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P. BOLLÉE ET AL
MEANS FOR TESTING HARDNESS OF MATERIALS
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4 Sheets-Sheet 2

Fig. 2

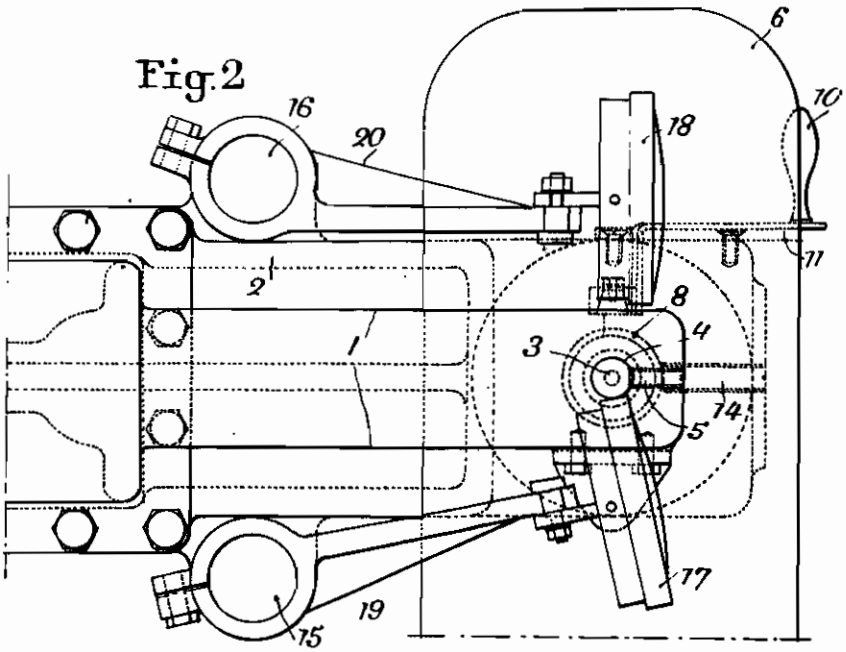

Fig. 4

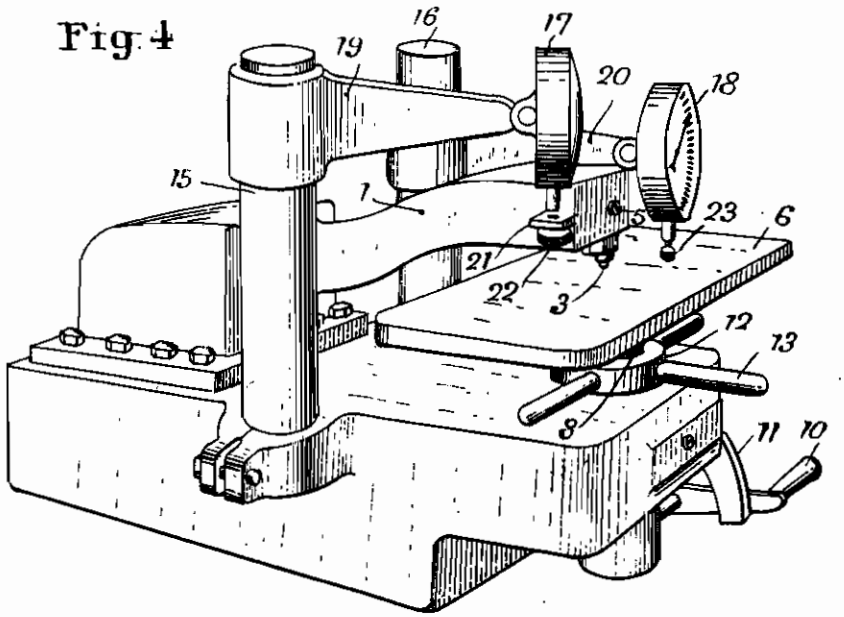

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Fig. 3.

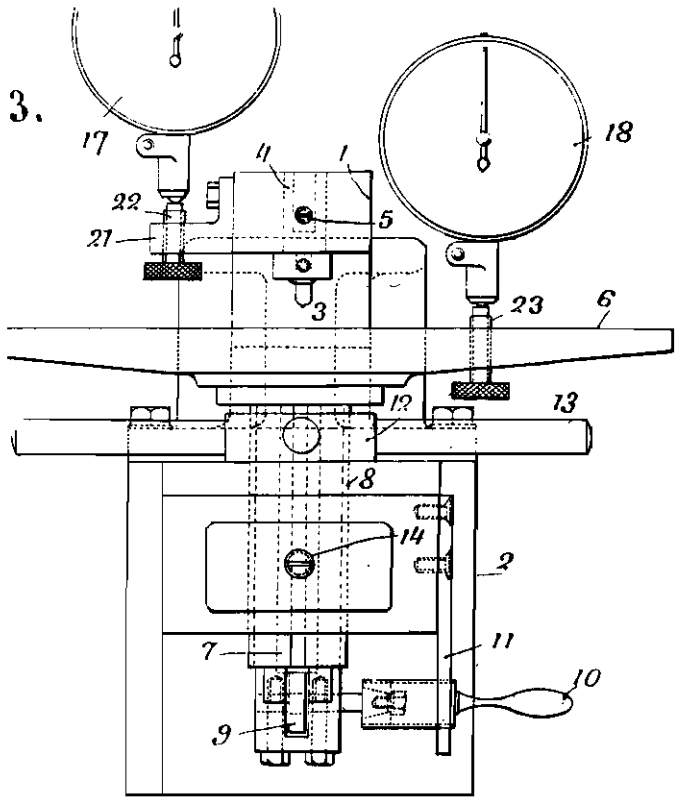

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Fig. 6

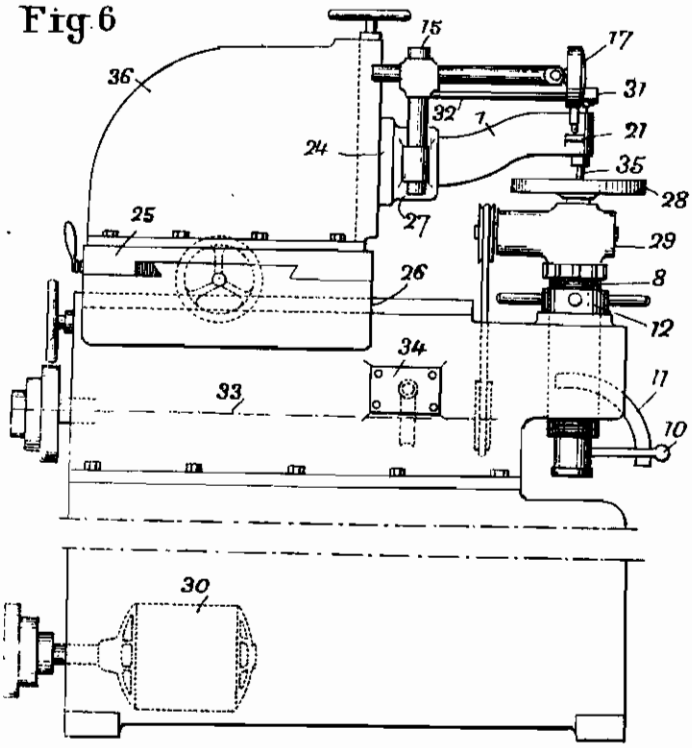
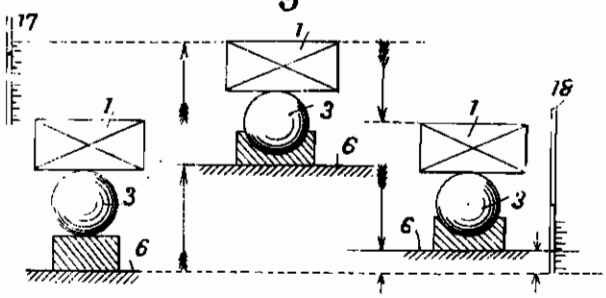


Fig. 5



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MEANS FOR TESTING HARDNESS OF MATERIALS

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vested in the Alien Property Custodian

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This invention relates to means for testing hardness of materials.

It is very well known that the hardness of materials may be determined by measuring the impression effected on a convenient sample of the substance to be tested by an impression producing element, such as steel ball, diamond sphere, diamond cone, or square point of diamond or any other convenient substance, the measurement of impression being effected by measuring either the depth or the diameter of said impression when said impression producing element is constituted by a sphere. With some known machines the hardness is determined by the load which must be exerted on the impression producing element for obtaining on the material to be tested a determined depth of impression.

The load exerted on the impression producing element is constituted either by a system of weights and a set of levers pivoted on shafts or on knives or by a liquid pressure (produced by a pump) or by a spring constituting a dynamometer or also by the combination of several of the cited means.

The mechanism which produces and transmits the pressure to the impression producing element (ball or other) requires a complicated delicate and expensive arrangement, which contributes for a large part to the cost of keeping in good state of repair and to the want of precision of the machine.

The means according to this invention which remedies above drawbacks comprises in combination a table designed for receiving the pieces or samples of material to be tested, provided with a hand operating device for displacing same and for resiliently applying the piece or sample to be tested against the impression producing element located on a convenient support, comparators in any number located on convenient supports being provided with contacting members or fingers respectively in contact with the supporting table of the substance to be tested and with the support of the impression producing element, with a view to realize a unit of a simple strong construction allowing a great precision of the test to be obtained.

In the accompanying drawings which show by way of example a preferred embodiment of a machine according to this invention,

Fig. 1 is a side view of the machine,

Fig. 2 shows a plan view of Fig. 1,

Fig. 3 shows an end view of Fig. 1,

Fig. 4 is a perspective view of the machine,

Fig. 5 is a diagram showing the principle of operation of the machine,

Fig. 6 shows a modification of machine, according to the principle of this invention and equipped for testing of wear.

The member which presses the impression producing element (ball or other) is an arm 1 having a convenient cross section, a convenient length and made of convenient substance, said member being rigidly located on the frame 2 of the machine. The impression producing element 3 shown on the drawing is a ball of $\frac{1}{8}$ of inch and is secured at the end of arm 1 by means of the socket 4 and tightening screw 5.

The sample of material to be tested is located on the table 6 which is provided with a tail 7 for instance cylindrical in shape which passes axially into the screw 8 constituting a jack. At rest, the table 6 rests upon the upper end of screw 8 while tail 7 which constitutes a pushing device is in contact with a cam 9 provided with an actuating hand lever 10 combined with a braking device constituted by a friction sector 11 secured on the frame 2 of the machine. The cam 9 is located on the lower end of screw 8. A nut 12 provided with handling arms 13 is designed for raising or lowering the screw 8 which is allowed only to slide endwise, a screw 14 or key preventing same against rotation.

Thanks to such an arrangement the vertical displacement of table 6 can be controlled either by the hand nut 12 for the quick displacements, or by means of the excentered lever 10 for slow displacements.

The vertical columns 15 and 16 (not shown in Fig. 3), rigidly secured on frame 2, are provided for securing the dial comparators 17 and 16 by means of two arms 18 and 20. The contact fingers of the comparators are located in the transverse plane of the machine which passes through the impact point of the impression producing element upon the material to be tested. The fixed point of said comparators being the frame 2 of the machine, said fingers are in contact, on the one hand, for the comparator 17, with arm 1 through the angle bar 21 with a micrometric regulating screw 22, and on the other hand, for the comparator 18, with the table 8 supporting the material to be tested, by means of the micrometric regulating screw 23.

The result of such an arrangement is that every yielding of the arm 1 is measured by means of the comparator 17, while the comparator 18 measures the raising of the table.

The operation is as follows:

The sample of material to be tested is first placed upon the table 6. By operating the hand screw 12, the operator actuates the screw jack 8 until the pointer of the comparator 17 begins to move, the comparator 18 being already in contact with the plate 6 thanks to the regulation effected by means of the screw 23.

When the said pointer of comparator 17 starts moving, the operator brings both dials of comparators to zero. He acts then upon the cam lever 10 for actuating the pushing member 7 thus exerting a thrust of the sample to be tested against the ball 3, which transmits such thrust to the end of arm 1 and deflects said arm until said deflection, measured by the comparator 17, owing to the characteristic features of the arm (length, cross section, shape and elasticity) indicates that the required pressure for testing the hardness is obtained on the ball 3.

The pointer of comparator 17 having attained a mark of the dial relating to the load deflection, the operator, by actuating the lever 10, depresses said lever and lowers the table 8. Said table is stopped when the pointer of comparator 17 attains its starting zero point, that is to say, when the pressure or thrust on the ball has become equal to zero. The pointer of comparator 18 is behind of a quantity which is equal to the depth of the impression on the sample to be tested.

Fig. 5 diagrammatically shows in positions I, II and III, the respective positions of the table 6, of substance to be tested, of the arm 1, of the ball 3 and of both comparators 17 and 18.

Such diagram, moreover, shows that if the comparator 18 were secured on arm 1 instead of being secured on frame 2, it would be possible to test the hardness starting from a required depth of impression, the hardness being indicated by the thrust which is necessary for obtaining the necessary depth of impression.

The operation is effected in two stages, as follows:

Both comparators 17 and 18 starting from zero, the depth of impression is indicated by the difference between both comparators. When the extreme difference is obtained, the indication of hardness is then read on the comparator 17.

The arm 1 may be rendered removable by locating its stationary end on a supporting device, similar for instance to the support of a broaching tool on a lathe, by means of a wedge or through any other means giving the necessary rigidity. Such removable fixture of the arm allows same to be adapted as to its cross section to the test to be executed and to the nature of the material to be tested.

The important particular for the arm is that the deflection which it has to bear, does not cause an excessive stress of same in order to be sure that after each of the resilient deformations of said arm, same comes back to its starting zero point. A vibrating device located on its free end and constituted for instance by a small motor slightly unbalanced may render its return to the zero position easier by actuating same after each test.

It is to be noticed that the impression producing element could be located on the arm 1 through a socket containing a plunger which supports a ball acting upon a calibrated spring, a device which allows a previous "setting" pressure to be exerted before any resilient deformation of the arm. Said previous pressure, for instance of 10 kgs. per square centimeter, may be more simply exerted by the deformation of the arm itself.

The arm 1 may be beforehand conveniently tightened by an adjustable member located on the machine frame and constituting an abutment for preventing the arm to resume an absolutely free position of balance. Said arrangement thus leaves a reduced degree of elastic tension of the arm and thus secures the regular bringing to the zero position of the comparator 17.

The machine while keeping the same principle of elastic deflection of an arm 1 bearing the impression producing element, could also have a shape different from that which is shown in Figs. 1, 2 and 3.

The parts producing the raising of the table 6, which carries the material to be tested, could be different from those hereabove described.

Fig. 6 shows that the machine could advantageously have the shape of a milling machine, the arm 1 being for instance located on a group of carriages 24, 25 and 26, provided with an instantaneous locking device for allowing the displacement of same in the three directions of the space. In such a constructional form the columns 15 and 16 which carry the comparators 17 and 18, are secured on the box 27 which contains the arm 1 locked by means of a wedge. The columns 15, 16 and box 27 are a part of the carriage 24 having a vertical displacement.

The machine shown in Fig. 6 is equipped for a friction testing. The comparator 18 has consequently been removed. The rotating table 28 located on the box 29 is actuated by an adjustable gear 33 controlled by means of motor 38. The box 29 replaces the stationary table 6 of Fig. 1, on the end of screw jack 8. The internal thrust producing device and the cam actuated by the hand lever 10 are kept. A pick-up 31 located on the arm 32 is pivoted on the box 27. The vibrating member of pick-up 31 rests on a machined part of arm 1 on the movable end of same.

For the testing executed by the machine shown in said Fig. 6, the impression producing element is replaced by a friction device 35 of tungsten-carbide or any other convenient substance, having a convenient shape and located either rigidly or through a ball joint at the free end of the arm 1. A small oiling canal may be arranged in the vicinity of the friction device in order to allow the friction testings to be made with a lubricant substance.

A revolution counter connected with the shaft 33 of the gear is secured on a part 34 of the frame. The comparator 17 and the counter secured on the frame 34 give indications concerning the results of the testing which takes as a fixed basis either the travel of the sample secured on table 28 or the reduction of the deflection of the arm 1 produced by the wear of the sample.

For the testings which require a long duration, a compensating means acting upon the micrometric raise of the device which supports the sample keeps constantly the deflection at its maximum value in the same way as in the gear truing machines, the automatic advance of the mill bearing compensates for the wear of mills. For such a purpose, a feeling device is located near the pick-up on a rigid arm provided on the poppet 36. The comparator 18 may be used for

appreciating the degree of wear of the sample at the stopping time of the machine.

The pick-up has for its duty to electrieally detect and amplify for instance: the alteration of the rubbing surfaces, the first stripping of substance as a result of a seizing, or the undue presence of foreign substances between the sample and the friction device **35**. A regular noise having periodic changes of intensity characterises a normal friction.

The seizing caused by a stripping of substance is perceived as a parasitary spark. Such detection may be an optical one and in this latter case a neon lamp may be fed by the amplified circuit.

The pick-up makes it possible to record the wear testing on a gramophone disc or cylinder or even on a magnetic wire and to compare the result thus obtained with a standard record. For that purpose a disc rotating device actuated by the gear **33** is provided on the frame of the machine together with a registrating device. The comparison may be made either acoustically or optically. In the latter case, a photometric arrangement may be provided for determining the differences existing between the record of the sample and the standard record.

It is also possible to have, the standard record put into rotation by a corresponding device, an optical mark, for instance a neon lamp, constituting a comparison term for the luminous mark concerning the tested sample.

Galvanometers could be provided in the place of earpieces or of the lamps or together with said devices. An electrical system comprising convenient relays could actuate a signal device or stop the machine as soon as the wear of the sample corresponds to predetermined satisfactory or nonsatisfactory conditions.

A device comprising a table having a to-and-fro movement for the testing of alternative wear could be substituted for the box **28**.

The friction device **35** could also be replaced by a rotating smooth disc or a quickly rotating disc of tungsten carbide or other convenient substance, the sample being still secured on table **28**. In such instance, it is not necessary to have the sample displaced, so that the rotating table **28** may be kept unmovable unless it is preferred to simply use the table **6** of Fig. 1 which, in that figure, is used for testing hardness. The disc rotating around a horizontal axis depresses in the stationary sample a wear impression in the form of a half-moon. The sample could also be secured on the arm **1** in a similar manner as the friction device of Fig. 6. The wearing disc is then located on the screw **8**, its horizontal shaft being located on a convenient box which is then secured in the place of box **28**, the movement being transmitted by the gear **33**. The box can also be directly mounted on the table **6** which is used for testing hardness.

The vibrating device which is optionally located upon the arm **1** may be actuated for some wear testings. The vibrations of said device produce a sounding background which does not modify the detection of the particulars of the wear.

The compensating movements between the arm **1** and the sample carrying table could be totalized in function of the number of revolutions of the counter and be recorded by pulsations on the disc.

The machine could also be used for appreciating the degree of achievement of cylindrical or plane surfaces. It is thus only necessary to place the carriage **24** at the top end of its course and to substitute the pick-up for same, so that the latter directly rubs upon the surface to be controlled. The control could be realized by the recording method previously described.

The arm **1** is devised for working by deflection. It is obvious that nothing would be changed to the invention when using an arm, a bar or like member, either simple or composite, working by torsion, traction or compression, thermical processes being eventually used for obtaining the lengthening of the bar.

The machine being devised for testing hardness could also be used for obtaining testings of any kind on convenient samples which could substitute for arm **1** and which would be submitted to a vibratory standing in order to follow the variations of load and of deflection of a metal under the effect of vibration communicated to the latter.

In the several constructional forms the elastic arm **1** may have any desired constitution: it could, for instance, be constituted by a series of spring leaves, of any convenient arrangement and having any desired shape. It could also be constituted by a rigid arm pivoted upon a shaft located in the box **27** with interposition of a torsioning spring, any other arrangement being used for that purpose.

The described arrangement could also be inverted, the arm **1** being rendered rigid and the table **6** (or **28**) being provided with an elastic means such as for instance coil springs or the like, the operation of the comparator being conveniently modified for that purpose.

The machine according to this invention, and more particularly the machine described and shown in Figs. 1 to 4, could be provided with only one single comparator located on the impression producing element.

The invention applies for determining the hardness of metals or any other substances as well as the resistance of said substances to wear.

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