PATENT SPECIFICATION

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(54) DUROMETER ACCORDING TO ROCKWELL SYSTEM

(71) I, ALFRED ERNST, a citizen of Switzerland, of Casa Carolina, Curio Ticino, Switzerland, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a durometer for measuring hardness according to Rockwell system.

In accordance with the invention, there is provided a durometer for measuring hardness according to the Rockwell system comprising;

a lower structure having a surface engageable with an article the hardness of which is to be measured, the surface forming a reference plane,

a penetrator movable along an axis between a position at which it is flush with the reference plane and an outer position beyond the reference plane,

a preload spring mounted between the lower structure and the penetrator to urge the penetrator towards the outer position thereof,

an upper structure connectable to means for applying a downwardly directed load thereto along the said axis,

connecting means between the two said structures to allow the upper structure to move parallel with the axis between a position spaced from the lower structure and a position abutting the lower structure,

a penetration load spring carried by the upper structure for urging an abutment downwardly and parallel to the axis,

an intermediate structure carried by the connecting means and movable parallel with the axis to a position at which it engages the penetrator, whereby when the downwardly directed force is applied to the upper structure and the reference plane surface is engaged with the article, the upper structure moves into abutment with the lower structure and a force is exerted by the penetration load spring through the intermediate structure on the penetrator,

and the past of the downwardly directed force in excess of the force exerted by the penetration load spring is absorbed by the lower structure.

An embodiment of the invention by way of example is shown in the accompanying drawings, wherein:—

Figure 1 is a diagrammatical view of the instrument partially in section;

Figures 2 and 3 show, in section, two different columns to which resilient strips are secured.

With reference to Figure 1, the instrument of the invention is composed by a rigid lower structure 1, comprising a horizontal stout plate 2, which is an integral part of a lower support 3 ending at the bottom forming a reference plane 4 constituted by the edge of a bush 5, in which a penetrator is coaxially housed and can axially slide during the successive steps of the measurement.

An upwardly directed vertical column 6 is rigidly connected to the plate 2.

An upper structure 7 of the instrument comprises a plate 8 parallel to the plate 2 and a vertical column 9, parallel to the column 6, connected thereto. The column 9 extends below the plate 2, freely through a hole 10 provided on the latter.

The plate 8 supports a rod 11 serving for the transmission of the outer applied load, said rod 11 being fixed to said plate 8 by means of a neck 12 within a coaxial hole, provided on the plate 8, and prevented from axial displacement relative to the plate 8 by a lower shoulder 13 and by an upper nut 14 with interposition of a ring nut 15 provided with radial holes 16 spaced along its circumference.

The rod 11 is rotatable around its own axis and its rotation can be obtained by rotating the ring nut 15 by means of pin members inserted into the holes 16.

The portion of the rod 11 extending below the shoulder 13 presents a threaded portion 11′ on which a shoulder flange 17 is screwed, while the terminal portion 11″ has a smooth surface and ends with an annular abutment 18 serving to support a counter-flange 19. Between the flange 17 and the counter-flange 19 is a spring 20 serving to provide the constant measurement load, in the manner hereinafter explained.

The flange 17 is prevented from rotating by a vertical pin 21 depending from the plate 8 so that by rotating in either direction the rod 11 through the ring nut 15, said flange 17 can screw in either direction relative to the rod 11 to pre-load the spring 20 to a predetermined value. This value can be measured by a graduated scale shown by the vertical strips 22 and along which an index pointer 23 supported by the flange 17 slides.

Around the cylindrical portion 11″ of the rod 11, two small spaced flanges 24 and 25 are provided, between which lies a coil spring 26 so that the flange 25 in the rest position of the instrument abuts against the flange 19, while the flange 24 is thrust against a shoulder 27 constituted by the step formed by the diameter difference between the portions 11′ and 11″ of the rod 11.

The flange 24 is assembled in a free condition on the portion 11″.

The flange 25 is rigidly connected to the plate 2 by means of one or more vertical pins 28.

A third rigid structure, intermediate between the structures 1 and 7, is constituted by the same flange 19, by a thrust member 30 placed under the plate 2 and by a vertical column 31, rigidly connecting the flange 19 and the thrust member 30 and passing freely through a hole 32 in the plate 2.

The column 31 is parallel to the columns 6 and 9.

The columns 6 and 9 are connected therebetween by two resilient strips 33 and 34, preferably of steel material, whose ends surround the columns without any clearance. This connection allows a mutual support between the structures 1 and 7, as well as a relative displacement without any play between said structures, in the axial direction of the columns and the rod 11, owing to its limited value in the operation of the instrument.

Similarly the intermediate structure, and particularly the column 31, is connected to the columm 9 by a respective pair of parallel resilient strips 35 and 36, so that the intermediate structure is connected to the structure 7 and is capable of small axial displacements with respect to the latter, without any play.

The pairs of strips 33 and 34, on the one hand and 35 and 36 on the other hand constitute parallelograms with the columns connected by them, so that the bending of the strips ensures parallellism between the columns. The formed parallelograms are preferably rectangular, so that the relative displacements of the columns can be considered straight-line to a good approximation.

Arranged co-axial with the rod 11, the penetrator 37 which is housed in the bush 5, supporting the reference plane surface 4, and whose point of diamond or other hard material, can move beyond said reference plane by a distance determined by a conical abutment 38. The penetrator 37 is supported by a penetrator holder 39 which, in its intermediate portion, is hollow and through which is passed a lever 40 which, from one end, has its fulcrum at 41 and, to the other end, extends beyond the support 3 to support a rod 42 operating a comparator 43, the latter being a reading instrument already known, of the type with manual or automatic zeroing.

Said comparator 43 is not further described because it is well known in the art.

The lever 40 is connected to the penetrator holder 39 by means of a pin 44, passing through an elongated hole of the same lever.

Upwardly the penetrator holder is prolonged with a stem 45 entering inside a hole 46 in the thrusting member 30, the hole being co-axial with the rod 11.

Between the lever 40 and the plate 2 is disposed a spring 47 designed to provide the preload during the measurement, in the manner hereinbelow explained, said spring providing a thrust considerably less than the thrust provided by the spring 26 already described.

The rod 11 has at its top a stem 48 so sized and projecting that can be gripped by the toolholder head of a spindle having an axial movement without any rotation. Besides the stem 48 can be provided for the assembly of the instrument on an adequate equipment, able to exert an axial thrust on the rod 11.

At the bottom, the rod 11 has a rounded end 49 which, at rest, is at a predetermined distance from an abutment 50 preferably of yielding damping material or resting in any case on the plate 2 with the interposition of a damping shim, such an abutment defining the operating stroke of the rod 11 and therefore the deformation value of the spring 20 for the transmission of the constant measurement load to the penetrator. The damping nature of the abutment 50 is provided only to eliminate vibrations when contacted the end 49. Said abutment 50, however, constitutes a fixed stop between the upper structure 7 and the lower structure 1 disposed on the penetrator axis.

Fig. 2 shows in section, the structure of the column 6 and the attachment thereto of the strips 33 and 34. The column 6 is composed by a central rod 51, whose lower end 52 is threaded and screwed in a hole provided in the plate 2, while its upper end 53 is threaded for the engagement of a nut 54.

The rod 51 is surrounded by a cylindrical sleeve 55, in register with the rod 51 by spaced cylindrical shims 56 and 57. Said sleeve 55 presses with its lower edge against the strip 34 supported by an annular washer 58, the latter in turn abutting against the plate 2. The upper end of the sleeve 55 presses the strip 33 against a ring 59. On said ring 59 acts the nut 54. It is evident that tightening of all the members between said nut 54 and the plate 2 will take place on screwing the nut 54 on the threaded end 53, so that the strips 33 and 34 will be rigidly locked to the column 6, without any possibility of clearance.

Fig. 3 is an axial section of the column 9 illustrating the structure of this column and the fastening thereon of the strips 33, 34, 35 and 36.

The column 9 is composed by a long rod 60 having its upper end 61 threaded so that it is screwed into the plate 8 of the member 7.

The rod 60 has, further, an intermediate threaded portion 62, around which a nut 63 is screwed, and a lower end provided with an axial blind hole 64 into which a bolt 65 is screwed.

Around the rod 60 is disposed a first sleeve 66, similar to the sleeve 55 of Fig. 2, which is kept in register with respect to the rod 60 by the interposition of cylindrical shims 67 and 68 respectively. On the top the sleeve 66 presses on the resilient strip 33 through which the same rod 60 passes and resting on a ring 69 which abuts against the lower face of the plate 8. At the bottom the sleeve 66 presses on the resilient strip 35 and, with the interposition of an annular washer 70, presses also on the strip 34 supported by the nut 63 with the interposition of a washer 71.

It is evident that, on tightening the nut 63, all the members between the nut 63, and the plate 8 are locked together and therefore the strips 33, 34 and 35 remain tight, without any possibility of clearance.

The head 65′ of the bolt 65, by means of a washer 72 and one or more annular shims 73, presses axially against a second sleeve 74, surrounding the lower portion of the rod 60 and abutting against the lower edge of the nut 63. Between the shims 73 and the edge of the sleeve 74 is interposed the resilient strip 36 through which is passed the rod 60. In this manner by tightly screwing the bolt 65, locking of all the members comprised between the head 65′ and the nut 63 is caused, so locking the strip 36 to the column 9 without any possibility of clearance.

The strips 35 and 36 are locked on the column 31, in a manner similar to that shown in Fig. 2, concerning the column 6.

The operation of the instrument so described is explained hereinbelow.

By turning the ring nut 16, the rod 11 is rotated in either direction, so that the flange 17 is raised or lowered to give the spring 20 a selected precompression, to which will correspond, owing to the substantially constant deformation of the spring, a predetermined measurement load readable on the scale of the strip 22.

The instrument is then mounted by the stem 48 on a tool or machine-tool, for example a drilling-machine, by means of which the instrument can be operated and placed on the piece to be measured.

When the instrument is placed on the piece, the penetrator tip 37 touches the piece and is then pushed backwardly in the bush 5, until the reference plane 4 touches the piece. The displacement of the penetrator relative to the reference plane causes at the same time the deformation of the spring 47, which supplies the preload to the penetrator, and the displacement of the rod 42 acting on the comparator 43. At this moment, the comparator 43 is zeroed, manually or automatically, according to the kind of comparator employed and a load is applied through the stem 48. The column 28 prevents the flange 25 from being displaced downwardly, therefore the counter-flange 19 is moved away therefrom so that it is not influenced by the spring 26, but it is only subject to the thrust of the spring 20. On further displacement of the rod 11, the bottom of the hole 46 engages the head of the stem 45, to press the tip of the penetrator 37 against the piece. In this moment, the flange 19 is stopped by the column 31 thus leaving the shoulder 18, as the rod freely continues its travel together with the structure 7, whose column 9 can move relative to the columns 6 and 31 thanks to the resiliency of the strips 33 and 34, on the one hand, and 35 and 36 to the other hand.

The displacement of the rod 11 continues until the end 49 touches against the abutment 50.

At this moment the thrusting member 30 is subjected solely to the whole load of the spring 20, while the structure 1 which is supported by the reference plane surface 4, absorbs the rest of the outer applied load. Therefore, at this point, on the penetrator acts only the preload and the load of the spring 20, whose total amount is the measurement load.

In these conditions the diamond point of the penetrator 37 will cause the measurement impression.

Thereafter the return stroke of the rod 11 can be started.

During the return stroke, firstly the detachment of the end 49 of the rod from the abutment 50 takes place until the shoulder 18 meets again the counter-flange 19 raising the latter, so that the bottom of the hole 46 of the thrusting member 30 leaves the penetrator, on which only the preload spring 47 will act again. At this point the measurement of Rockwell hardness is shown by the comparator.

Continued raising of the rod 11 restores contact between the flange 19 and the small flange 25 and finally restores the whole instrument to the rest position. The cancellation of the thrust causes the whole instrument to lose contact with the piece to be tested.

It can be noted in Figs. 1, 2 and 3 that the pairs of columns 6 and 9 and the corresponding resilient strips 33 and 34, on the one hand, and the pairs of columns 9 and 31 with the corresponding resilient strips 35, 36 to the other hand, constitute two different parallelogram resilient suspensions, whose strips form arms of equal length and of equal resilient deformation, to secure displacements which, owing to the limited amplitudes of the moving parts, are to be considered axial.

It can also be noted that the different moving parts do not need close mutual fits to guide their axial displacements, and this makes easier the reduction of the instrument to its component pieces, the elimination of accurate machining, the simplification of the assembly operations, and the elimination of friction.

Notwithstanding that in the figures the strips are directed perpendicularly to the column axes, it is preferable that at rest, they are inclined relative to the perpendicular to said axes of about one half of the foreseen displacement, to the end to render practically unappreciable the transversal displacements arising from the bending of the strips.

It is obvious that the practical embodiment of the instrument of the present invention can be varied both in the disposal and in the shape of the various members in order to respond to the common requirements of instruments of this kind, above all as far as it concerns the axiality of the movements and the true line of thrust. For example, the columns 6 and 9 are both indicated in the figures on the same side of the instrument, in practice they may be disposed symmetrically relative to the rod 11. Further the column 31 can be augmented by a similar column to prevent yielding during the transmission of the load. The bush 5 and the penetrator will generally be detachable to allow replacement.

WHAT I CLAIM IS:—

1. A durometer for measuring hardness according to the Rockwell system comprising:

a lower structure having a surface engageable with an article the hardness of which is to be measured, the surface forming a reference plane,

a penetrator movable along an axis between a position at which it is flush with the reference plane and an outer position beyond the reference plane,

a preload spring mounted between the lower structure and the penetrator to urge the penetrator towards the outer position thereof,

an upper structure connectable to means for applying a downwardly directed load thereto along the said axis,

connecting means between the two said structures to allow the upper structure to move parallel with the axis between a position spaced from the lower structure and a position abutting the lower structure,

a penetration load spring carried by the upper structure for urging an abutment downwardly and parallel to the axis,

an intermediate structure carried by the connecting means and movable parallel with the axis to a position at which it engages the penetrator,

whereby when the downwardly directed force is applied to the upper structure and the reference plane surface is engaged with the article, the upper structure moves into abutment with the lower structure and a force is exerted by the penetration load spring through the intermediate structure on the penetrator, and the part of the downwardly directed force in excess of the force exerted by the penetration load spring is absorbed by the lower structure.

2. A durometer according to claim 1, wherein a stop abutment between the upper structure and the lower structure is disposed on the penetrator axis.

3. A durometer according to claim 1 or 2, wherein at least two of said structures are connected to be relatively displaceable without play by means of parallel resilient strips.

4. A durometer according to claim 3, wherein the structures are each provided with a respective rigidly connected column, the columns being parallel to each other and to the penetrator axis, one of the columns being connected to the other two by the resilient strips.

5. A durometer according to claim 4,

wherein the resilient strips connecting together each connected pair of the columns are two in number and are parallel, in order to form with the columns respective parallelograms.

6. A durometer according to claim 4 or 5, wherein the upper structure is constituted by a horizontal plate, from one side of which a respective column depends, said plate supporting a rod to which the outer load is axially applied, said rod being supported so to be prevented from axially sliding with respect to said plate, but being able to rotate around its own axis, said rotation being effected by means of a ring nut mounted on said rod and abutting against said plate.

7. A durometer according to claim 6, wherein said rod, immediately below the plate supporting it, presents a threaded portion on which is screwed a non-rotatable flange, and presents further at its lower end a shoulder on which a counter-flange forming the load spring abatement rests, between said load and said counter-flange being located the penetration load spring whose initial precompression can be adjusted by displacing said non-rotatable flange, the displacement being obtained by rotating said rod in either direction.

8. A durometer according to claim 7, wherein the stop abutment of the upper structure relative to the lower structure is constituted, by an abutment supported by the lower structure engageable by an end of the said rod so that contact therebetween takes place on a point located on the penetrator axis.

9. A durometer according to claim 7, wherein the lower rigid structure comprises a horizontal plate, parallel to the plate of the upper structure and perpendicular to the penetrator axis, the plate of the lower rigid structure carrying a support on which is disposed a bush surrounding the penetrator and having a lower surface constituting the reference plane, the respective rigid column connected to the upper structure from the intermediate passing freely through the lower rigid structure plate.

10. A durometer according to claim 7, wherein the intermediate rigid structure comprises the counter-flange supported by the rod, a thrust member secured to a support under the plate of the lower rigid structure, and a rigid connection between said counter-flange and said thrust member, said rigid connection being connected to the upper structure column by means of a respective pair of resilient strips, said thrust member forming the member to transmit the measurement load from said counter-flange to the penetrator.

11. A durometer according to claim 10, wherein the thrust member is displaceable so that when it acts on the penetrator, it causes the detachment of the counter-flange from the shoulder provided on the load transmitting rod to allow the transmission to the penetrator of the sole thrust exerted by the measurement load spring alone, while the excess load on the rod is transmitted by the same rod to the lower rigid structure.

12. A durometer according to claim 9 wherein the penetrator holder acts on a lever, fulcrumed on the support provided under the lower rigid structure, to receive the thrust of the instrument preload spring and to activate the comparator of the instrument.

13. A durometer according to claim 6, wherein the rod for the load transmission has, above the plate of the upper rigid structure, an axial stem engageable by a axially displaceable toolholder of a machine-tool by means of which the outer load can be applied to the instrument.

14. A durometer according to any of claims 4—13, wherein the resilient strips are rigidly connected with their respective columns by means of locking members.

15. A durometer constructed and arranged substantially as hereinbefore described and shown in the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

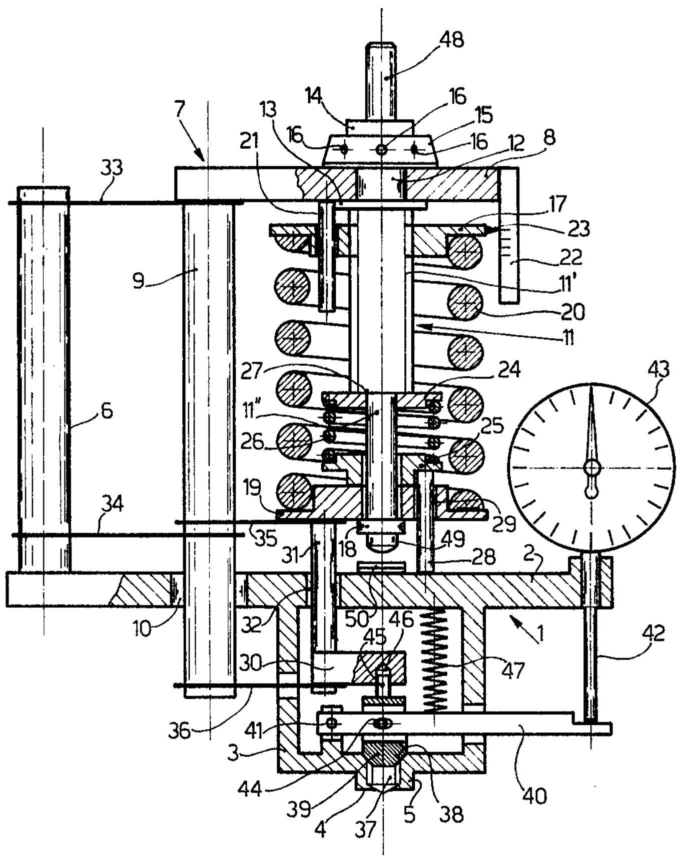

FIG. 1

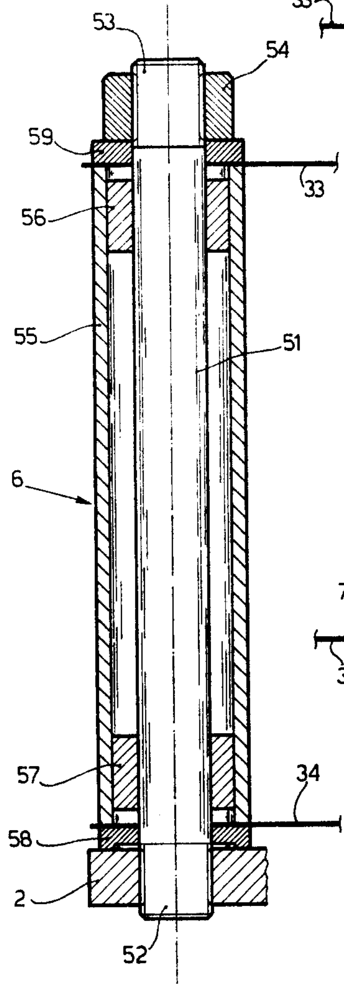
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FIG. 2

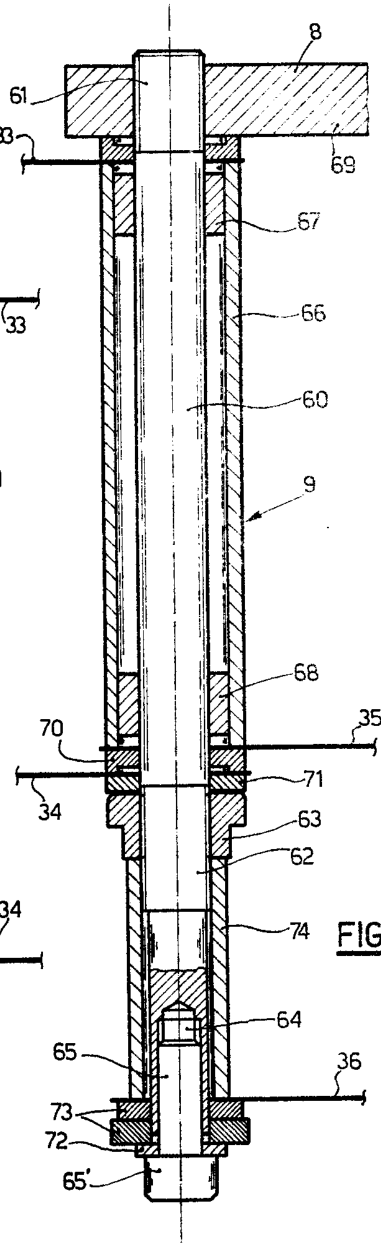
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FIG. 3