

Oct. 2, 1962

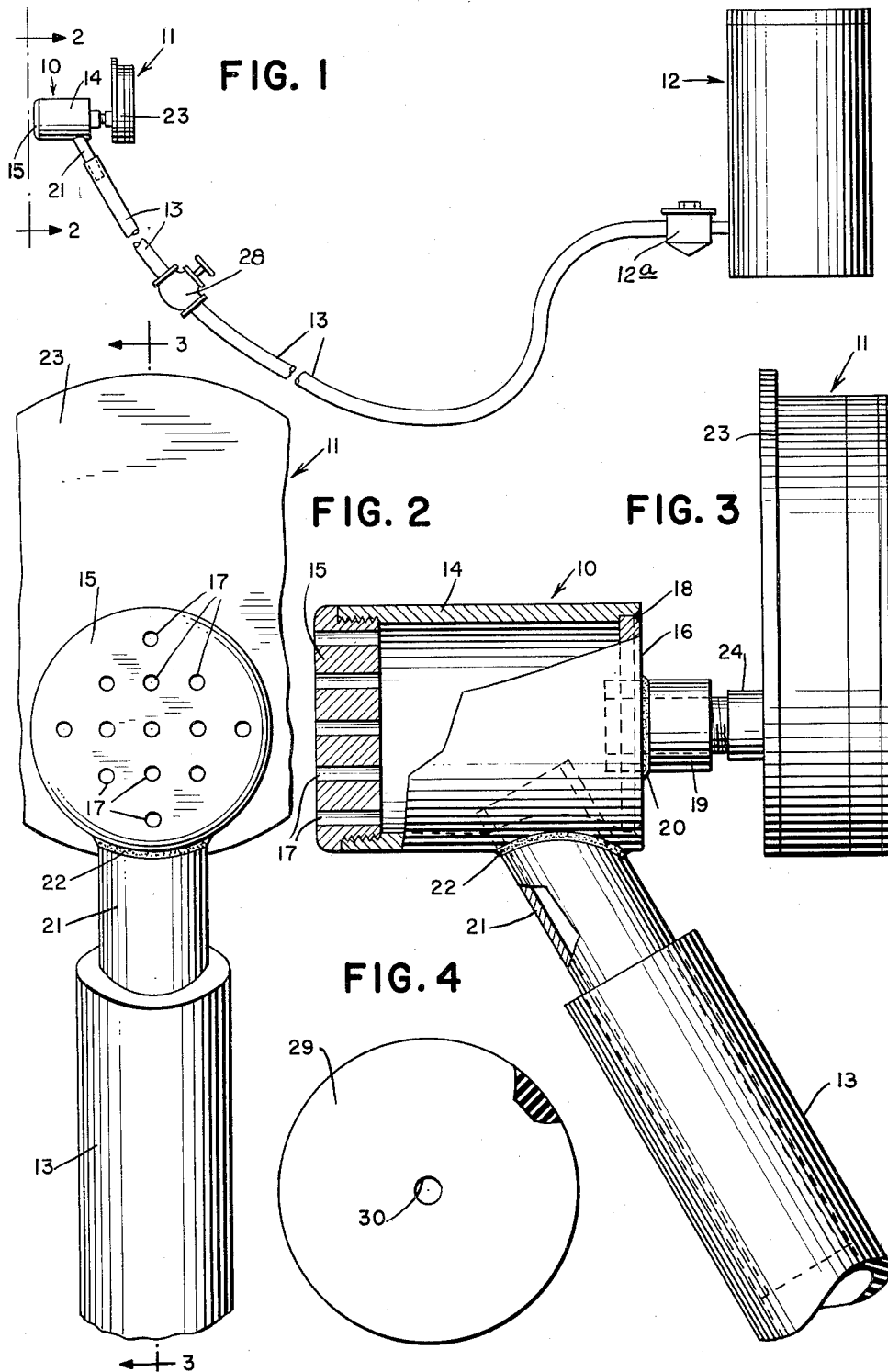
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POROSITY TESTING OF PAPERMAKER'S FELT

Filed Jan. 28, 1959

2 Sheets-Sheet 1



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FIG. 5

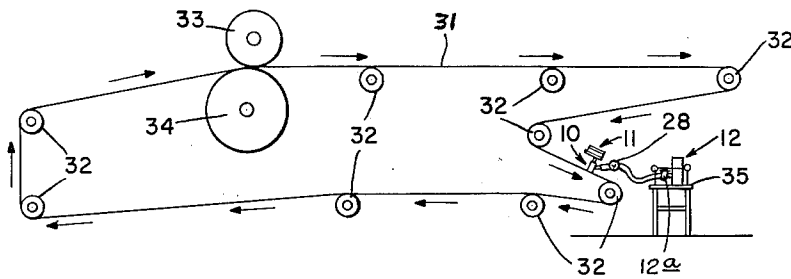
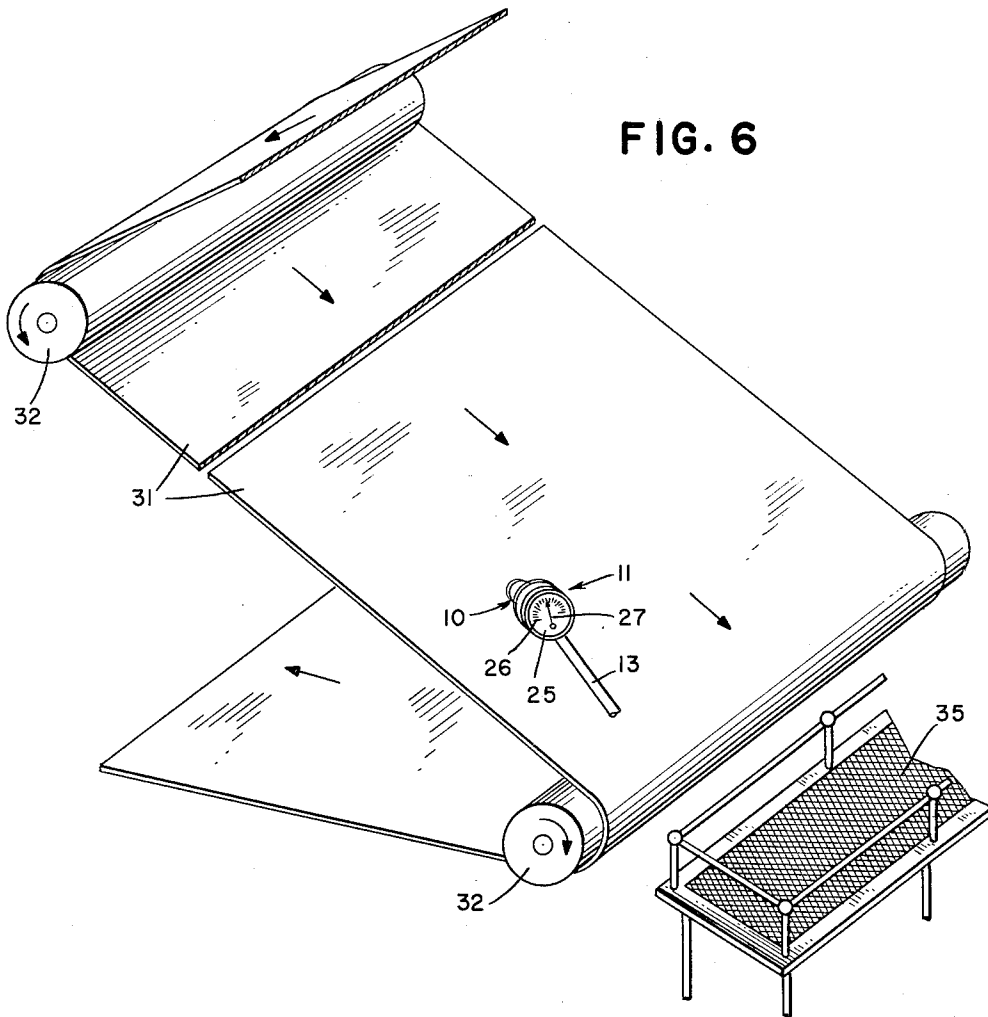


FIG. 6



1

3,056,281

## POROSITY TESTING OF PAPERMAKER'S FELT

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Filed Jan. 28, 1959, Ser. No. 789,583

2 Claims. (Cl. 73-38)

This invention relates to porosity testing and more particularly to a method of testing the porosity of a papermaker's felt.

As is well-known in the art of papermaking, paper is initially formed from water saturated pulp which is deposited on a perforate screen-like structure, commonly referred to as the "wire." Some of the water is removed from the pulp through the wire. The wet paper is picked up from the wire by a papermaker's felt and transmitted by the felt through suction presses where the water content is squeezed out and sucked through the felt. The paper is then passed through a drier to remove remaining moisture.

A papermaker's felt is a continuous band of an appropriate air-permeable flexible material ordinarily being a woven, napped fabric of wool or synthetic fibers or blends thereof. In a papermaking machine, the felts are mounted on arrangements of drive rolls and support rolls and are adapted to move along corresponding predetermined endless paths. These felts are expensive items of equipment and it is important that they be carefully and scientifically designed and constructed and that they be maintained in proper condition for purposes of operating economy and to insure desired quality of paper products.

The efficiency of a papermaker's felt in use depends to a large extent on its condition of porosity or permeability. Also, the uniformity of porosity throughout the felt determines the uniformity of paper products. During the manufacture of paper, pulp fibers enter the body of the felt and tend to plug the same. This reduces the porosity of the felt and makes it more difficult to properly suck water therethrough. Although many methods and devices are used to "condition" the felt, including the dislodgment of pulp fibers therefrom, while it is in use on the papermaking machine, a felt frequently must be discarded before it is otherwise worn out because it is plugged throughout or in spots. Heretofore there has been no method for reliable checking of the condition of a felt while in use and no method of evaluating, in a precise manner, the porosity behaviour of felts from various sources or made from different materials and the like. The present invention provides a simple but precise method for checking and evaluating felts which is valuable to the papermaker as a user of felts and to the felt manufacturer for the improvement in design and construction of the felts.

The principal object of this invention is to provide an improved method and apparatus for testing the porosity of papermaker's felts.

Another object of the invention is to determine the porosity of selected areas of a papermaker's felt with the aid of vacuum equipment.

A further object of the invention is to ascertain the porosity of a papermaker's felt in an expeditious manner and while the felt is in actual use.

To the end that the foregoing objects may be readily attained, the method of this invention is carried out with the aid of testing apparatus, one form of which is described in detail further along herein. Such apparatus includes a hollow head having a wall which is provided with one or more through openings which constitute an orifice of predetermined effective area, a vacuum gauge connected to the head, a vacuum-creating unit and a flexible conduit establishing communication between the unit and the interior of the head. With the vacuum-

2

creating unit in service and the felt in motion or stationary as preferred, the hollow head is disposed with its said wall in intimate contact with a selected area of the felt. Air is drawn through the felt and into the hollow head through the opening or openings which form the orifice. The inspector observes the pressure of the air drawn through the felt and into the head on the gauge. This procedure is repeated at other selected felt areas which are spaced transverse of the direction of movement of the felt. The gauge readings may be plotted on a graph or a bar chart may be made from such readings, as desired. The procedure just described will show the condition of the felt at the time the tests are made and will reveal the presence of plugged streaks or spots before they become so badly plugged as to cause severe defects in the paper.

The invention also provides method and apparatus for calibration of the testing apparatus so that the condition of a felt may be periodically checked throughout its life with the results of successive tests being directly comparable. Calibration also makes it possible to evaluate different felts under directly comparable conditions and it also makes it possible to use the same apparatus to evaluate felts having widely different basic porosities due, for example, to different constructions or to the fact that they may be wet or dry. Calibration is effected by means movable to and from an effective position in which it temporarily reduces the effective area of the testing orifice to such a degree that when opened directly to the atmosphere it will offer resistance to the flow of air therethrough in the same general magnitude as that offered by the incremental area of the felt to be tested by placing the orifice in its original size against the felt, as described above.

The enumerated objects and other objects, together with the advantages of this invention, will be readily apparent from the detailed description that follows taken in conjunction with the accompanying drawings.

In the drawings, wherein like reference numerals denote corresponding parts throughout the several views:

FIG. 1 is a view in elevation of a preferred and recommended apparatus for use in practicing the method of this invention;

FIG. 2 is a view in enlargement taken along line 2-2 of FIG. 1;

FIG. 3 is a view taken along line 3-3 of FIG. 2, certain parts being shown in central vertical cross-section and other parts being broken away for better illustration;

FIG. 4 is a view of a flexible diaphragm for use in calibrating the apparatus of FIG. 1;

FIG. 5 is a diagrammatic representation of a press section of a typical papermaking machine and shows the apparatus of FIG. 1 associated therewith; and

FIG. 6 is an enlarged isometric view of the devices shown in the lower right hand portion of FIG. 5, certain parts being omitted for better illustration of other parts.

Referring initially to FIG. 1, the arrangement of apparatus shown therein comprises four main units, namely a hollow head 10, a pressure gauge 11, a vacuum-creating unit 12 and a flexible conduit or hose 13 of any desired length extending between head 10 and unit 12.

Hollow head 10 includes a tubular body 14, a front wall 15 and a rear wall 16. Front wall 15 is threadedly connected to the tubular body and is provided with a plurality of through openings 17. Rear wall 16 registers with an annular recess in the tubular body and is affixed thereto by solder, as indicated at 18. A short rigid conduit 19 extends through rear wall 16 and is soldered in place, as indicated at 20. A second rigid conduit 21 extends through the bottom of the tubular wall and is maintained in the illustrated position by solder 22. The

threaded connection between tubular body 14 and wall 15 and the several soldered connections 18, 20 and 22 form fluid tight joints.

Pressure gauge 11 may be any suitable known form of vacuum gauge and includes a casing 23, a conduit 24 5 threadedly connected to conduit 19, a dial 25 (FIG. 6) having graduations 26, and an indicating pointer 27.

Vacuum-creating unit 12 may also be of any desired known type. It may comprise a portable unit especially provided for use with the present invention or it may 10 comprise an existing vacuum system such as that used in the papermaking machine for suction presses and the like. A control valve 28, such as a manually-controlled throttling valve, is interposed in a convenient position between the head 10 and the vacuum-creating unit 12. 15 For Example the valve 28 may be inserted in the flexible conduit 13.

If the vacuum unit 12 is not a constant pressure unit or if the device of the present invention is to be used at 20 various points with vacuum sources which may differ, a porosity test made with the apparatus herein disclosed at one time or place may not be directly comparable with tests made at other times or places. If it is desired to have all tests directly comparable it is preferred to provide an automatically operable vacuum control valve 12a for regulating the pressure to a constant level in the portion of 25 the conduit 13 extending from the unit 12 to the throttle valve 28. The valve 12a may be of any conventional form or it may comprise a "vacuum breaker," a U-tube manometer or other suitable device.

FIG. 4 illustrates a flexible diaphragm 29 for use in calibrating the apparatus of FIG. 1. This diaphragm is made of rubber or other suitable air impervious material and is adapted to cover a large number of the openings 17 in the head 10. For example, the diaphragm 29 may 30 be provided with a single central opening 30.

To calibrate the apparatus, the rear face of diaphragm 29 is moistened and placed against the outer face of wall 15 with opening 30 aligned with the central opening 17 in wall 15. Thus it will be appreciated that the disc covers the other openings in wall 15. Vacuum unit 12 is placed in service and valve 28 is adjusted until gauge 11 registers a predetermined pressure, for example 5" Hg, when the apparatus is to be used to test porosity of a wet felt. The calibration may be readily checked by closing diaphragm opening 30 with a finger and then removing the 40 finger to determine whether the reading consistently returns to the predetermined pressure. The diaphragm is then removed and the apparatus is ready to be placed in actual service.

When the apparatus is to be used to test the porosity of a dry felt, it is calibrated by the use of diaphragm 29 in the manner outlined above, except that valve 28 is adjusted so that the gauge registers a higher predetermined pressure, for example 18" Hg. The provision for calibration of the instrument is a particular feature of the present invention. A felt which is wet will be much less porous than the same felt when dry. The predetermined pressures mentioned above may be established by experiment to suit different types of felts either wet or dry thus giving the instrument great versatility. Nevertheless, by calibrating the instrument to the same pressure each time a test is made which is to be compared with a previous test, the results will be directly comparable. Thus the performance, with respect to porosity, of a particular felt may be checked and recorded throughout the life of the felt. Also, felts from different manufacturers or of different construction may be evaluated by subjecting them to tests under identical conditions by the simple expedient of calibrating the instrument to the same pressure each time such test is made.

Reference is now had to FIGS. 5 and 6 which show the above-described testing apparatus and parts of a press section of a typical papermaking machine. The illustrated press section includes a continuous paper-

maker's felt 31 which is mounted for movement, as indicated by the arrows, on a plurality of drive and/or support rolls 32. The press section also includes a pair of suction press rolls 33 and 34. Adjacent the forward portion of the press section there may be a platform or walkway 35 which extends substantially the full width of the felt. The inspector conducting the test may walk along the platform if required to provide access to an open draw of the left 31.

For the purpose of outlining the manner of testing the porosity of felt 31, it is assumed that the testing apparatus has been calibrated and is in active service. The inspector holds hollow head 10 in his hand and places it against the outer surface of the felt, as shown in FIGS. 5 and 6, so that wall 15 is in intimate contact with a selected area of the felt. Usually the inspector tilts the hollow head backward and forward to insure proper contact between wall 15 and the felt. The inspector observes and makes a record of the reading on the gauge at the selected area. If the felt 31 is in use at the time the head 10 may be held in contact with the felt long enough for the felt to make at least one complete pass. In this manner any irregularities in porosity throughout the length of one point in the width of the felt may be observed. Similar readings may be made at other selected areas across the width of the felt. It is recommended that the areas tested be spaced apart substantially equal distances, for example 12 inches. Obviously, the head 10 may be moved across the felt by mechanical means if so desired. Also, the 30 readings may be recorded automatically.

The readings obtained may be plotted on a graph. Alternatively, the high and low readings obtained across the felt may be used to produce a bar chart.

Testing may be carried out while the press is in normal operation and the felt is in motion, or while the felt is at rest. It is important that the hollow head be examined periodically to make sure that openings 17 are not obstructed by fibers or another foreign material. If any of these openings are clogged, they may be readily cleaned 40 by use of a suitable instrumentality.

The method and apparatus herein disclosed for calibration of the instrument for operation on air-permeable materials having widely varying basic porosities have been described in connection with a papermaker's felt 45 which has a much higher basic porosity when dry than it has when wet. Since the purpose of this invention is to obtain readings which will unmistakably reveal relatively small differences in the porosity of different areas of the material being tested, the calibration of the instrument in accordance with the example given herein takes into account the basic porosity of the material being tested so that relatively small differences in porosity between different areas thereof will cause relatively large changes in pressure readings on the gauge 11.

Thus, a felt when wet, has relatively low porosity and small differences in porosity will effect significant changes in pressure readings on a wide-range pressure gauge when a relatively small volume of air per unit of time is passed through different equal or "standard" areas of the material. For this reason a relatively low differential in pressure is set up by adjusting the throttle valve 28 with the diaphragm 29 on the head 10 to reduce the rate of flow of air through the uncovered opening or openings 15 to such a point that the pressure gauge 11, 65 which is calibrated as a vacuum gauge, will read, for example, 5" Hg.

When a material having a high basic porosity, such as a papermaker's felt in dry condition is to be tested, a larger quantity of air per unit time must be passed 70 through the same "standard" areas in order that small changes in pressure will effect significant changes in readings on the same, wide range vacuum gauge. Thus, as described above, the throttle valve 28 is adjusted to cause a relatively large flow of air through the uncovered opening or openings 17 when the diaphragm 29 is in

5

place upon the head 10. The larger flow of air will result in a relatively high reading on the scale of the vacuum gauge 11, for example 18" Hg.

It will be recognized that the opening or openings 17, left uncovered when the diaphragm 29 is placed on the head 10, serve as a standard orifice for calibration of the instrument. The area of this standard orifice relative to the combined area of all of the openings exposed when the diaphragm 29 is removed must be taken into account when selecting the vacuum gauge readings to which the instrument is calibrated, as above described, for use on materials of various basic porosity. However, when appropriate calibration readings have been established for each type or condition of material to be tested, the instrument can be used at any time on any such material with complete assurance that the results will be validly comparable with previous results based on the same calibration.

For greatest precision it may be preferred to observe the pressure simultaneously on opposite sides of the felt. Thus, with the present apparatus the barometric pressure of the ambient atmosphere may be observed at the time the gauge readings are taken. In a broader sense the method of the present invention rests upon the measurements of resistance to passage of air through the felt and this is most accurately expressed in terms of the pressure drop across the felt.

In the embodiment chosen for illustration the testing orifice is made up of a plurality of openings 17 and the calibrating means comprises the diaphragm 29. When the diaphragm is placed on the suction head it is in an effective position in which it reduces the area of the testing orifice so that the apparatus may be calibrated against a resistance to the flow of air which is in the same general magnitude as the resistance offered by the area of a papermaker's felt through which air is drawn by the testing orifice. It will be apparent that other means may be used for temporarily reducing the area of the orifice for purposes of calibration. For example, the testing orifice may comprise a single opening or a plurality of openings and the calibrating means may comprise a slide or shutter mounted within the suction head and movable across the opening or openings to temporarily reduce the area thereof.

From the foregoing, it is believed that the objects and the advantages obtainable by the practice of this invention will be readily understood by persons skilled

6

in the art, without further description. However, since certain changes may be made in carrying out the method of the invention without departing from its scope, as defined by the appended claims, it is intended that all matter contained herein shall be interpreted as illustrative and explanatory, rather than in a limiting sense.

What is claimed is:

1. In a method of testing the porosity of a continuous papermaker's felt, which is movable in flattened tensioned condition through an endless path, with the aid of testing apparatus including a hollow head having a wall which is provided with one or more through openings defining a testing orifice the dimensions of which in any direction constitute a small fraction of the width and length of the felt to be tested, a fluid pressure gauge communicating with the interior of said hollow head, a unit for creating a partial vacuum, and a conduit establishing communication between said unit and the interior of said head, the steps of pressing said wall of said hollow head into sliding contact with a selected area of the felt while the felt is moving through said endless path to establish sealing contact between said felt and said testing orifice, drawing air through the felt and into the hollow head by means of the unit, maintaining said hollow head stationary with respect to said felt while maintaining sealing contact for a period of time sufficient at least for substantially the full length of said felt to move through said endless path whereby a narrow lengthwise extending area of said felt is progressively brought into sealing contact with said orifice, and observing the pressure of the air drawn through the felt and into the hollow head as registered on said gauge during the period in which said head is maintained in contact with said felt.

2. The method set forth in claim 1 wherein all of said steps are repeated at a predetermined number of selected areas spaced transversely of the width of said felt.

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