May 28, 1935. T. E. HEPPENSTALL 2,003,077

MATERIAL TESTING APPARATUS

Filed Sept. 14, 1928 2 Sheets-Sheet 1

Fig. 1.

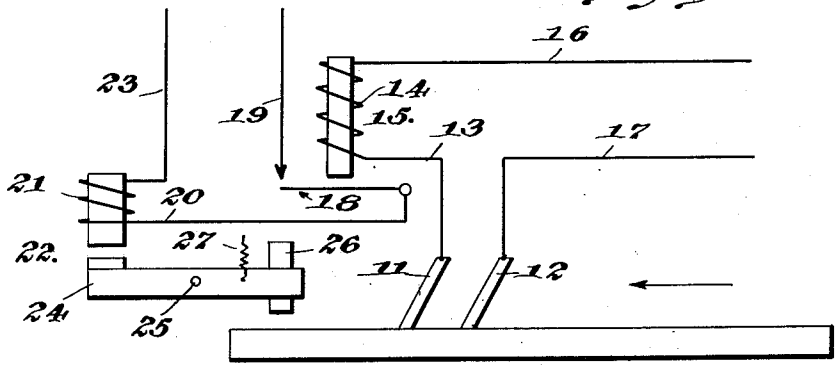
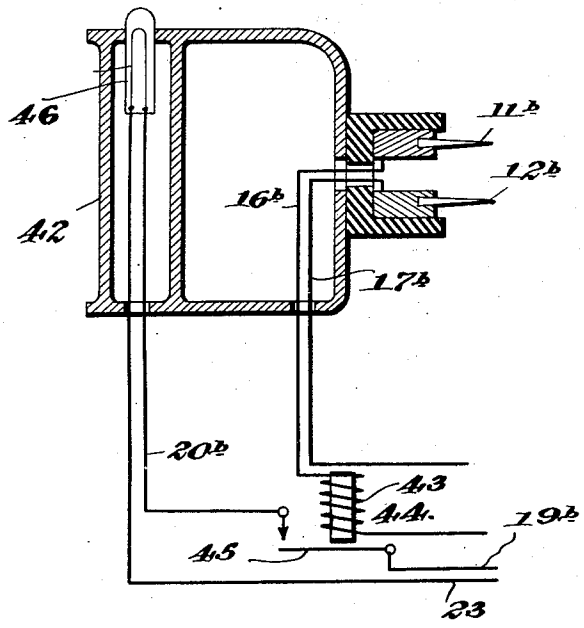


Fig. 3.



WITNESS

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MATERIAL TESTING APPARATUS

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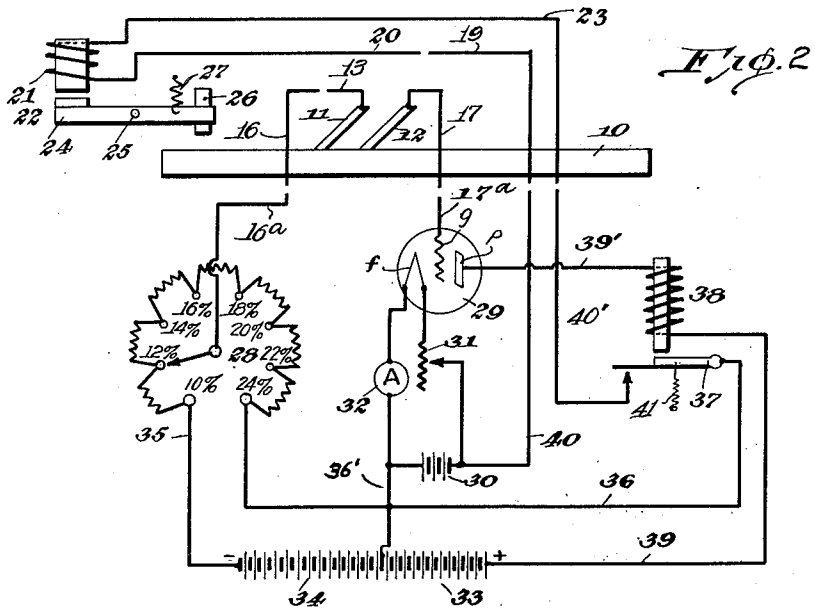


Fig. 2

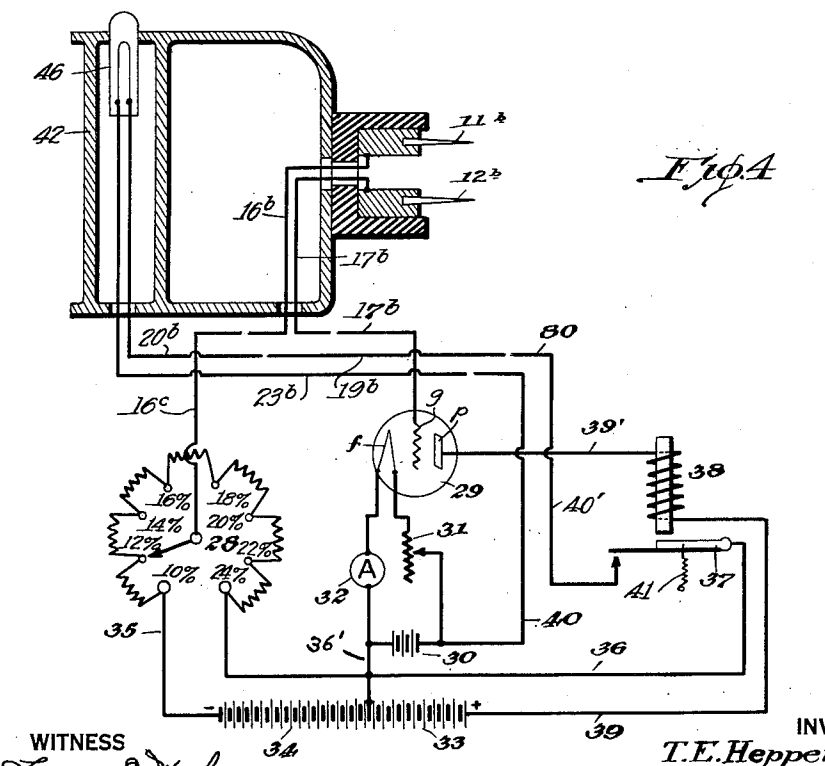


Fig. 4

WITNESS

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Patented May 28, 1935 2,003,077

UNITED STATES PATENT OFFICE

2,003,077

MATERIAL TESTING APPARATUS

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Application September 14, 1928, Serial No. 306,050

6 Claims. (Cl. 175—183)

This invention appertains to improvements in material testing apparatus generally, and more particularly to types of such apparatus for determining the fitness for use of certain classes of building or other similar materials and more especially lumber, by a measurement of the moisture content thereof.

In the manufacture of building materials, and particularly lumber, the moisture content of the wood plays a very important part in determining the fitness of the completed material for construction purposes, since wood has the undesirable property of shrinking or swelling as the result of the change of moisture content thereof, and which varies according to the temperature and humidity of the atmosphere. However, if the manufacturer knows for what purpose the lumber is to be used, he can dry the same in kilns to the proper moisture content, so that it will not shrink or swell enough to cause trouble in the completed work. For example, lumber to be used indoors in a heated building, would be dried to about seven percent (7%) moisture content, but, if used outdoors it would not be necessary to dry below fifteen percent (15%) moisture content. In the present kiln drying methods, however, lumber will not dry uniformly and a few pieces at least will have a moisture content which is much too high for ordinary building purposes, and these pieces should be removed from the pile before shipment or use.

The present known method of determining the moisture content of lumber is to cut off small samples and weigh the same carefully, then dry in an oven and reweigh. The difference in weight, before and after drying, is then multiplied by one hundred (100) and the resultant product is divided by the last weight obtained, which gives the moisture content in percentage of dry weight. This method, however, is a very slow one and of course cannot be performed without destroying a portion of each piece of lumber so tested.

An object of the present invention, therefore, is to provide a method and means for obtaining accurate measurements of the moisture content of construction materials, particularly lumber, in a more rapid and efficient manner than is possible with the method aforesaid and without in any way marring the surfaces of the material or destroying any part of the same.

Another object of the invention is to provide a method and means as hereinbefore characterized wherein the apparatus will embody certain electrical devices and instruments so connected in circuit with one another and with a suitable source of current supply as to take advantage of the known fact that the electrical resistance of moisture bearing materials, such as wood, varies indirectly as the moisture content thereof below fibre saturation point, which point is between twenty percent (20%) and thirty per cent (30%) moisture content.

A further object of the invention is to provide a method and means of the character above mentioned, which may be readily employed in conjunction with a wood planer or other wood working machine, whereby the desired measurements can be obtained just after the pieces of material have been acted upon thereby.

Another object of the invention is to provide an apparatus of the character mentioned, which will be entirely automatic in operation, when employed in connection with a wood planer or the like for the testing out of each piece of material passing therethrough, but which may be readily manipulated by hand with only a slight modification for the testing out of individual pieces of material either before or after the same have been passed through a planer.

A further object of the invention is to combine with measuring apparatus of the class set forth which will operate automatically to mark certain pieces of material which are of proper moisture content as determined by the setting of the measuring instruments, or the pieces of material of excessive moisture content, as the case may be, whereby the material may be graded accordingly.

With the foregoing and other equally important objects and advantages in view, the invention resides in the certain new and useful combination, construction and arrangement of parts as will be hereinafter more fully described, set forth in the appended claims, and illustrated in the accompanying drawings, in which:

Figure 1 is a diagrammatical view of material testing and marking circuit, in accordance with the invention,

Figure 2 is a similar view of a moisture content measuring circuit combined with a modified form of the circuit shown in Figure 1,

Figure 3 is a vertical section through a portable form of material testing device and showing the electrical circuits associated therewith, and

Figure 4 is a view similar to that of Figure 2, but showing the moisture content measuring circuit combined with a modified form of the circuits associated with the testing device depicted in Figure 3.

Referring to the drawings, and more particu-

larly to Figure 1 the embodiment of the invention, as shown therein by way of example only, is comprised in a pair of contacts 11 and 12 disposed in a suitable position to be engaged with pieces of material passed beneath the same, a conductor 13 connecting contact 11 with a terminal of the coil 14 of a relay 15 which has its other terminal connected to a conductor 16 leading to an adjustable potential source of current (not shown), and a conductor 17 leading from the other contact 12 to the said current source. The movable armature 18, of the relay 15, is arranged to make and break contact with the adjacent fixed terminal of a conductor 19 leading to another suitable source of current supply (not shown) and itself has connection with a conductor 20 leading to one side of the coil 21 of an operating magnet 22 of a material marking device, the other side of the coil 21 being, in turn, connected to a conductor 23 leading to the latter current source. The armature 24, of the magnet 22, is centrally pivoted, as at 25, and carries a marking member 26 at the end thereof opposite to that which is associated with the core of the magnet. The armature 24, of the magnet 22, is also normally tensioned by a spring 27 to sustain the marking member 26 in its inoperative position.

This assembly of parts and circuits constitutes within itself a complete material testing and marking apparatus, but, with an elimination of the relay 15 therefrom and a joinder of the conductors 19 and 20, it is to be employed in conjunction with a moisture content measuring circuit after the manner as shown in Figure 2, as will presently be described.

In the use of the apparatus (Figure 1), the control relay 15, the magnet 22, and the aforesaid sources of current supply, will preferably be housed within a suitable casing (not shown) which can be conveniently positioned adjacent a lumber conveyor, wood planer or the like, and in a manner that the contacts 11 and 12 will engage the surface of each piece of material as it passes along the conveyor or from the planer, so that the moisture content of successive pieces of material will close the circuit on the relay 15. With the relay 15 adjusted to function at a predetermined current strength, the bridging of the contacts 11 and 12 by a piece of material having a greater percentage of moisture content than is desired will cause the armature 18 to operate to close the circuit on the conductors 19 and 20 and the magnet coil 21. With the energizing of the coil 21, the armature 24 will be actuated against the tension of the spring 27 and the marking device 26 will be moved thereby against the opposed surface of the material to mark it for later identification. By thus marking the high moisture content pieces of material they may be readily separated out from the drier and unmarked pieces and thereafter be subjected to a further drying out or seasoning.

In Figure 2, the aforesaid moisture content measuring circuit is shown, and it generally consists of a potentiometer 28 arranged in the grid circuit of a three-electrode amplifier tube 29, the filament *f* of the latter being energized from a low voltage current source or "A" battery 30 in circuit with a control rheostat 31. An ammeter 32 is also here included in the filament circuit. The plate circuit of the tube 29 is supplied with current from a "B" battery 33, and the grid circuit from a "C" battery 34. However, any suitable source of direct current, other than the "C" battery 34, may be substituted for the latter if desired. The potentiometer 28 is preferably calibrated in units of percentage of moisture content, somewhat as shown, and the grid circuit, in which the potentiometer is connected, is preferably negative but may be positive if desired.

In the contemplated operation of this measuring network in conjunction with the material testing circuit in Figure 1, a conductor 16a leads from the movable contact arm of the potentiometer 28 and connects the conductor 16 and the material engaging contact 11, after the relay 15 has been removed and the conductors 19 and 20 joined together. One terminal of the series resistance coils of the potentiometer 28 is connected by a conductor 35 to one side of the "C" battery 34, while the other terminal thereof is connected by a conductor 36 to the movable armature 37 of a control relay 38. A branch conductor 36' connects the conductor 36 to the filament circuit of the tube 29, at a point between the battery 30 and the ammeter 32, and to the intermediate common terminal of the batteries 33 and 34. A conductor 17a leads from the grid *g* of the tube 29 for connection with the conductor 17 leading from the material engaging contact 12. A conductor 39 leads from the positive side of the battery 33 and connects one terminal of the coil of the relay 38, and a conductor 39' leads from the other terminal of the latter and connects the plate *p* of the tube 29. A conductor 40 leads from the filament circuit of the tube 29 and connects with the conductor 19 leading from one side of the magnet coil 21, after the conductor 19 has been connected up with the conductor 20, upon the removal of the relay 15 from the material contacting circuit. A conductor 40' leads from the fixed contact of the relay 38 for connection with the conductor 23 leading from the other terminal of the magnet coil 21.

As shown, the armature 37, of the relay 38, is preferably maintained normally closed on the fixed contact by the tension of a spring 41, when the relay 38 is de-energized and the material engaging contacts 11 and 12 are disengaged from the material under test. However, this relay control circuit may be employed in open condition at the contacts of the relay, depending upon the desired mode of operation of the marking device 26; and it is to be here noted that an indicator or visual signal may be substituted for the marking device when the automatic marking of material under test is not desired; also that the control relay 38 acts as a substitute for the control relay 15 (Figure 1) to effect the operation of the marking device or indicator as the case may be.

With the two circuits or networks thus joined together, an attendant will first note that the marking device 26 is in its normally inoperative position, when the contacts 11 and 12 are disengaged from the material, or engaged with a drier material than that at which the potentiometer 28 is set at the moment. Now, with the contacts 11 and 12 engaged with a piece of material, if the marking device 26 moves to operative position, the attendant will immediately know that the material is wetter than that indicated by the moisture content setting of the potentiometer 28, and he will reject the same, and, in the use of the marking device, all rejected pieces of material will be plainly marked thereby. However, if he desires to ascertain the ex-

act percentage of moisture content of a particular piece of material, he will leave the contacts 11 and 12 against or in the piece and then manipulate the potentiometer 28 until the marking device 26 returns to its inoperative position. The reading thus obtained from the indicated percentage unit on the potentiometer will be the exact value of the moisture content of the piece of material at the point tested. It will be understood that, instead of employing the potentiometer 28 alone, various taps may be made direct to the battery 34 and connected with an instrument having a dial calibrated in units of percentage of moisture content.

Referring now to Figure 3, a portable form of material testing device is shown, and, in use, greatly facilitates and expedites the separation and grading of wet and dry materials, one kind with respect to the other, but without marking any of the same for later identification. By reason of its portability, lumber in separated piles or stacks, as usually arranged in lumber yards, may be readily and quickly graded.

In this form of the invention, the material engaging contacts 11^b and 12^b are preferably in the form of pointed metal pins or the like, and they are mounted in spaced relation at one side of a hand grip 42, whereby they are carried from one place of use to another and plunged by an operator into a board or other piece of material to be tested. This type of contact is particularly efficient for testing out rough or undressed lumber, in that the points will penetrate the outer and usually drier layer of the wood which is often found to be practically free from moisture and especially when the lumber has been long exposed to air and reach into the interior that is very frequently found to have a relatively high percentage of moisture content.

As shown, the contacts are insulated one from the other and from the hand grip 42, the contact 11^b being provided with a conductor 16^b leading to an adjustable potential source of current (not shown) through the coil 43 of the control relay 44, and the contact 12^b with a conductor 17^b leading directly to the said current source. The relay armature 45 is arranged to cooperate with a fixed terminal of a conductor 20^b leading to one side of a signal lamp or the like 46, which is carried at a convenient point in the hand grip 42. The armature 45 is directly connected to a conductor 19^b leading to one side of a second current source (not shown), while the other side of the signal device 46 is also directly connected to that current source by a conductor 23.

In the use of this form of the apparatus, the relay 44 will be adjusted to function at a predetermined current strength which will correspond to the percentage of moisture to be employed as a basis for the selection or rejection of pieces of material, so that, upon the engagement of the contacts 11^b and 12^b with a particular piece of material, the signal or indicator 46 will be unaffected should the percentage value of moisture content of the material be below that corresponding to the predetermined current strength required to operate the relay 44, or the signal 46 will be actuated by the closing of its circuit at the armature 45 upon the increased energization of the relay coil 43 as the result of a flow of current therethrough due to the material having a percentage value of moisture content above that of the predetermined current strength.

This testing circuit in Figure 3 is also to be employed, with some modification, in conjunction with the aforesaid moisture content measuring circuit and after the manner as shown in Figure 4, wherein the conductor 16^b from the contact 11^b will be connected to the conductor 16^c leading from the potentiometer 28, after the removal of the relay 44 and the direct joining together of the conductor 19^b and 20^b in the signal or indicator circuit. Similarly, the conductor 19^b of the latter circuit will be connected to the conductor 40' of the measuring circuit and the conductor 23^b of the former to the conductor 40 of the latter. In making this hookup of the testing and measuring circuits, it will of course be understood that the current sources usually employed in the circuit in Figure 3 will be replaced by those shown in the measuring circuit in Figure 4.

In both of these hookups (Figures 3 and 4), the signal or indicator 46 will be actuated whenever the contacts 11 and 12 are bridged by material of too high a moisture content, and, in order to make the hookups readily transportable in their respective entireties, the external circuits and the instrumentalities connected therein will be housed within suitable casings (not shown) for convenience in handling and moving from one point of use to another, along with the hand grip assembly, as is desirable particularly in testing out lumber arranged in piles in storage buildings and yards and whereby an inspector can readily and easily test a pile of lumber and quickly grade out the high moisture content boards or timbers for subsequent kiln treatment or other seasoning.

The methods of testing involved in the devices and circuits in Figures 1 and 3 are practical for testing materials having a high moisture content but, when testing materials of a comparatively low moisture content, the amplifier measuring circuits in Figures 2 and 4 are preferred.

What is claimed is:—

1. Means for grading construction materials having a moisture content, such as a number of pieces of lumber, comprising an audion tube, sources of current for the filament, grid and plate electrodes of said tube, a pair of relatively fixed material penetrating contacts in the grid circuit of said tube, a relay in the plate circuit of said tube, a normally open indicating circuit controlled by said relay, and a potentiometer in circuit with said material engaging contacts and the said grid, said potentiometer being calibrated in terms of moisture content, said relay being actuated to close the indicating circuit as a reduced current flows in the plate circuit of said tube due to an increased flow of current in the grid circuit when the material engaging contacts are forcibly driven into a piece of material having a moisture content above that for which the potentiometer has been set.

2. An apparatus for grading lumber and the like by an electrical measurement of the moisture content thereof comprising a three electrode tube, normal sources of potential for the filament and plate circuits of said tube, spaced relatively fixed contacts adapted to be bridged by material into which they are forced to penetrate, the grid electrode of said tube being connected to one of said contacts, a grid battery of relatively high potential, and a potentiometer calibrated in percent of moisture content bridging said grid battery and having an adjustable arm connected to the other of said contacts.

3. An apparatus for grading lumber and the

like by an electrical measurement of the moisture content thereof comprising a three electrode tube, normal sources of potential for the filament and plate circuits of said tube, spaced relatively fixed contacts adapted to be bridged by material into which they are forced to penetrate, the grid electrode of said tube being connected to one of said contacts, a grid battery of relatively high potential, a potentiometer calibrated in percent of moisture content bridging said grid battery and having an adjustable arm connected to the other of said contacts, a relay in the plate circuit of said tube, and an indicator circuit, including a current source, connected to the control contacts of said relay.

4. The apparatus as set forth in claim 3, wherein the said indicator circuit, including the control contacts of said relay are connected to the current source for the filament circuit of said tube.

5. The apparatus as set forth in claim 3, wherein a material marking device is employed in the said indicator circuit for the purpose of designating certain of the material for subsequent identification.

6. The apparatus as set forth in claim 3, wherein the said material engaging contacts and the moisture content indicating device in said indicator circuit are mounted on a hand grip for the testing out of separated groups of materials, the hand grip assembly being readily portable from one group of the materials to another.

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