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APPARATUS FOR TESTING STAYBOLTS

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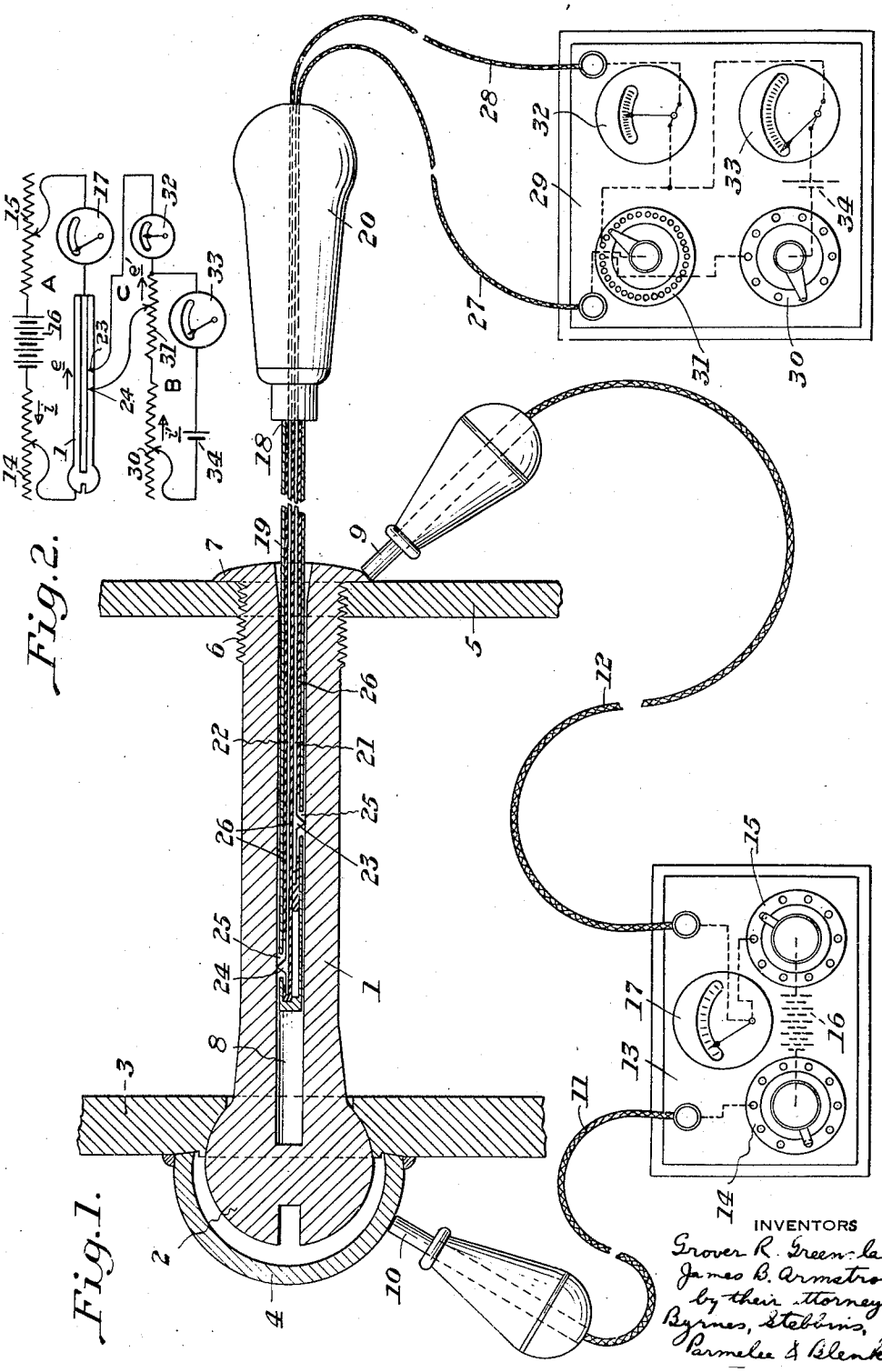


Fig. 2.

Fig. 1.

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APPARATUS FOR TESTING STAYBOLTS

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5 Claims. (Cl. 175—183)

Our invention relates to the testing of staybolts used in boiler construction.

Several methods and forms of apparatus have been proposed in the last few years for testing staybolts. None of these methods or forms of apparatus, as far as we are aware, is able to detect a crack or similar defect in a staybolt in the incipient stage, that is before the crack has reached the tell-tale hole with which staybolts are usually provided. Some of the previous devices, indeed, have been able to detect only a complete failure of the bolt. It is obviously very desirable to detect fractures in staybolts while in the incipient stage, so that suitable replacement can be made before the bolt is dangerously weakened.

We have invented an apparatus and method for detecting fractures in staybolts during the incipient stage, so that a defective bolt may be removed before it fails completely and, of greater importance, even before the fracture reaches the usual axial tell-tale hole. The outstanding advantage characterizing the invention is apparent in that the timely replacement of defective bolts made possible thereby contributes to a marked reduction in the number of boiler failures and wrecks resulting from collapsing fire boxes.

Our invention is based on the principle that an electric current traversing a metallic member of uniform cross section is distributed substantially uniformly throughout such section, and the fact that the electrical resistance of a conducting member varies in inverse proportion to the area of cross section. Our invention thus contemplates the circulation of a steady current of any suitable magnitude longitudinally through a staybolt to be tested, and a determination of the fall of the potential between successive points spaced along the length of the bolt. If such determination reveals that the fall of potential between all pairs of equally spaced points along the length of the bolt is identical, it may safely be assumed that the effective cross section of the bolt is uniform throughout its length. If there is a difference in the potential drops between two pairs of equally spaced points along the length of the bolt, this signifies that a particular cross section of the bolt offers greater resistance to the flow of current therethrough than adjacent cross sections, or, in other words, has an area less than that of the adjacent sections. This justifies the conclusion that an incipient crack or fracture of the bolt has reduced the effective current carrying cross section thereof, and that the bolt, therefore, should be replaced.

Our invention also contemplates an apparatus for readily comparing the drops of potential between a succession of pairs of points equally spaced along the bolt axis, and includes a device insertible into the usual tell-tale hole of the staybolt, for establishing contact between a series of pairs of points on the wall of the tell-tale hole equally spaced apart.

For a complete understanding of our invention, reference is made to the accompanying drawing, representing the present preferred embodiment. In the drawing—

Figure 1 is a diagrammatic view, partly in section, showing the apparatus of our invention for carrying out the method described and claimed herein; and

Figure 2 is a circuit diagram further illustrating the connections between the various pieces of apparatus shown in Figure 1.

Referring now in detail to the drawing and, for the present, particularly to Figure 1, a staybolt 1 has an enlarged head 2 seated in a suitably shaped opening in a boiler wrapper sheet 3. A cap 4 overlies the head of the bolt and tightly closes the opening in which the head 2 is seated. The other end of the bolt 1 is threaded at 6 and is thus adapted to be screwed into a threaded opening in a boiler fire sheet 5, the projecting end of the bolt being riveted over as at 7. A tell-tale hole 8 extends axially of the bolt 1 and, in the particular embodiment illustrated, is open at the inner or fire sheet end of the boiler. The invention about to be described may be utilized in connection with any staybolt having a tell-tale opening, regardless of which end is closed or even if both ends are open.

In order to circulate an electric current longitudinally of the staybolt 1, we provide terminals 9 and 10 engageable with opposite ends of the staybolt or adjacent parts in conducting engagement therewith. The terminals 9 and 10 are connected by leads 11 and 12 to a case 13 conveniently containing rheostats 14 and 15 of coarse and fine adjusting characteristics, respectively, a storage battery 16 and an ammeter 17. As will appear more clearly from Figure 2, the staybolt 1, the rheostats 14 and 15, the battery 16 and the ammeter 17 are connected to form a series circuit A.

While we have illustrated the terminals 9 and 10 as provided with handles by which they may be manually maintained in contact with the boiler structure as above described, for the best results, it will probably be desirable to utilize a more stable form of contact of any suitable type. It will be

apparent that by manipulation of the rheostats 14 and 15, the current traversing the staybolt 1 may be controlled, the magnitude of the current being indicated by the reading of the ammeter 17. It will be understood, of course, that additional staybolts similar to that shown at 1, extending between the wrapper sheet and the fire sheet, constitute additional circuits in parallel with that through the bolt 1. The same is true of other framing connections between the sheets.

The total current supplied by the battery 15 is thus distributed in a number of parallel paths, in accordance with their respective resistance. The existence of these parallel paths, however, does not affect the practice of the method to be described since it is only necessary, for a satisfactory comparison of the drops of potential between successive pairs of equally spaced points on a staybolt, that a steady current traverse the length of the bolt. The current actually traversing any particular bolt may be as small as the sensitivity of the apparatus to be described later for measuring the drop of potential will permit.

We provide a device 18 for establishing contact with a succession of pairs of equally spaced points along the length of the tell-tale hole 8. The device 18 comprises a cylindrical shell 19 preferably metallic, of such length as to penetrate completely the longest bolts which it is desired to test. The shell 19 is secured to a handle 20. Conducting members 21 and 22, conveniently in the form of strips, extend through the shell 19 and the handle 20. The members 21 and 22 are provided with points 23 and 24 extending outwardly of the shell 19 through suitable holes 25 therein. The members 21 and 22 are separated from each other and from the shell 19 by insulating material 26, and resiliently urge the points 23 and 24 into engagement with the wall of the tell-tale hole 8 when the shell 19 is inserted in the latter. The members 21 and 22 are connected by leads 27 and 28 to an instrument case 29 embodying rheostats 30 and 31, of coarse and fine adjusting characteristics, respectively, a galvanometer 32, an ammeter 33, and a battery 34.

The connections between the pieces of apparatus in the instrument case 29 and the points of the testing device 18 are more clearly shown in Figure 2. From the latter, it will appear that the rheostats 30 and 31, the ammeter 33 and the battery 34 are connected in a series circuit B. The contact points 23 and 24 and the galvanometer 32 are connected in a series circuit C which also includes a portion of the resistance element of the rheostat 31.

While the method of practicing our invention will be understood from the general description thereof and the specific explanation of the apparatus involved, we shall now explain in detail the necessary steps in testing staybolts according to the invention.

The terminals 9 and 10 are first applied to the boiler structure in the manner described so that the battery 16 causes a current to circulate longitudinally of the bolt. The total current circulating through the boiler structure may be adjusted by the rheostats 14 and 15 to a suitable magnitude as observed on the ammeter 17. The shell 19 of the testing device 18 is then inserted in the tell-tale hole 8 of the bolt to be tested. If the polarity of the battery 16 is such that current flows through the circuit A of Figure 2 in the direction indicated by the arrow i, the drop of potential along the bolt between the points 23 and 24 of the device 18 will be in the direction indicated by the arrow e. At the same time, the battery 34 causes a current to flow in the circuit B.

The battery 34 should be connected so that the direction of current flow in the circuit B is in the direction of the arrow i'. The current i' traversing the portion of the resistance element of the rheostat 31 included in the circuit C, causes a potential drop in the direction of the arrow e'. Now, if the circuit C is traced, it will be apparent that the potential across the galvanometer 32 or between the point 23 and the right hand terminal of the rheostat 31, is equal to the algebraic sum of the potential drops e and e'. If the voltage across the galvanometer 32 is designated by E, a mathematical relation may be defined thus:

$$E=(-e)+e'.$$

It will be evident that by suitable manipulation of the rheostats 30 and 31, the potential drops e and e' may be made equal so that the potential E will be zero. Under such condition, of course, the galvanometer 32 is undeflected. As long as the potential drops e and e' are different, the galvanometer will be deflected in one direction or the other.

When the adjustment above described has been made, it is easily possible to compare the potential drops between all pairs of points equally spaced along the bolt with the drop between the points on the interior of the tell-tale hole 8 which are initially engaged by the contact points 23 and 24 of the testing device 18, by moving the latter along the length of the bolt inwardly and outwardly of the bore therethrough. If such movement of the testing device effects no change in the reading of the galvanometer 32, it is obvious that the potential drops between all pairs of equally spaced points along the length of the bolt are identical, indicating a uniform conductivity and, therefore, uniform effective area of the bolt section. If movement of the device 18 effects a change in the galvanometer reading, it is evident that the drop of potential between certain pairs of points along the length of the bolt is different from that between other pairs of points. This indicates a change in the resistance at a certain cross section of the bolt, since the same current flows throughout the entire length thereof and the potential drop is the product of the current and the resistance of that portion of the bolt between the contact points 23 and 24.

Assuming a uniformity of the metallic structure along the bolt length, this change in resistance could result only from a change in the effective cross section resulting from the development of an incipient fracture. The invention thus makes it possible to discover fractures in staybolts before they have reached the tell-tale hole. This result has not heretofore been accomplished insofar as we are aware.

Since the method of our invention is based upon a balancing of potential drop, that is, on zero current conditions, no error is introduced by changes in the contact resistance between points 23 and 24 and the interior of the tell-tale hole. Since a single setting of the terminals 9 and 10 causes current to circulate through a plurality of parallel paths including adjacent bolts, it is possible to test a number of bolts without changing the setting of the terminals 9 and 10. Each bolt is marked, of course, as it is tested, bolts which are indicated defective being marked distinctively for replacement.

Further advantages of the invention include the simplicity of the structure involved, its low cost, and the fact that comparatively unskilled

labor can readily be trained to use it successfully. The outstanding advantage, however, is the additional safeguard provided against the progressive weakening of staybolts to an extent such that there is danger of failure of the fire box.

Although we have described herein but one preferred embodiment of the apparatus of our invention and the practice of the method thereof, it will be apparent that many changes in the apparatus and method described may be made without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. Apparatus for testing staybolts having tell-tale holes therein, comprising in combination, means for circulating an electric current longitudinally through a bolt, means for establishing electrical contact with successive pairs of equally spaced points along the length of the tell-tale hole, and means for indicating a difference in the drop of potential between said successive pairs of points.

2. In an apparatus for testing staybolts having tell-tale holes, the combination with a current source and terminals connected thereto adapted to supply current longitudinally of the bolt, of a device insertible into the tell-tale hole having contact points spaced therealong adapted to establish electrical contact with the interior of the bolt, and a potentiometer balance for comparing the drops of potential in portions of the bolt successively included between said contact points.

3. Apparatus for testing staybolts having tell-tale holes, comprising means for circulating a steady current longitudinally through a bolt, means for engaging a succession of pairs of equally spaced points on the interior of the hole, a local circuit adjustable to provide a potential drop equal to that between a pair of said points, and means for indicating a disturbance of the balance of said potential drops.

4. A staybolt testing tool comprising a generally tubular member having such shape and dimensions as to be insertible into a tell-tale hole extending axially into the bolt from one end thereof, a pair of spaced contacts extending laterally of said member and adapted to engage the interior of said hole, and connections from said contacts extending along said member and outwardly of said hole.

5. A tool for testing staybolts having tell-tale holes extending thereinto from one end, said tool comprising a tubular shell insertible into such holes, a pair of contacts extending laterally from the shell and adapted to engage the interiors of said holes, and connections from said contacts extending axially of the shell.

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