded rod 25 are reverse rotated to cause the sliding block 26 to be retracted. As a result, the block member 30 is moved in a reverse direction to cause the dressing member 38 to be moved away from the grinding surface 12*a* of the grinding wheel. Simultaneously therewith, the air cylinder 32 is driven to cause the dressing element 38 to be lifted up to a predetermined position. In this way, the dressing mechanism 10 is periodically and automatically operated each time the dressing operation starting signal is delivered.

In the position setting mechanism 11, shown in FIG. 3, a speed reducer equipped motor 41 is mounted. A cylindrical casing 42 is mounted on a machine frame 22 and extends from the machine frame 22. Within the cylindrical casing 42 a threaded rod 43 is arranged to be rotated by the motor 41. The rod 43 is connected at one end to the motor 41 through a coupling and at the other end screwed into an internal thread 45 formed in a sliding block 44. The central portion of the threaded rod 43 is rotatably supported by bearings 46, 46 which are fitted into the casing 42. The sliding block 44 is slidably moved outwardly of the casing by rotating the threaded rod 43 in one direction and slidably retracted into the casing 42 by rotating the threaded rod 43 in the other direction. In this way, the sliding block 44 is slidably guided along the inner surface of cylindrical casing

42. A stub shaft 47 fixed to the outer end of the sliding block 44 is secured to a block member 48 an air cylinder 50 is mounted through a bracket 49.

A plunger member 51 of the air cylinder 50 passes through the block member 48 and extends below the block member 48 in a state parallel to the grinding surface 12*a* of the grinding wheel 12.

The structure of the above-mentioned position setting mechanism 11 is substantially similar to that of the dressing mechanism 10 of FIG. 2.

In a position somewhat remote from the lower end of the plunger member 51 an enlarged portion 51*a* is integrally formed. A roller-like position setting element 52 is rotatably mounted on the lower end portion of the plunger element 51. A lever 53 is mounted by a pivot 54 on the side surface of the enlarged portion 51*a* of the plunger member 51 and has upper and lower arms 53*b* and 53*a*. The lower arm 53*a* extends up to the position setting element 52. A compression spring 55 is disposed between the upper arm 53*b* and the enlarged portion 51*a*. The lever 53 is constantly urged counterclockwise, under the action of the compression spring 55, as shown in FIG. 3. The lever 53 is normally held against the urging force of the spring 55 in an original position in which it is engaged with a stop 56 fixed to the enlarged portion 51*a* of the plunger member 51. In this original position the end of the lower arm 53*a* of the lever 53 forwardly extends somewhat beyond the position setting element 52. A limit switch 57 is also provided between the upper arm 53*b* of the lever 53 and the enlarged portion 51*a* of the plunger member 51. The limit switch 57 is adapted to be closed when the lever 53 is swung through a predetermined angle from the original position.

When a position setting starting signal is delivered from the counting mechanism connected to the contact element 21, the motor 41 and air cylinder 50 are operated. The operation of the motor 41 causes threaded rod 43 to be rotated in one direction to permit the sliding block 44 to be advanced a predetermined distance. Simultaneously therewith, the block member 48 is moved in a direction substantially perpendicular to the grinding surface 12*a* of the grinding wheel 12 and the position setting element 52 is set in a predetermined position substantially perpendicular to the grinding surface 12*a* of the grinding wheel 12.

The air cylinder 50 is supplied with an air from an air supply source, not shown, to cause the plunger member 51 to be driven to permit the position setting element 52 to be lowered in a manner substantially parallel to the grinding surface 12*a* of the grinding wheel 12. As a result, the position setting element 52 is set in a predetermined position substantially parallel to the grinding surface 12*a* of the grinding wheel 12.

When the position setting element 52 has been so set, the moving mechanism, not shown, is operated to cause the grinding wheel 12 to be moved toward the position setting element 52 to permit the grinding surface 12*a* of the grinding wheel 12 to be abutted against the element 52. Before this abutment, the arm 53*a* of the lever 53 is abutted against the grinding surface 12*a* of the grinding wheel 12 to cause the lever 53 to be swung. Simultaneously with the abutment of the element 52 against the grinding surface 12*a* of the grinding wheel 12, the limit switch 57 is closed to cause the moving mechanism to be stopped. As a result, the grinding wheel 12 is stopped in the "abutted" position. In other words, the grinding wheel 12 is set in a correct grinding position. An electrical connection between the limit switch 57 and the moving mechanism is omitted.

When the position setting of the grinding wheel 12 is complete, the air cylinder is again operated to cause the plunger member 51 to be lifted up. Simultaneously therewith, the motor 41 is reverse rotated, causing the threaded rod 43 to be rotated in the other direction to permit the sliding block 44 to be retracted. In consequence, the block member is returned to an original position and the position setting element 52 is moved away from the grinding surface 12*a* of the grinding wheel 12 and returned to the original position.

The above-mentioned position setting mechanism 11 is operated after the dressing mechanism 10 has been operated so as to prevent clogging of the grinding surface 12*a* of the grinding wheel 12, while accurately correcting the grinding surface of the grinding wheel. Even when the dressing mechanism 10 is not operated, the position setting mechanism 11 is usually operated, for example, prior to a grinding operation. The time intervals of both the mechanism 10 and 11 can be suitably determined dependent upon the size and material of a workpiece to be ground. The position setting mechanism 11 and dressing mechanism 10 may have substantially the same structure as mentioned above. Since the speed reducer equipped reversible motors 23 and 41 are used as driving means for moving the dressing element 38 and the position setting element 52, respectively in the direction substantially perpendicular to the grinding surface 12*a* of the grinding wheel 12, a very accurate movement can be provided. With the above-mentioned embodiment the air cylinders 32 and 50 are employed as driving means for moving the elements 38 and 52, respectively, in the direction substantially parallel to the grinding surface 12*a* of the grinding wheel 12. Since in this case no accuracy is required, the air cylinders 32, 50 are employed as such.

The motors 23 and 41 and air cylinders 32 and 50 are automatically operated by applying an electrical or mechanical signal thereto. It is therefore possible to easily incorporate the mechanisms 10 and 11 into an automatic control system. As a result, not only can reduction of labor be attained, but also a more accurate, rapid operation can be effected.

What we claim is:

1. A grinding machine comprising a machine frame, carrier means for moving workpieces such as coil springs, while holding them in a direction transverse to the longitudinal direction of a passageway, driving means for driving the carrier means, and a grinding wheel rotatably mounted on one side of the passageway and having a grinding surface substantially perpendicular to an axis of the workpiece, said grinding wheel being movable in the direction transverse to the longitudinal direction of the passageway so as to vary a grinding depth, said grinding machine further including a reversible motor mounted on the machine frame, a cylindrical casing, a threaded rod disposed within the cylindrical casing and rotatably driven by the motor, a sliding block having an internal thread into which the threaded rod is screwed, said sliding block being slidably advanced and retracted by the rotation of the threaded rod, a block member secured to the sliding block and movable in a direction substantially perpendicular to the grinding surface of the grinding wheel as a result of the sliding movement of the sliding block, an

air cylinder supported by the block member, a plunger member reciprocably movable by the air cylinder in a direction substantially parallel to the grinding surface of the grinding wheel, and a dressing element coupled to one end of the plunger member and adapted to be contacted with the grinding surface of the grinding wheel, in which the dressing element is moved, by the reversible motor, into abutment with the grinding surface of the grinding wheel and is reciprocably movable, by the air cylinder, on the grinding surface of the grinding wheel substantially radially thereof.

2. A grinding machine according to claim 1, in which said dressing element is elastically urged under the action of a spring against the grinding surface of the grinding wheel.

3. A grinding machine according to claim 1, further including a position setting mechanism for setting the position of the grinding surface of the grinding wheel relative to the workpiece.

4. A grinding machine according to claim 3, in which said position setting mechanism further includes a second reversible motor fixed to the machine frame, a second cylindrical casing, a second threaded rod disposed within the second cylindrical casing and rotatably driven by the second motor, a second sliding block slidably movable along the inner surface of the second cylindrical casing as a result of the rotation of the second threaded rod, a second block member secured to the second sliding block and movable in a direction substantially vertical to the grinding surface of the grinding wheel as a result of the sliding movement of the second sliding block, a second air cylinder supported on the second block member, a second plunger member driven by the second air cylinder in a direction substantially parallel to the grinding surface of the grinding wheel, and a position setting element connected to one end of the second plunger and movable into abutment with the grinding surface of the grinding wheel, in which the position of the grinding wheel relative to the workpiece is set by moving said position setting element by the second reversible motor in a predetermined position substantially perpendicular to the grinding surface of the grinding wheel, moving said position setting element by the second air cylinder into a predetermined position substantially parallel to the grinding surface of the grinding wheel and moving the grinding wheel into abutment with said position setting element.

5. A grinding machine according to claim 4, in which said position setting mechanism further includes a lever pivoted in a neighborhood of one end of the second plunger member and having first and second arms, said first arm extending in a neighborhood of the position setting element and being adapted to be abutted against the grinding wheel before the grinding wheel is abutted against the position setting element.

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