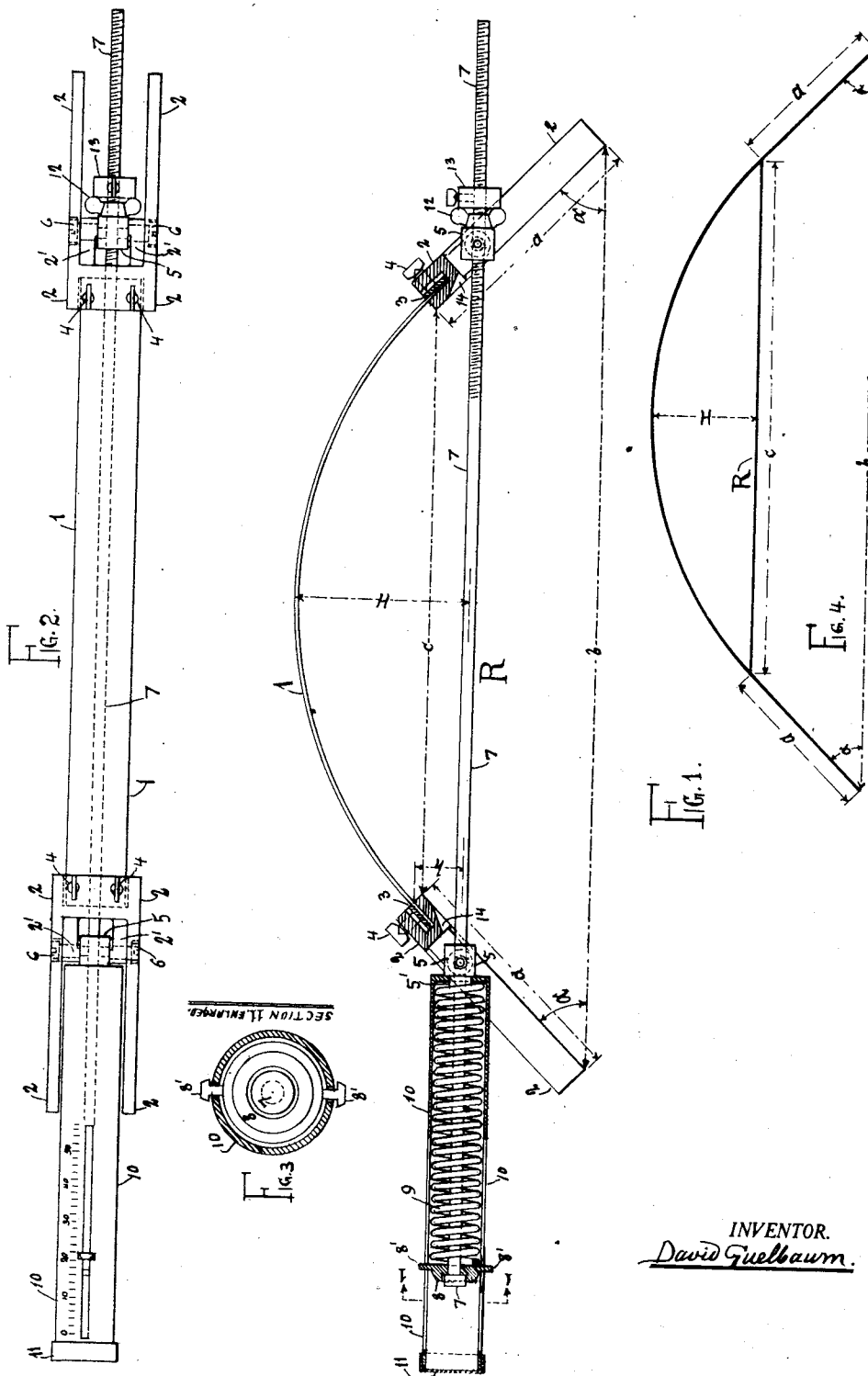


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D. GUELBAUM.
DYNAMOMETER FOR DETERMINING THE MODULUS OF ELASTICITY.
FILED JUNE 19, 1922.



INVENTOR.
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UNITED STATES PATENT OFFICE.

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DYNAMOMETER FOR DETERMINING THE MODULUS OF ELASTICITY.

Application filed June 19, 1922. Serial No. 569,556.

To all whom it may concern:

Be it known that I, DAVID GUELBAUM, a citizen of the United States, and a resident of Syracuse, in the county of Onondaga and State of New York, have invented a certain new and useful Dynamometer for Determining the Modulus of Elasticity, of which the following is a specification.

This invention of a dynamometer has for its object the exact mathematical determination of the modulus of elasticity in metals and woods, without the necessity of measuring minute elongations under heavy loads, as is at present the case.

My invention comprises the above set forth novel feature, embodied in combinations and constructions as hereinafter described, and as illustrated in the accompanying drawings, in which like characters designate the same corresponding parts in all the views.

Fig. 1 is a vertical section of my dynamometer.

Fig. 2 is a top view of same.

Fig. 3 is an enlarged cross section of the spring casing.

Fig. 4 is a diagram of a bow.

On the Figs. 1 and 2, 1 represents a light strip or band of the material to be tested, metal or wood, of uniform cross section, easily yielding itself to bending.

The ends of the strip 1, which may have the form of a thin band, as shown on the drawing, or of a light rod of round or rectangular cross section, are held tight inside the recess at the top of the extension clamps 2 by means of the plates 3 and the pressing on it screws 4. These clamps 2 are forked out and extended further down tangentially to the ends of the strip 1, forming an extension of same, for the purpose that will be explained later on.

Inside the forks of the extension clamps 2, between the cast on bosses 2', are pivoted the two square blocks 5 by means of the screws 6 with concealed heads, as shown on Figs. 1 and 2. Through holes drilled in the centre of these blocks 5 passes slidingly the long rod 7, having a bolt head at one end and threaded at the other end, as shown.

On the rod 7, between the washer 8 gripping the bolt head and the adjacent pivoted block 5, is mounted the spring 9 housed inside the cylindrical casing or pipe 10, having one end blanked off and supported and

centered by the passing through it of the round tail 5' cast on the pivoted block 5. The other end of the spring casing 10 may be left open, or may be closed by the screw cap 11, as shown on Figs. 1 and 2, and is supported by the washer 8 gripping the bolt head of the rod 7.

The threaded end of the rod 7 is provided with the thumb nut 12 holding the freely sliding pivoted block 5 in its position on the rod.

Thus the strained bent strip 1 is held stationary in its position on the rod or cord 7 between the two pivoted blocks 5, on one end by the pressure of the spring 9, at its other end by the thumb nut 12.

The dynamometer in its ensemble is placed on a horizontal table, for the elimination of vertical load influences.

The extension clamps 2 are partly notched out at 14, as shown on Fig. 1, to clear the cord or rod 7, so that the testing strip 1 may be flattened out as much as possible when desired.

The spring casing 10 is provided with two longitudinal slots with graduations marked on alongside, as shown on Fig. 2. Along these slots are sliding the lugs 8' of the washer 8, as shown in section on Fig. 1 and in plan on Fig. 3, indicating the compression of the spring in pounds, which measures the tension R of the rod 7 forming the cord that holds the testing strip 1 in its bent and strained position.

Knowing the tension R of the cord 1 as registered by the spring and the indicated on Fig. 1 dimensions H and h by direct measurement, also the moment of inertia I of the cross section of the testing strip 1, the modulus of elasticity E of the testing strip 1 is determined by the following exact mathematical formula:

$$(1) \quad R(H^2 - h^2) = 2EI(1 - \cos \alpha);$$

The angle α is that between the cord 7 and the extension clamp 2 which is tangential to the testing strip at the point of its entrance into the clamp, and is determined from the indicated on Fig. 1 dimensions a, b and c, namely:

$$\cos \alpha = \frac{b - c}{2a};$$

This explains the reason for elongating the clamps 2 into "extensions" to the test-

ing strip 1, so that by the same the angle α can be at once determined without the use of a protractor.

The setscrew collar 13 shown on Figs. 1 and 2 serves for verifying, whether the test has been carried on within the elastic limit or not, namely: setting the collar 13 close to the thumb nut 12 at the start of the test and noting the corresponding tension R of the cord as indicated by the spring at some slight compression of same, then, if at the close of the test, when the pivoted block and thumb nut are brought again close to the collar 13, the spring registers the same tension as at the start, then the elastic limit has not been surpassed; if the tension is less than at the start, then the elastic limit has been transgressed, and the testing strip has lost part of its resisting tension. Thus, the elastic limit may be determined simultaneously with the modulus of elasticity.

The above given formula (1) applies to "straight" strips only and which at the close of the test, when the cord is relaxed, become "straight" again.

In case the testing strip is already partially bent and curved at the start, then the following procedure may be followed, applying the given below formula (2), which may also be utilized for "straight" strips with greater precision than formula (1), as it may sometimes be difficult to obtain perfectly straight strips.

The procedure is as follows: Place the bent strip in the extension clamps 2 and screw down the thumb nut 12 till the spring is slightly compressed, and note the tension R and the dimensions H, h , b and c . Then, screw the thumb nut 12 a little further down, and note the "change" ΔR in the tension and the new dimensions H_1 , h_1 , b_1 and c_1 . Apply these dimensions to the following formula:

$$(2) \quad \Delta R \cdot (H^2 - h^2) (H_1^2 - h_1^2) = 2E \cdot I [(H^2 - h^2) (1 - \cos \alpha) - (H_1^2 - h_1^2) (1 - \cos \alpha)]$$

$$\cos \alpha = \frac{b_1 - c_1}{2a}$$

In this procedure the dimensions H and h are larger, the tensions R and $R + \Delta R$ are smaller, and a lighter spring may be used and all measurements can be made with greater precision, so that it may prove preferable to use in all tests a slightly bent strip than a straight one.

In case the member within the brackets in formula (2) becomes negative, the change of tension ΔR will also be negative, that is, the tension will decrease when the thumb nut 12 is screwed further down. This may happen in case the angle α is too large, and may or may not affect the result of the test; to avoid it the testing strip should not be bent too much at the start.

Formula (1) may also be applied to a bow, such as shown on Fig. 4, for determining the tension R of the cord, E and I being known. In this case $h=0$, and formula (1) gives:

$$RH^2 = 2E \cdot I (1 - \cos \alpha); \quad (1)^1;$$

The deduction of formula (1) will be entered in the specification if required.

What I claim is:

1. A dynamometer, comprising two extension clamps recessed on top for gripping the ends of the testing strip and elongated and forked forming an extension to said testing strip and provided each with a pivoted block, a rod passing slidably through said pivoted blocks and having a bolt head and washer at one end and threaded at the other end and a spring mounted on said rod between said washer and the nearest one of said pivoted blocks, a casing surrounding said spring and having

on one end a blank bottom with a hole in the center for said rod to pass through and its other end closed by a screw cap and provided with longitudinal slots and graduations for indicating the spring pressure, substantially as and for the purpose specified.

2. A dynamometer, comprising two extension clamps each having a recess on top with a plate inside pressed upon by setscrews for gripping the ends of the testing strip and elongated and forked forming an extension to said testing strip and having each two bosses cast on inside of said fork with setscrews passing thro said bosses and supporting each between said bosses a block pivoted on said setscrews and having a hole in centre and a projecting round tail on one of said two pivoted blocks, a rod passing thro said two pivoted blocks and having a bolt head and washer on one end and threaded at its other end and a spring mounted on said rod between said washer and the nearest one of the said two pivoted blocks, a casing surrounding said spring and supported by said washer and the projecting round tail on said nearest pivoted block and provided with longitudinal slots and graduations, substantially as and for the purpose set forth.

3. A dynamometer, comprising two extension clamps elongated and forked with a recess on top containing a clamping plate and setscrews and provided each with a pivoted block, and a rod passing thro said pivoted blocks and having a bolt head on one end and threaded at the other end and provided with a washer gripping said bolt

head and having two projecting lugs and with a mounted spring between said washer and the adjacent pivoted block and provided with a thumb nut and a setscrew collar on its said threaded end, a casing surrounding said spring and supported by said washer and the round tail on said adjacent pivoted block, substantially as and for the purpose described.

4. A dynamometer, comprising two extension clamps for gripping the ends of the testing strip and forming an extension of same and provided each with a pivoted block with a projecting round tail on one of them, a rod passing thro said pivoted blocks and provided with a bolt head and a washer with projecting lugs at one end and threaded at its other end with a spring mounted on it between said washer and the adjacent pivoted block provided with a projecting round tail, and a casing surrounding said spring and having one end open and the other end with a blank bottom with a hole in the center for said rod to pass through and being supported by said adjacent pivoted block with its round tail end passing thro it and by said washer with its projecting lugs passing thro and sliding along longitudinal slots in said casing with graduations marked on along said slots for indicating the spring pressure by the sliding projecting lugs on said washer and provided with a screw cap for closing the other open end of said casing, substantially as and for the purpose specified.

In testimony whereof, I have hereunto signed my name, at Syracuse, in the county of Onondaga, and State of New York, this 9 day of June, 1922.

DAVID GUELBAUM.