

May 11, 1943.

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2,318,993

AUTOMATIC SCLEROSCOPE

Filed Feb. 21, 1941

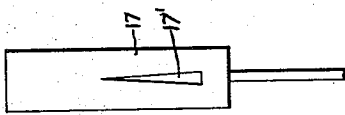


Fig. 2.

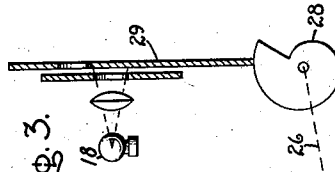


Fig. 3.

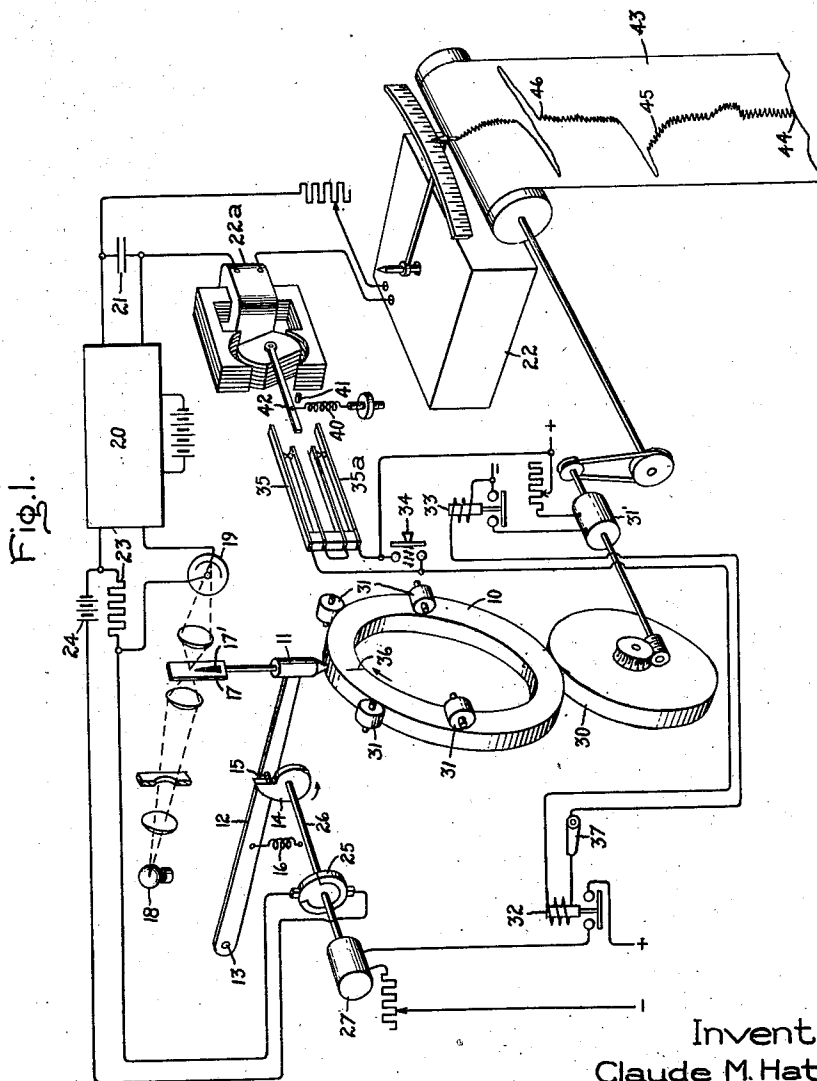


Fig. 1.

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UNITED STATES PATENT OFFICE

2,318,993

AUTOMATIC SCLEROSCOPE

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Application February 21, 1941, Serial No. 380,005

4 Claims. (Cl. 265—13)

My invention relates to an automatic scleroscope and its object is to enable hardness tests on materials to be made at various points along or about the test piece quickly and automatically, and the test procedure stopped or otherwise controlled in case the sample under test does not conform to a desired standard of hardness.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention, reference is made in the following description to the accompanying drawing in which Fig. 1 represents a diagrammatic view of a preferred form of my invention as arranged to test the hardness of a ring such as the race ring for a ball bearing, and Fig. 2 is a face view of the hammer shutter and Fig. 3 is a cam-operated shutter that may be employed.

Referring to the drawing, Fig. 1, 10 represents a ring such as for example the ring race used in ball bearings which it is desired to test for hardness by the scleroscope method at various points around its periphery to determine if the ring is of a prescribed, uniform hardness. 11 is the hammer of a scleroscope and the tests are made by allowing the hammer to strike the test piece with a certain force and measuring the rebound. The extent of the rebound is proportional to hardness and may be calibrated in suitable hardness units. The hammer head is on the end of a lever 12 pivoted at 13 which lever is raised by a prescribed amount by a cam 14 which engages with a pin 15 on the hammer lever. The rapidity, force and accuracy of the blows which are struck by fall of the hammer may be increased by the use of a spring 16 which is tensioned when the hammer is raised and, by reason of the fact that friction during the fall of the hammer, has been practically eliminated. The step in the cam should be sufficient that pin 15 does not strike the cam when the hammer drops on the test piece but the hammer is stopped entirely by the blow on the test piece and rebounds freely without touching the cam. The operation of the hammer may be sufficiently rapid as to be compared to a vibrating reed. The lift of the hammer may be as small as about $\frac{1}{4}$ inch. Means are provided to obtain a measurement of the extent of rebound in terms of hardness and one means for doing this will now be described.

The hammer carries an upright screen 17 which is interposed in the path of light from a source 18 to a photocell 19. The light rays are suitably concentrated by lenses and it will be understood that an opaque enclosure will be provided to ex-

clude external light from the light ray system. The screen 17 is provided with a vertical slit 17' (see Fig. 2) which slid may be wedge-shaped or otherwise as required by the calibration. The screen with its slit is so positioned with respect to the path of light as to cut off all light when the hammer is in contact with the test piece 10 as shown. When the hammer and screen are raised by a rebound the slit in the screen 17 is raised and allows light to pass to the photocell 19 in proportion to the extent of such rebound. That is, the time during which the light passes to the photocell per rebound increases with the extent of the rebound and also the volume of light passing at any instant may be made to suitably increase if desired with the extent of rebound by suitably graduating the width of the slit up to the width of the light beam.

20 represents amplifying apparatus by means of which the photocell current is amplified to charge a condenser 21 and the voltage across the condenser is measured by a suitable electrical measuring instrument 22. The instrument or instruments may be employed to indicate, record and control in response to hardness measurements. It will be understood that the current flowing through the instrument discharges the condenser. However, the rate of charge will be so proportioned to the rate of discharge as to make the instrument response proportional to hardness measurements when the hammer is being operated at the desired rate. The rate of operation of the hammer, the shape of the slit 17', the amplifying characteristics of the amplifier, the capacity of the condenser and the resistance of the measuring instrument circuit will all enter into the calibration of the measuring system. Each time there is a rebound of the hammer, light reaches the photocell 19 and a charging impulse is given to the condenser which is proportional to the rebound. The condenser is thus charged by periodic current impulses of varying duration or magnitude or both, such that the average charge on the condenser is proportional to hardness. The charge is measured by the instrument which also discharges the condenser so that any decrease in the charging rate due to decrease in hardness of the test piece and correspondingly smaller rebounds of the hammer are reflected in a decreased instrument indication.

Unless prevented, light also passes to the photocell when the hammer is raised by the cam, as well as when it rises in response to a rebound and means are provided to eliminate the charg-

ing current impulses which would otherwise flow, due to the raising of the hammer by the cam. For this purpose I may provide a resistance 23 in the amplifier control circuit of the photocell and produce a nullifying bias across such resistance during the time in which the hammer 11 is being raised by the cam. Connected across the resistance 23 is a battery 24 and a contactor 25, the latter being driven from the cam shaft 26 of the hammer raising cam 14. The contactor 25 is so positioned on the cam shaft in relation to cam 14 that approximately at the instant the hammer 11 strikes the test piece the circuit of battery 24 through resistance 23 is broken and remains broken during the initial rebound portion of a revolution of cam 14, but is made during that portion of the revolution when the hammer is being raised by the cam. During the period when the circuit of battery 24 is closed, it produces a voltage across 23 which opposes and nullifies the voltage that would otherwise exist due to energization of the photocell caused by raising of the shutter 17 for any reason. Hence charging of condenser 21 is due solely to the amount of light passing shutter 17 during an initial rebound action. The shaft 26 may be driven by a small motor 27, the speed of which may be accurately adjusted to the desired value.

An alternative arrangement for preventing any charging of condenser 21 except in response to the desired rebound action of hammer 11 is represented in Fig. 3 where an additional cam 28 on cam shaft 26 is provided to operate a second shutter 29 located between the light source 18 and shutter 17. The cam 28 and shutter 29 are arranged to cut off light when the shutter 29 is raised and this will occur except during the initial rebound period of the hammer 11. The step in cam 28 will be approximately in line with the step in cam 14 but it will generally be preferable to use separate cams 14 and 28 in order that each may be shaped to best perform its particular function.

In order that the material under test may be tested for hardness at various points along its surface, the work in test position is arranged to be fed past the scleroscope. Where the work is in the shape of a ring its inner or outer periphery may rest on a rotatable supporting arbor such as represented at 30 in Fig. 1. Additional guide rollers 31 are shown for accurately positioning the test piece 10 with respect to the scleroscope while permitting it to be rotated. An adjustable speed motor 31' is represented for rotating support 30 and the ring 10 at the desired rate so that the hammer 11 in normal operation will strike the test piece at different points around the periphery of ring 10 and the apparatus is then used to determine the hardness and hardness-uniformity at closely spaced points around the ring.

The apparatus may be set into automatic operation and then in case the hardness does not conform to or departs from a desired range, the apparatus may be arranged to shut down automatically under control of contact made or broken by the instrument 22a. For example, in Fig. 1 I have shown relays 32 and 33 controlling the circuits of motors 27 and 31' contained in a circuit which may be energized through a push button 34 or contacts 35 and 35a of the instrument 22a.

The instrument 22a is especially designed for control purposes. It has a clockwise torque proportional to the current in the instrument circuit

which torque is opposed by a spring 40 which may be adjustable. A stop 41 establishes the minimum torque position. In this position the arm 42 opens the contact 35a, and this contact will not close until the instrument torque has become appreciable. At some higher torque value arm 42 will open contact 35. Contacts 35a and 35 are connected in series in the control circuit such that if either is open, the test apparatus will stop operation. This control instrument will be so adjusted and calibrated that the arm 42 will be between the contacts with both closed over the allowable hardness range of the material under test but will open one or the other contacts if the hardness measurements go beyond such range in either direction.

To test a ring such as the ring 10, the ring is placed in position as shown and a mark 36 made thereon to indicate when it has been rotated a complete revolution. The apparatus having been calibrated and contacts 35 and 35a set to the desired position, the button 34 is pushed and held in momentarily. The motors start and if the hardness of the test piece is of the desired value, the charge on condenser 21 will, after a few hammer blows, build up to a value sufficient to deflect the instrument 22a to a point which will allow contact 35a to close. The push button 34 may then be released and the operation continues automatically. If, however, the hardness drops below or goes beyond the range for which the contacts 35 and 35a are set, one of the contacts will open and stop the testing procedure. The test piece may then be removed and discarded or put aside for rehardening. If, however, the apparatus continues in operation until the piece 10 has been tested around its entire periphery, the ring is of satisfactory uniform hardness and may be removed and another piece inserted for testing. Removing the test piece will automatically shut down the apparatus since the pin 15 will then strike the low part of the cam 14 and there will be no appreciable rebound and contact 35a will open. Also, the apparatus may be shut down by opening the relay circuits as with a switch 37.

The nature of the conveyor for passing material under the scleroscope hammer will depend upon the shape of the material or articles to be tested and it is not essential that the material be moved in any particular horizontal direction. If the apparatus stops automatically during a testing operation, the record made by the recording instrument 32 will show whether the shut down was due to over or under hardness or for some other reason.

The record shown on the chart 43, Fig. 1, indicates that from point 44 to point 45 the hardness was fairly uniform. At about point 45 the hardness decreased and allowed contact 35a to open, stopping the testing procedure. At point 46 the record indicates sudden increase in hardness followed by a shut-down.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An automatic scleroscope comprising a scleroscope hammer, means for supporting material to be tested for hardness in testing position beneath such hammer, means for intermittently raising said hammer a predetermined distance and allowing it to fall upon said material, photoelectric measuring means for measuring the extent of rebound of such hammer and means for suppressing the operation of said measuring means when the hammer is raised by the hammer raising means.

2. An automatic scleroscope comprising a scleroscope hammer, means for supporting material to be tested for hardness in testing position beneath said hammer, means for intermittently raising said hammer a predetermined distance and allowing it to fall upon such material, a light source, a photo-sensitive cell, a screen operated by the rise and fall of said hammer interposed between said light source and cell for controlling the light to said cell in response to the extent of raising of said hammer, electrical means energized in response to the controlling action of said photocell for measuring the hardness of material being tested, and means operated by said hammer raising means for nullifying the controlling action of said photocell when the hammer is raised by said hammer raising means.

3. An automatic scleroscope comprising a scleroscope hammer, means for advancing material to be tested for hardness in testing position beneath said hammer, means for intermittently raising said hammer a predetermined distance and allowing it to strike such material, electric control means operated in response to the extent

of rebound of said hammer, electrically operated means for producing a measurement indication of hardness of the material being tested and electrically operated means for stopping the material advancing means and the hammer raising means, said two electrically operated means being energized in response to the operation of said controller in proportion to the extent of such rebound.

4. A scleroscope comprising a scleroscope hammer, means for supporting material to be tested in testing position with respect to said hammer, means for causing the hammer to strike the material to be tested with uniform blows, means responsive to the rebound of said hammer for producing an electrical impulse proportional to the extent of such rebound, amplifying means controlled in response to such impulses, a condenser charged by current from said amplifier, and an electrical measuring instrument for measuring the charge on said condenser in terms of the hardness of the material under test.

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