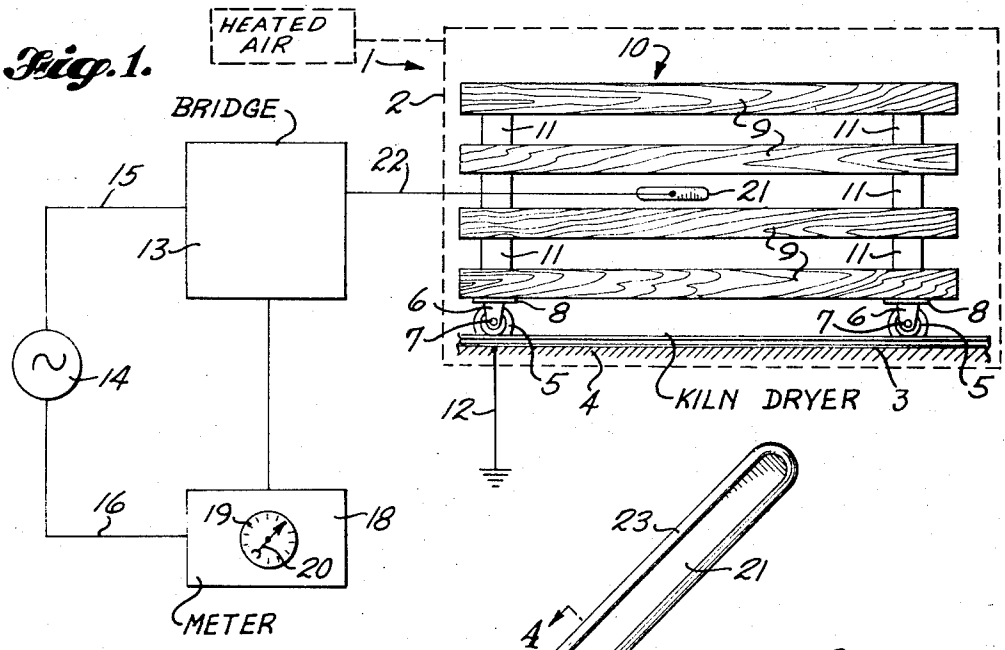
March 4, 1969 W. D. PERRY 3,430,357

METHOD OF DRYING WOOD AND MOISTURE INDICATOR

Filed May 17, 1967

Fig. 1.



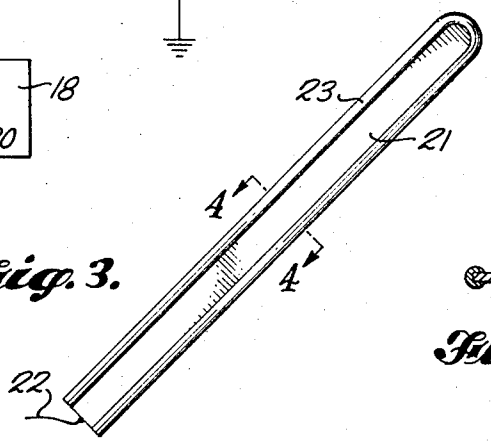


Fig. 3.

Fig. 4.

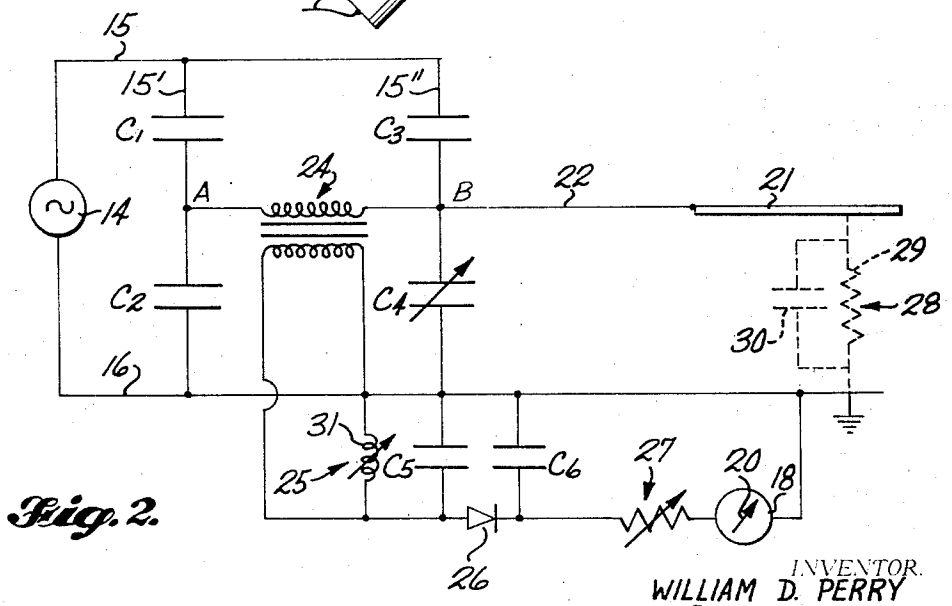


Fig. 2.

INVENTOR.
WILLIAM D. PERRY
BY Leslie G. Hobbs &
Daniel C. Block
ATTORNEYS

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METHOD OF DRYING WOOD AND MOISTURE INDICATOR

William D. Perry, Longview, Wash., assignor to Weyerhauser Company, Tacoma, Wash., a corporation of Washington

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Int. Cl. F26b 5/04, 5/00; G01n 25/56

ABSTRACT OF THE DISCLOSURE

A method of drying dimensioned lumber in a kiln wherein the lumber is stacked on carriage means and heated air is circulated through the kiln. The moisture content of the loads of lumber is monitored by an instrument having a probe connected across one leg of a capacitance bridge. The instrument measures the current flow between the probe and ground, thus indicating the impedance of the wood that is related to the moisture content.

Background of the invention

In the art of drying lumber, it is the practice to load carts or carriage means with the dimension lumber properly spaced apart and place the loads of lumber in a kiln. Heated air or other gas medium is circulated within the kiln to remove moisture from the lumber. Dwell time for a load of lumber within the kiln is dependent upon a number of varying factors. These factors are wood species, thickness and initial moisture content. The initial moisture content is effected by the growth conditions of the tree and storage conditions of the lumber between the time the tree was harvested and the time the lumber enters the kiln. While the lumber is in the kiln, the factors of air temperature, humidity and velocity affect the moisture removal rate. Thus, it is important that the dwell time for the loads of lumber within a kiln be exactly determined because too much time within the kiln will result in overdrying, breaking up of lumber and added expense while too little time within the kiln will necessitate additional drying due to excessively wet stock.

Common methods of determining moisture content in production kilns involve guessing the moisture content from past experience on the basis of species; size and residence time in the kiln; opening the kiln and picking at the lumber with a jackknife for an indication of brittleness and therefore moisture content; opening the kiln and guessing the moisture content by estimating the amount of shrinkage of the lumber; and opening the kiln, sawing off the end of a board for an oven dry measurement assuming that one sample is representative of the entire kiln load.

Previous methods of remote measurement involved the use of pairs of pins driven into selected pieces of wood and connected via wires to an instrument that measured the electrical resistance of the wood at these points. These electrical resistance values are correlated to the moisture content of the wood. The accuracy of this method depends on getting enough pairs of pins to be able to predict the average moisture content of the kiln load. Because the time necessary to prepare a kiln load with a sufficient number of pins is large, this method has not found wide acceptance in the industry. Heretofore, it has been known to use capacitance measurements for determining moisture content of wood with appropriately designed electrode systems. Commonly used systems use either a parallel plate capacitor with the lumber acting as a dielectric between the plates, or a capacitor arrangement with the wood acting as a dielectric in the fringe field at the edge of the capacitor. These systems are complex and expensive, thus they have not found application for control in drying of lumber.

Summary of the invention

This invention is directed to both a method of drying wood and an instrument for measuring the average moisture content of the lumber inside a dry kiln during the drying process. The method of drying involves placing probes into the loads of lumber and monitoring the lumber moisture content during drying. When the instrument indicates the desired moisture content, the drying schedule is terminated.

The instrument monitoring the lumber moisture content sees the load of lumber as a large volume of dielectric material between the probe and ground. This dielectric material shows both capacitive and resistive effects, each dependent on moisture content. The probe is connected to a balanced capacitance bridge so that the probe and dielectric parallel one leg of the bridge to ground and thus unbalance the bridge. During drying the capacitive effect of the dielectric decreases and the resistive effect increases, resulting in a decreasing imbalance of the capacitance bridge. The imbalance is then related to wood moisture content.

The probe is a conducting strip inserted parallel to the air flow through the load and extending from side to side of the load. Used in this manner, an average moisture content is obtained from boards across the load and a relatively large sample can be measured with a single capacitor probe, or in other words, adequate sampling with minimum effort. Moreover, this average moisture content can be obtained without the necessity of shutting down the kiln to check lumber visually as heretofore known. Use of several probes on a kiln track will permit measuring at several locations.

Brief description of the drawing

FIGURE 1 is a schematic side view of a kiln dryer illustrating the manner in which the electrical circuit is is connected to the probe.

FIGURE 2 is a wiring diagram of the electrical circuit of the present invention.

FIGURE 3 is a plan view of the capacitor probe used in the present invention.

FIGURE 4 is a cross sectional view taken along line 4—4 of FIGURE 3.

Detailed description of the invention

Referring to FIGURE 1, the kiln dryer is illustrated at **1** and includes an elongated housing **2**. The housing **2** is provided with a track or rail **3** which is mounted to the flooring as indicated at **4**. The track **3** is adapted to receive rollers **5** mounted on axles **7** which carry a yoke support **6**. The yoke support **6** carries an elongated support **8** for loading the stack of lumber **10** thereon. The stack of lumber **10** includes a plurality of dimensioned lumber **9** that is spaced from each other by spacer members **11**. As is apparent from FIGURE 1, the load of lumber **10** is grounded through the wheel members **5** as indicated at **12**.

The moisture content of the load of lumber can be indicated by a mechanism including an oscillator **14** connected by leads **15** and **16** to a bridge **13** and a readout meter **18**. The readout meter member **18** may be provided with a dial **19** having a pointer **20** thereon. The bridge **13** is connected to a capacitor probe member **21** by lead **22**.

The capacitor probe member **21** is an elongated metal member of a sufficient length to extend the entire width of the load **10** and may be up to 6" in width. The outer edges of the member **21** may be covered with insulating means **23** to prevent short circuiting by contacting the lumber members **9**.

Referring now to FIGURE 2, the electrical circuit employed with the present invention is illustrated. An oscillator **14** is employed to drive the bridge **13** which is interconnected by leads **15** and **16**. The oscillator **14** drives the bridge **13** with a predetermined signal at about 3 to 30 volts. Within the bridge **13** itself, the leads **15** and **16** are interconnected by a lead **15'** having capacitor C_1 and C_2 connected in series. The leads **15** and **16** are again connected to each other by a lead **15''** having a pair of capacitors C_3 and C_4 in series. The probe **21** is connected by lead wire **22** to point B between the capacitors C_3 and C_4. A transformer **24** or other means for coupling to a bridge unbalance indicating system is interconnected between points A and B just below capacitors C_1 and C_3 but above capacitors C_2 and C_4. The function of the transformer **24** is to couple the difference in voltage between points A and B to the readout circuit. A filter mechanism **25** is connected into the electrical circuit and includes a variable inductor **31** connected between one side of the transformer and the lead **16** with the capacitor C_5. This filter mechanism is for the purpose of reducing stray signals picked up from the atmosphere. Diode **26** and capacitor C_6 convert the filtered AC bridge unbalance voltage to a DC voltage which is sent to the readout meter **18**. A variable resistance **27** is connected to one side of the meter **18**. The function of the variable resistor **27** is to adjust the readout on the meter **18** to a finite amount and to set the gain of the system.

The operation of the instrument is as follows: the oscillator **14** drives the bridge circuit **13** at a predetermined voltage. The bridge is balanced so that a minimum signal is sent from the bridge circuit to the meter **18**. This balance of the circuit would indicate that 0% moisture content is present between the electrode probe **21** and ground. A load of lumber **10** stacked with spacers **11** between the layers of boards **9** is placed into a kiln dryer. The probe **21** is slid into the space between the layers of boards **9** within the kiln. The wire **22** is connected to the probe **21** and the instrument is operating. When the probe **21** is in this position, electrical current is transmitted through the lumber to ground. This current causes a change of impedance in the lower leg of the bridge containing capacitor C_4 and upsets the balance of the bridge. This impedance is indicated at **28** in FIGURE 2 and consists essentially of a resistance **29** having a capacitance **30** coupled thereacross. Since wood contains water, it will transmit current from the probe **21** to ground. The amount of unbalance is transmitted through transformer **24** and filter **25** and becomes a direct current voltage. The amount of moisture within the wood determines the amount of unbalance in the bridge which in turn produces an output signal directly related to the amount of moisture within the load of lumber.

In this manner, the operator need not guess the amount of moisture content within the load of lumber within the kiln dryer since it can be read directly upon the meter **18**. Also, it should be noted that the components of the bridge are essentially unaffected by ambient conditions of humidity and the like.

What is claimed is:

1. In a method of drying lumber, comprising:
(a) stacking dimensioned lumber on a carriage means in a spaced apart relationship;
(b) placing the stacked lumber in a kiln dryer;
(c) circulating a moisture removal medium within the kiln dryer;
(d) the improvement comprising, monitoring the moisture content of the stacked lumber with a capacitance bridge circuit that is provided with a probe between the stacked lumber; said bridge circuit being imbalanced due to the impedance to current flow between the probe and ground, the amount of imbalance indicating the average moisture content of the stack of lumber.

2. A system for measuring the average moisture content in a stack of lumber in a kiln dryer, the combination comprising:
(a) an oscillator for producing an electrical output;
(b) a probe means adapted to be mounted between spaced apart dimensioned lumber stacked in a kiln;
(c) a bridge circuit coupling the oscillator output to the probe for producing an output signal dependent on the electrical impedance of the lumber; and
(d) meter means connected to the bridge circuit for indicating the unbalance of the bridge due to current flow between the probe and the stack of lumber.

3. The system of claim **2** in which the bridge circuit comprises capacitors in each leg.

4. The system of claim **2** in which a transformer couples the output signal from the bridge circuit to the meter means.

5. The system of claim **2** in which a filter network is used between the bridge circuit and meter means to reduce stray signal pickup in the output signal.

6. The system of claim **2** in which the output signal from the bridge circuit is rectified to permit the use of a direct current meter means.

7. The system of claim **2** in which the probe means extends essentially the full width of the stack of lumber.

8. The system of claim **2** in which the probe is insulated from the lumber.

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WILLIAM J. WYE, *Primary Examiner.*