

Sept. 8, 1931.

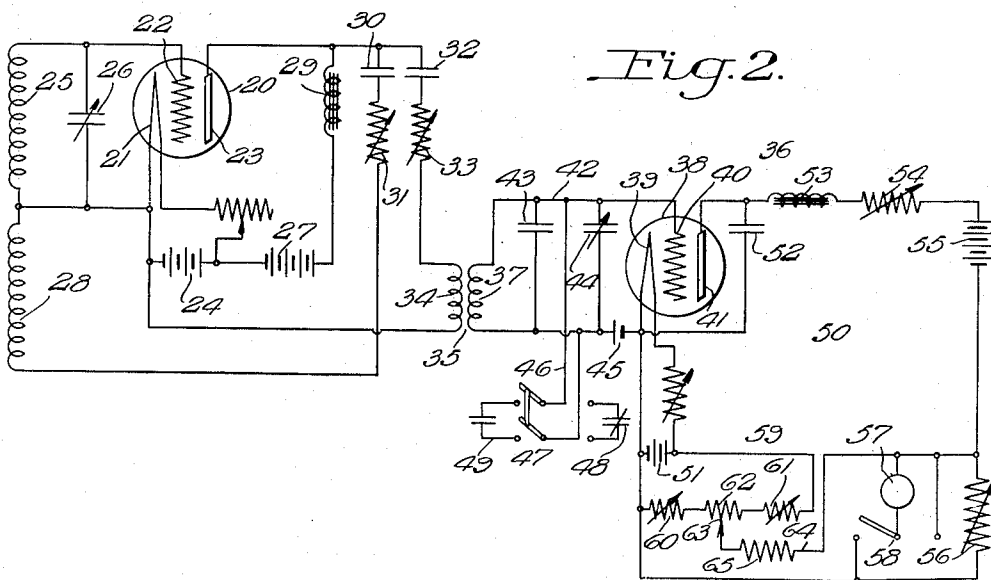
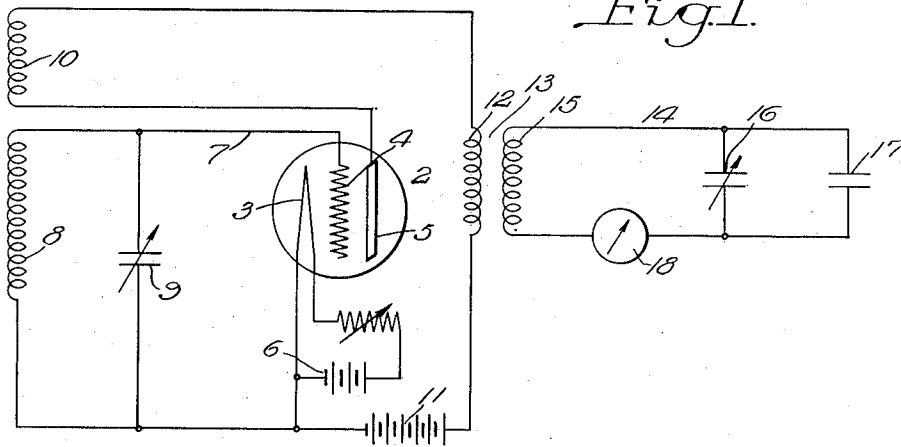
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1,822,604

MEASURING THE FREENESS OF PULP

Filed Aug. 22, 1929

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 3.

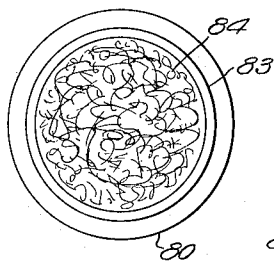


Fig. 4.

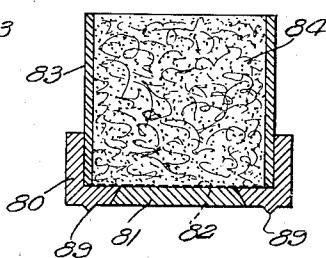


Fig. 5.

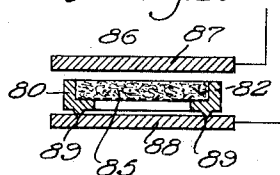


Fig. 6.

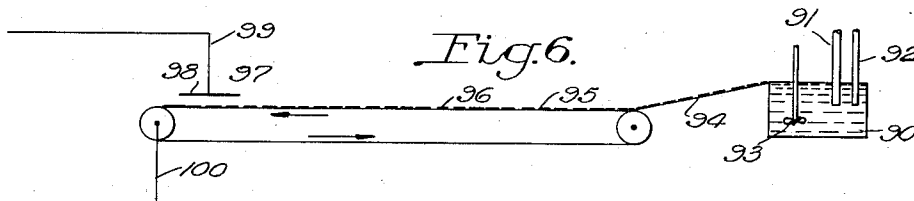
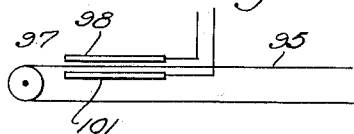


Fig. 7.



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MEASURING THE FREENESS OF PULP

Application filed August 22, 1929. Serial No. 387,773.

The present invention relates to measuring the freeness of pulp, and more particularly to measuring the freeness of paper pulp, although the invention may be applied to measuring the freeness of other fibrous pulps, such as those used in making pulp-board, fiber-board and the like.

The "freeness" of the pulp is usually measured by the rate at which water will drain from the pulp. A pulp is said to be "free" or "slow", depending upon whether the water drains from it freely or slowly. The beating of the pulp in the beater of the paper-making machinery tends to mechanically hydrate the cellulose fibers, giving different degrees of hydration depending upon the length of time that the pulp is beaten. A free pulp is one in which the fiber is but little if any hydrated and in which the water can drain rapidly. This type of pulp gives a paper like blotting paper. A slow pulp from which the water drains very slowly is a highly hydrated pulp and in the extreme case gives a paper like "glassine" paper.

We have found that the freeness of the pulp may be measured by placing suitably prepared samples of the pulp between the plates of the condenser and measuring the dielectric capacity of the pulp sample. A slow pulp has a greater dielectric capacity than a free pulp. In determining the dielectric capacity of the pulp for measuring its freeness, recourse is preferably had to the application of high frequency currents to the measuring condenser. These high frequency currents can be readily produced by an oscillator of the thermionic tube type which will generate currents of a million or more cycles per second. A secondary circuit containing the condenser is loosely coupled with the oscillator circuit and tuned to it. When the capacity of the condenser is changed, the circuit will be thrown out of tune, the degree to which it is thrown out of tune being indi-

cated by a change in the current of the secondary circuit which can be read by a suitable instrument.

For determining the freeness of the pulp, a sample of the thin pulp or water suspension of fiber is taken from the beater of the paper-making machine and with or without diluting is placed in a measuring vessel, and then the water drained out, leaving a pat of moist pulp. This standard pat of moist pulp may then be placed between the plates of a condenser spaced apart a predetermined distance, and the dielectric capacity of the pulp measured. A pat of free pulp will have the moisture drained out of it fairly completely, whereas a pat of slow pulp will retain a considerable proportion of the moisture. The variations in the freeness of the pulp may be measured by the change in the dielectric capacity of the condenser caused by the different pulp samples.

The freeness of the pulp may also be measured continuously, and the degree of beating controlled in accordance therewith. This may be done by draining a small stream of the pulp from the beater onto a continuously moving screen through which the water may be drained to produce a moving sheet of pulp. The dielectric capacity of the moving sheet of pulp may be continuously determined by passing it between the plates of the condenser and the changes in the freeness of the pulp can be continuously determined.

In the drawings, which illustrate the preferred embodiment of our invention:

Figure 1 is a diagrammatic view showing a simplified form of oscillating circuit and tuned-in secondary circuit containing the condenser used for measuring the freeness of the pulp;

Figure 2 is a modification showing a more complicated but more sensitive and refined circuit;

Figures 3 and 4 are plan and vertical sectional views, respectively, through the vessel

used for receiving a sample of the pulp suspension for measuring its freeness;

Figure 5 is a vertical section showing the drained pat of pulp between the plates of a measuring condenser;

Figure 6 is a diagrammatic elevation of a device for continuously measuring the freeness of pulp; and

Figure 7 is a fragmentary view showing a modification of the condenser used in the device of Figure 6.

Referring first to the simplified diagram of Figure 1:

Reference numeral 2 indicates the usual thermionic vacuum tube containing the filament 3, grid 4 and plate 5. The filament 3 is heated by the so-called "A" battery 6. A local or grid circuit 7 contains the coil 8 and the adjustable or tuning condenser 9. The plate circuit contains the coil 10, inductively mounted with respect to the coil 8, the plate or "B" battery 11 and the coil 12 of the transformer 13. The oscillating circuit thus described is a usual type of feed-back oscillating circuit. Oscillations are set up and amplified, producing high frequency oscillations through the plate circuit and coil 12. The secondary circuit 14 contains a coil 15, loosely coupled with the coil 12 of the transformer 13. It also contains an adjustable tuning condenser 16. In parallel with this condenser is the condenser 17, between the plates of which is placed the pulp for dielectric capacity measurements. The circuit 14 contains a suitable current-measuring device 18.

By suitably adjusting the tuning condenser 16, the secondary circuit 14 may be tuned to the oscillator circuit when the condenser 17 has between its plates a pat or sheet of pulp of a predetermined freeness. A variation from such predetermined condition will result in a variation in the capacity of the condenser 17, which will be indicated by a decrease in the current as measured by the ammeter 18.

In Figure 2 are illustrated circuits giving greater sensitivity of response. In Figure 2, reference numeral 20 indicates a thermionic vacuum tube having filament 21, grid 22 and plate 23. The filament is supplied by the usual "A" battery 24. The local or grid circuit contains an inductance coil 25 and an adjustable tuning condenser 26. The plate circuit has the usual "B" battery 27 and coil 28 inductively coupled with the coil 25. The plate circuit contains the choke coil 29 in series with the battery 27. It also contains the condenser 30 and variable resistance 31 in series with the coil 28. A branch circuit connected with the plate contains the condenser 32 and a variable resistance 33, and the coil 34 of the transformer 35. The circuit above described will operate as an oscillating circuit,

setting up a continuous train of oscillations through the coil 34.

A secondary circuit, indicated generally by the reference numeral 36, contains a coil 37, loosely coupled with the coil 34, and serving as an input to the secondary circuit. The secondary circuit contains the usual thermionic vacuum tube 38, having the usual filament 39, grid 40, and plate 41. The grid circuit 42 contains the coupling coil 37, the condenser 43, the tuning condenser 44 and bias battery 45. A branch circuit 46 leads to a double-throw, double-pole switch 47, which may be thrown to the right to connect with a variable condenser 48, or to the left to connect with a condenser 49, which corresponds to the condenser 17 of Figure 1; that is to say, it is the condenser between the plates of which is run or placed the pulp to be measured for its dielectric capacity.

With a standard pat or sheet of pulp having a predetermined freeness between the plates of the condenser 49, the grid circuit 42 may be tuned by means of the condenser 44 into resonance. A change in the dielectric capacity of the condenser 49, which would result from a change in the freeness of such standard pat or sheet, will result in a throwing of the circuit more or less out of tune depending upon the magnitude of the variation in dielectric capacity, thus diminishing the current fed in the grid circuit 42. The adjustable condenser 48 may be adjusted to be of equal capacity to the condenser 49 when a standard pat or sheet of pulp of a predetermined freeness is between the plates of the condenser 49. With the condenser 48 thus adjusted, it may be used as a check for the resonance setting of the circuits in use.

The variations in the oscillating current in the grid circuit 42 are amplified and rectified by the thermionic tube 40, giving measurable variations in the plate circuit of this tube. The plate circuit of the tube, indicated generally by reference numeral 50, contains the usual "A" battery 51 for heating the filament 39. It contains the condenser 52 connected between the plate and the filament. It is provided with a choke coil 53 and adjustable resistance 54 in series with the usual plate or "B" battery 55. The plate circuit contains an adjustable resistance 56 and an ammeter or galvanometer 57 which, by means of a single-pole, double-throw switch 58, may be either short circuited or connected in parallel with the resistance 56. The adjustment of the resistance 56 controls the magnitude of the deflection of the galvanometer. Since the resistance of the galvanometer is usually large compared with that of the resistance 56, the galvanometer may be either shunted around resistance 56 or short circuited, without much change in the resistance of the plate circuit. An auxiliary circuit 59 is connected across the "A" battery 51, and contains the

variable resistance 60 and 61 and a resistance 62, along which a contact point 63 may be moved. The contact point 63 is connected through wire 64 and resistance 65 to one side of the resistance 56 and galvanometer 57.

capacity of the condenser 49 followed by changes in the capacity of the condenser 44.

As will be understood from the above explanation, the condenser 48 is, in the methods 1, 2 and 4 above outlined, used as a check on the condenser 49. When the condenser 49 is in the predetermined or standard condition having a predetermined or standard capacity, due to a predetermined dielectric capacity of the material between these plates, the condenser 48 may be adjusted to the same capacity and may be occasionally thrown into circuit to check the readings of the galvanometer for such standard condition.

For the determination of the freeness of the pulp by intermittently taking samples thereof, the device shown in Figures 3, 4 and 5 is used. This device consists of a ring 80 having an opening closed by a watertight removable plug 81. This opening is covered by a fine wire screen 82. An open-ended cylindrical vessel 83 is placed in the ring 80 making watertight contact with it. Then a sample of the thin pulp or water suspension of fiber, dipped from the beater or other container for the pulp whose freeness is to be measured, is poured into the vessel 83, just filling it or filling it to a predetermined height, or said sample may be diluted with water before pouring into vessel 83. This water suspension is indicated by reference numeral 84. Then the plug 81 is removed, allowing the free water to drain from the pulp. When the free water has dripped away, cylinder 83 is removed, leaving a pat 85 of wet pulp in the ring 80 on the screen 82. The ring 80 with the pat of wet pulp is then transferred to the condenser indicated generally by reference numeral 86 and shown in Figure 5. This condenser may be either the condenser 17, indicated in Figure 1, or the condenser 49, indicated in Figure 2. It comprises upper and lower plates 87 and 88, respectively, which are arranged to be separated a predetermined distance. The ring 80 with the pat 85 of wet pulp on it is placed on the lower plate 88 and accurately positioned thereon by means of three conically pointed pins 89, which fit into depressions in the top of the plate 88.

Since a slow pulp retains more water than a free pulp, the capacity of the condenser 86 will be varied in accordance with the amount of water held in the pulp, and this capacity, when suitably calibrated, will give a direct determination of the freeness of the sample of pulp.

In Figure 6 is illustrated an apparatus for continuously measuring the freeness of pulp. A pulp from the beater is delivered into a mixing box 90, through an inlet 91 in a small substantially continuous stream, as by a chain-and-bucket conveyor or centrifugal pump. The pulp is diluted continuously with sufficient water to give a good thin mix-

The circuit 59 and slide resistance 62 act as a potentiometer by means of which electromotive force from the battery 51 may be opposed to the electromotive force of the plate current through the resistance 56 and galvanometer 57. In practice, the adjustable contact 63 is adjusted until the galvanometer shows a zero deflection. Then, if change takes place in the capacity of the condenser 49, due to a change in the dielectric capacity of the material being measured, the capacity of the grid circuit is changed and with it the effect of the grid upon the plate circuit, producing a change in the plate circuit current which is measured by a deflection of the galvanometer. Since the opposing current from the potentiometer 62 through the galvanometer remains constant the change in plate current is shown by the galvanometer deflection which may be used as a measure of the change in the capacity of the condenser 49. It will therefore be seen that an increase or decrease in the capacity of the condenser 49, due to the change in the dielectric capacity of the material between these plates, will be indicated by a deflection in the predetermined direction on the galvanometer scale. This arrangement gives a readily controlled and very sensitive determination of small changes in the dielectric capacity of the material between the condenser plates.

It will be seen from the wiring diagram that the apparatus affords at least four methods of following changes in the capacity of the condenser 49.

1. With the position of the potentiometer point 63 fixed and the capacities 44 and 48 fixed, changes in the capacity of the condenser 49 may be followed by changes in the galvanometer readings.

2. With the capacities 44 and 48 fixed, the galvanometer 57 may be used as a null instrument and changes in the capacity of the condenser 49 followed by changes in the setting of the potentiometer contact point 63.

3. With the position of the potentiometer contact point 63 fixed and the capacity of the condenser 44 fixed, the galvanometer 57 may be used as a null instrument and changes in the capacity of the condenser 49 followed by changes in the capacity of the condenser 48. For this method a third condenser should be used as a check or reference capacity so that it can be substituted in the circuit for the condensers 48 and 49.

4. With the position of the potentiometer contact point 63 fixed and the capacity of the condenser 48 fixed, the galvanometer may be used as a null instrument and changes in the

ture. The inlet for the water is indicated by reference numeral 92, through which a constant but adjusted stream of water may be admitted. An agitator 93 mixes the pulp and water and serves to maintain a uniform suspension of pulp. This suspension is fed over the overflow 94 on a slowly moving metal paper-making screen 95, forming a moving sheet 96 of pulp. The free water drains from the pulp through the screen. The length and speed of the screen and the rate of flow are adjusted so that a uniform sheet of pulp forms and completely drains of its free water by the time it reaches the far end of the device, where the pulp passes through a condenser 97. After passing through the condenser, the pulp may be dumped back into the beater. The condenser 97 has an upper plate 98, spaced a predetermined distance above the screen 95. The metal screen 95 may serve as the other plate of the condenser 97. Suitable leads 99 and 100 lead from the plates of the condenser 97 to the device, whereby the electrostatic capacity of the condenser 97 may be determined. The condenser may be either the condenser 17 of the circuits shown in Figure 1, or the condenser 49 of the circuit shown in Figure 2.

The condenser 97 of the device shown in Figure 6 may be otherwise constructed. For example, instead of utilizing the screen as the lower plate of the condenser, a separate plate 101 may be placed below the upper run of the screen 95, as shown in Figure 7.

The device shown in Figure 6 provides for the continuous determination of the freeness or slowness of the pulp. The measurements may be read on an indicating instrument or the measurements, as shown by the current changes, may be made through a suitable contact device to automatically control the beater, and thereby automatically maintain a predetermined desired freeness of the pulp in the paper-making machine.

In our copending application Serial No. 387,772 filed of even date herewith, we have described and claimed a method and apparatus broadly for measuring the relation between the fiber and water contents of fibrous pulps, and specifically, the measurements of the consistency of pulp. The present application is directed specifically to measuring the relation between the fiber and water contents of fibrous pulps to determine the freeness of the pulp.

While we have specifically illustrated and described the preferred embodiments of our invention, it is to be understood that the invention is not so limited, but may be otherwise embodied and practiced within the scope of the following claims.

We claim:

1. The method of measuring the freeness of

pulp, which consists in measuring its dielectric capacity.

2. The method of measuring the freeness of pulp, which consists in draining the free water from the pulp and then determining the dielectric capacity of the drained pulp.

3. The method of measuring the freeness of pulp, which comprises measuring out a predetermined amount of the suspension of pulp in water, draining the free pulp from the suspension, and determining the dielectric capacity of the drained pulp.

4. The method of measuring the freeness of pulp, which comprises draining the free water from the pulp, placing the drained pulp between the plates of a condenser, and determining its capacity.

5. A device for measuring the freeness of pulp, which comprises a vessel adapted to be filled with a predetermined quantity of the water suspension of the pulp fiber from which the free water may be drained away leaving a moist pat of pulp, a condenser, means for positioning the moist pat between the plates of the condenser and means for measuring the capacity of the condenser.

6. A device for measuring the freeness of pulp, which comprises means adapted to be supplied with a predetermined quantity of the water suspension of the pulp fiber from which the free water may be drained away leaving a moist layer of pulp, a condenser, means for positioning the moist layer of pulp between the plates of the condenser, and means for measuring the capacity of the condenser.

7. A device for measuring the freeness of pulp, which comprises means provided with a draining screen and adapted to be supplied with a predetermined quantity of the water suspension of the pulp fiber from which the water may be drained away through the screen leaving thereon a moist layer of the drained pulp, a condenser, means for positioning the moist layer of pulp between the plates of the condenser, and means for measuring the capacity of the condenser.

8. A device for continuously measuring the freeness of pulp, comprising a condenser, means for forming a continuous sheet of pulp, draining the free water therefrom and passing the sheet from which the free water has been drained but otherwise in an undried condition between the plates of the condenser, and means for detecting variations in the capacity of the condenser due to variations in the freeness of the pulp.

9. A device for continuously measuring the freeness of pulp, comprising a condenser, means for forming a continuous sheet of pulp, draining the free water therefrom and passing the sheet from which the free water has been drained but otherwise in an undried condition between the plates of the condenser, said means including a continuously moving

screen and mechanism for delivering continuously to the screen a predetermined quantity of water suspension of the pulp fiber, and means for detecting variations in the capacity of the condenser due to variations in the freeness of the pulp.

In testimony whereof we have hereunto set our hands.

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