Aug. 8, 1944. R. F. NELSON ET AL 2,355,391

PAPER MAKING METHOD AND APPARATUS

Filed July 27, 1940 2 Sheets-Sheet 1

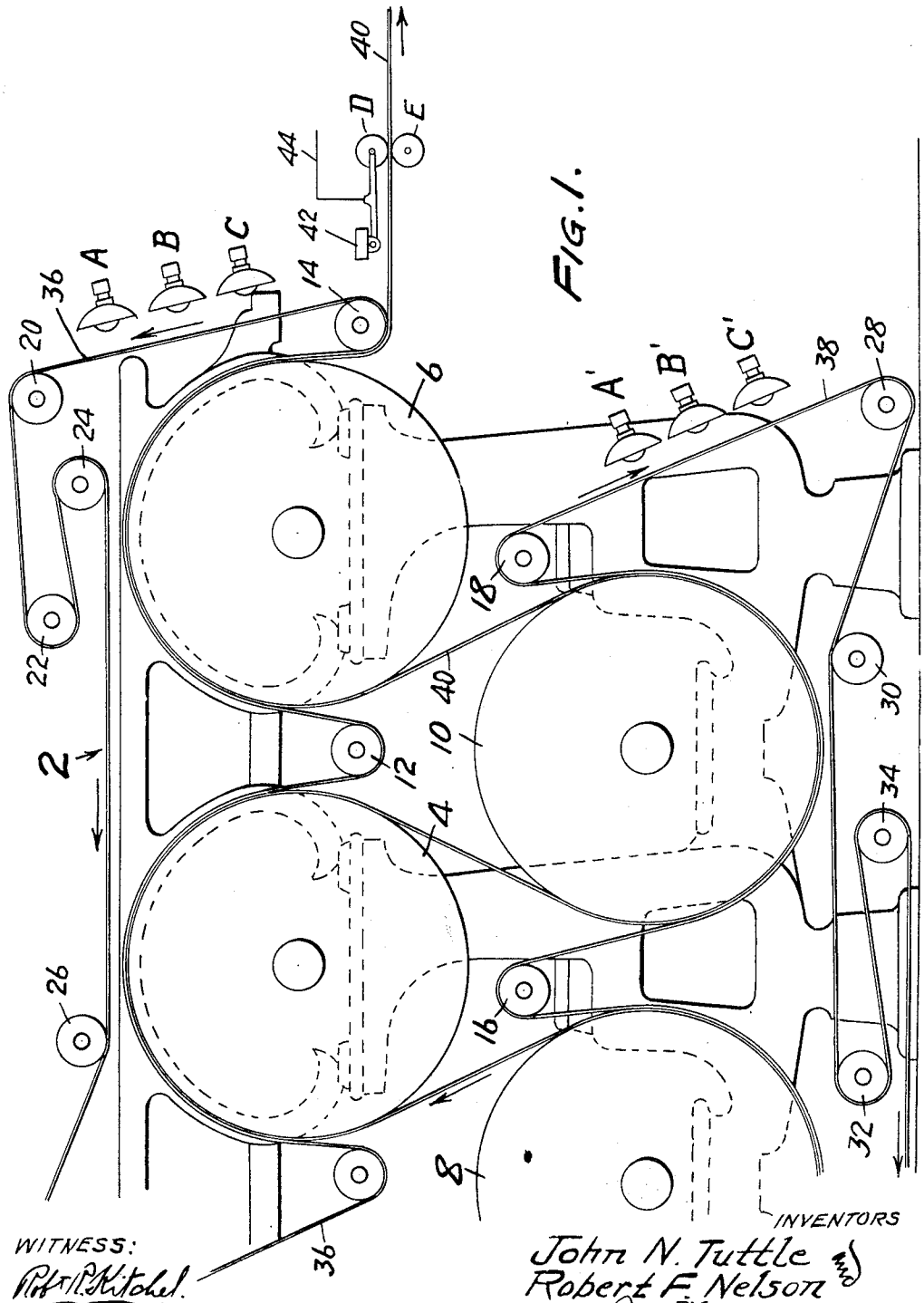


FIG. 1.

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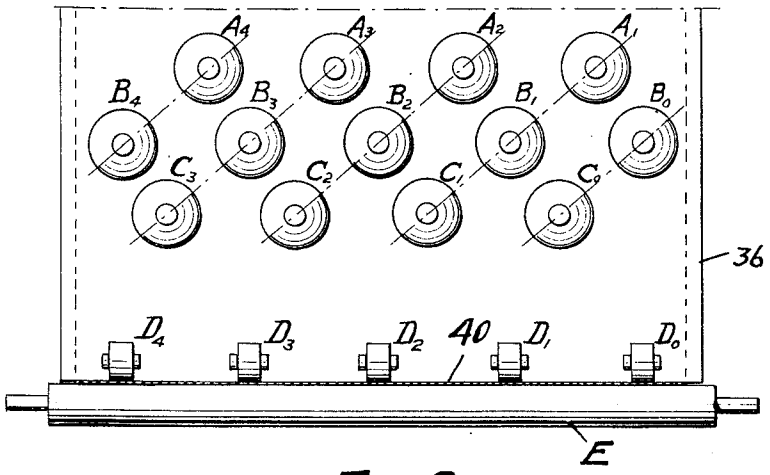


FIG. 2.

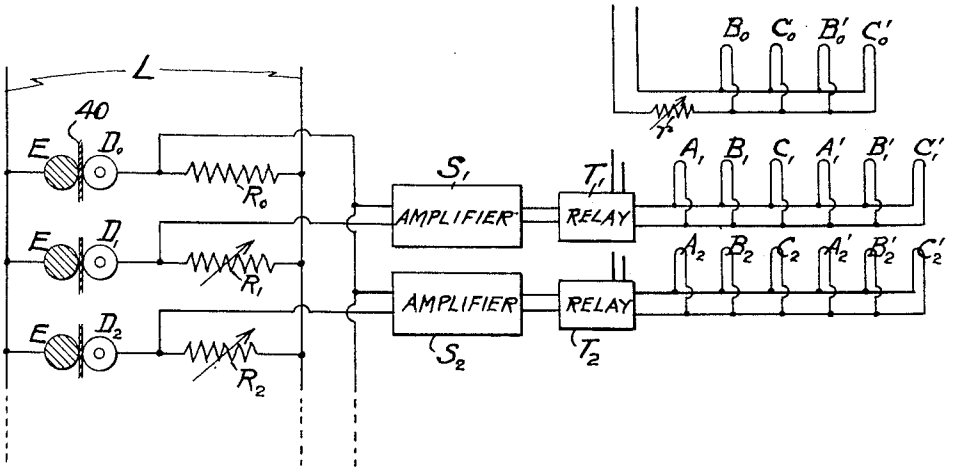


FIG. 3.

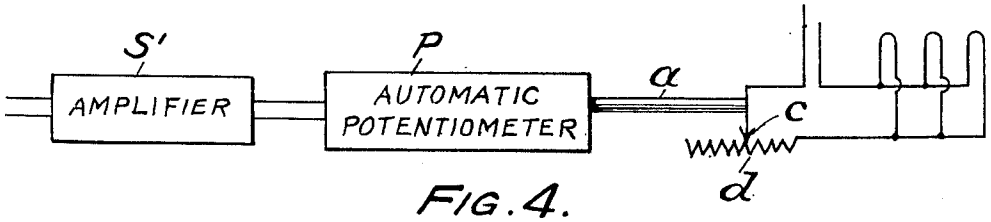


FIG. 4.

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UNITED STATES PATENT OFFICE

2,355,391

PAPERMAKING METHOD AND APPARATUS

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Application July 27, 1940, Serial No. 347,866

9 Claims. (Cl. 34—4)

This invention relates to paper making methods and apparatus and has particular reference to an improved method and apparatus for securing uniform webs of paper.

In conventional practice, the paper, after leaving the second press, is carried about steam heated rolls of large diameter to effect evaporation of moisture therefrom and the production of the finished, relatively dry web. The paper is held in close contact with these rolls by cotton or cotton and asbestos belts, usually referred to as dryer felts. Generally, additional drying rollers are provided about which the dryer felts pass to effect drying of the felts, so that they will cooperate to effect the drying of the paper.

The drying of the paper web is largely dependent upon the removal of the water vapor which is formed in the drying operation, and this is also true of the drying of the dryer felts. In view of the compact natures of the dryer sections of paper machines, the removal of water vapor is considerably more rapid at the sides of the machine than in the interior portions thereof, and consequently it is common to find that the paper web and the dryer felts may be quite considerably more moist in some parts of their width, generally the central parts, than at their edges. To avoid this result, special appliances are sometimes provided for removing the water vapor, for recirculating air, or for applying heated air in the central portions of the apparatus.

In forming some types of paper, this variation of moisture content across the sheet is not particularly material. In other cases, however, the variation in moisture content is quite material, as, for example, in the production of glassine paper where the initial web formed is a sheet of sulphite coniferous stock. In the transformation of such sheet to glassine by supercalendering, variations of transparency may occur across the final sheet, which variations are quite objectionable and lower the value of the product.

The detrimental effects of irregular drying are particularly noteworthy in the case of the practice of the method described in the patent to Robert F. Nelson, No. 2,211,348, dated August 13, 1940. In accordance with the method of this patent, the initial sheeted web is dried only partially, as compared with the usual greaseproof webs produced in the initial stage of the manufacture of glassine. Then, without additional moistening in the conventional fashion, this moist web is supercalendered to produce glassine. While with quite careful control on conventional machines substantial uniformity of moisture across a relatively narrow web can be obtained, this becomes quite difficult in the handling of wide webs, and special control of the moisture content is desirably effected in accordance with the present invention.

Briefly stated, the present invention relates to the control of moisture content by the proper selective, and most desirably automatic, control of the moisture content of the dryer felts of the machine by directing thereupon intense radiant energy of from about 6500 to 14,000 Angstrom units. This radiation is produced by lamps selectively controlled so as to heat more effectively the portions of the dryer felts tending to retain excess moisture, with the resulting production of a sheet having uniform moisture content across its width. It is found that the use of radiation of this type produced by so-called infra-red lamps is highly effective to produce proper drying of the drier felts, apparently acting to produce a more thorough removal of moisture from the innermost portions of the belts than is produced by a mere heating locally of one or both surfaces of the belts. The radiation apparently penetrates the belts in such fashion as to produce great uniformity of result.

While for some purposes a selective but non-automatic control is sufficient, where, for example, the machine is producing a finished sheet the final moisture content of which may be satisfactorily subject to considerable variation, it is desirable, when a more critically controlled product is desired, as for example, in the production of the sheet to be supercalendered in accordance with the method of said Nelson patent, to provide automatic control for the radiation producing means to secure quite complete uniformity of moisture content across the web within narrow limits. This result may be secured by having the radiating lamps subject to control by means responsive continuously to the moisture content of the web as it passes through the machine.

The above indicated objects of the invention, and other objects relating particularly to details, will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevation of the rear portion of the dryer section of a paper machine;

Figure 2 is a diagrammatic elevation of the upper rear portion of the machine showing the infra-red ray producing lamps for effecting drying of the top dryer felt;

Figure 3 is a wiring diagram showing the control means for the lamps; and

Figure 4 is a diagram of an alternative radiation control means.

There is illustrated in Figure 1 at 2 the rearmost portion of the final dryer section of a conventional paper machine comprising primarily the conventional elements of such machine. In the portion of the machine illustrated, there are shown the steam heated drums 4, 6, 8 and 10 constituting the end members of a large group of such drums about which the paper web is passed to be dried. About intermediate guiding rollers indicated at 12, 14, 16, and 18, and about steam heated felt drying rollers, and take-up rollers indicated at 20, 22, 24, 26, 28, 30, 32 and 34, the top and bottom dryer felts 36 and 38, respectively, are trained, serving to press the paper web 40 against the paper drying drums. Each of these dryer felts generally extends throughout its section of the machine (the machines generally having several sections), and the drying of the felts largely occurs in their idle passes respectively above and below the machine.

In accordance with the present invention, banks of lamps are provided at the rearmost portions of the felts at the delivery end of the machine for directing on the felts radiation of from 6500 to 14,000 Angstrom units. These lamps are of conventional carbon or tungsten filament type used for therapeutic or other applications. The lamps are preferably arranged in each bank as illustrated in Figure 2 for the upper bank. They are there illustrated as arranged in three horizontal rows carrying the letters A, B and C and in diagonal groups designated by subscript numerals. With the arrangement illustrated, and with the provision of reflectors, which are, for best efficiency, desirably gold plated, the zones of radiation from each lamp overlap to such extent as to cover the felt throughout its entire width and over a substantial area. In order to prevent damage due to vibration of the machine, the lamps are desirably resiliently mounted by spring or rubber means.

If manual control is acceptable, the lamps may be controlled individually or in groups, for example, in the groups illustrated bearing the same numeral subscripts. In such case, observation of the results from time to time will generally indicate quite clearly the lamps which should be used to secure the desired uniformity. Generally, though not necessarily, it will be evident that without the lamps the central portion of the web will contain a greater proportion of moisture than the edges, and the same will be true, generally speaking, of the dryer felts. Under such conditions, only the central lamps of the banks may be used, which may effect a lower moisture content of the central portions of the felt than of the edges. The lamps selected will then result in a substantial uniformity of the moisture content across the paper web.

Where closer control is desired, however, the lamps are subject to automatic control by means responsive to the moisture content of the web. This may be done most conveniently by the use of means responsive to the electrical resistance of the web which is a good measure of the moisture content when, as is commonly the case, the soluble mineral content of the web is substantially constant throughout extensive periods of operation. For this purpose, the web as it leaves the last dryer felt passes over a conducting roller E and beneath a series of conducting rollers D, the locations of which are indicated in Figure 2, these rollers corresponding to the lamp groups bearing similar subscript numerals. In the adoption of an arrangement of this sort, it is desirable that some particular portion of the web should form the basis of reference, the other drying portions of the machine being adjusted to bring this portion of the web to the desired moisture content. The control of the lamps is then effected to produce throughout the web the corresponding moisture content. This may be effected through the use of the electrical control arrangement illustrated in Figure 3.

As illustrated therein, the roller D_0 is connected to a resistance R_0, which may be of fixed value across a supply line of either alternating or direct current, indicated at L. The web passing from the machine passes between the rollers D_0 and E.

Similarly connected across the line L are the combinations of the rollers D_1 and D_2, etc., with E and adjustable resistances R_1, R_2, etc. It will be evident from Figure 3 that if the resistance of the paper web between D_0 and E is regarded as a fixed resistance, or at any rate, a standard of resistance, there is provided a Wheatstone bridge comprising D_0 and E in one arm, R_0 in a second, D_1 and E in a third and R_1 in the fourth for the detecting roller D_1. A similar arrangement is provided in the case of each of the other rollers D_2, D_3, etc. Unbalance of each such Wheatstone bridge will accordingly produce a voltage difference between the points of junction of R_0 and D_0 and of R_1 and D_1, etc. The voltage thus produced may be used to control, for example, through an amplifier S_1 of conventional vacuum tube type, and a relay T_1, the current to the lamps A_1, B_1 and C_1 of the upper bank and the lamps A_1', B_1' and C_1' of the lower bank. Similar control of each of the other groups is effected.

The lamps B_0, C_0, B_0' and C_0' are preferably subject to control by means of a rheostat r. These may be set initially to secure the desired moisture content at the particular portion of the sheet used for reference purposes, here illustrated as the edge corresponding to D_0. The intermittent control of the lamps is satisfactory to secure a uniform product, since the action of drying or permitting the felt to acquire moisture is a gradual one, i. e., the correction of the moisture content is not effected by any rapid immediate action, but, since the change of moisture content in a detrimental direction is also quite gradual, the gradual correction is quite satisfactory.

While normally a uniform moisture content across the web is desirable, if a graduated nonuniformity is desired, that also may be accomplished by proper relative adjustments of the resistances. For example, in some cases the drying actions of supercalenders are not uniform across the sheet and hence those portions of the web which will be subject to less drying in the supercalender may be selectively over-dried in the apparatus described.

Alternatively, and adapted for even finer control than that effected by the arrangement of Figure 3, there may be used the control devices of Figure 4, in which S' represents an amplifier corresponding to any one of the amplifiers of Figure 3 and similarly connected to the Wheatstone bridge resistance arrangement of that figure. The output of this amplifier is fed to an automatic potentiometer P of which it may, of course, be an integral part. Such a potentiometer

is provided with a power driven arm or the like for recording purposes, and in the present instance, an extension of such arm, indicated at *a*, carries a contact *c*, riding over a rheostat *d* in circuit with the lamps of the particular group to be controlled through the amplifier. The arrangement is such that if the web at the location of the corresponding contact roller D is too wet, the potentiometer will automatically operate to cut out some resistance from the lamp bank circuit, thereby increasing the dryness of the portion of the felt passing thereunder. Such automatic potentiometers are standard articles of commerce and need not be further described.

It will be evident that the control arrangement of Figure 4 may also be adapted to shift laterally banks of infra-red lamps mounted on tracks transverse to the direction of movement of the felt, thereby to control selectively the moisture content of transverse portions thereof.

While response to the moisture content of the paper web has been illustrated and described as effected by measurement of its resistivity, it will be evident that the moisture content may be determined in other fashions, for example, by the use of a series of sensitive hygrometers adjacent the travelling web in essentially the positions of the rollers D, the responses of which may be translated into potential or current variations to effect control through means illustrated in Figures 3 and 4. Alternatively, the transparency of the sheet to infra-red radiation may be used as the control, since this varies with the moisture contents.

It will be noted that the drying effected by the use of the infra-red lamps is only a small percentage of the total drying involved in the machine. The selective drying by the lamps merely serves for the correction of a few per cent. of the moisture content of the web, and despite the substantially higher cost of electrical energy for drying than that of the steam used for the major part of the drying, the results secured render the method satisfactory. In view of the higher cost of the electrical energy in general, it is desirable, despite the presence of the lamps to take the usual precautions to secure, by the conventional elements of the machine, as even and proper drying as possible, so that the auxiliary means carries a minimum of the burden.

What I claim and desire to protect by Letters Patent is:

1. A paper making machine comprising a drying section having heated drums and at least one felt for pressing a paper web against the drums, and means for subjecting said felt to infra-red radiation substantially in the range of 6500 to 14,000 Angstrom units to effect drying thereof.

2. A paper making machine comprising a drying section having heated drums and at least one felt for pressing a paper web against the drums, and adjustable means for subjecting said felt to infra-red radiation substantially in the range of 6500 to 14,000 Angstrom units to effect selective drying thereof transversely of its length.

3. A paper making machine comprising a drying section having heated drums and at least one felt for pressing a paper web against the drums, means for subjecting said felt to infra-red radiation to effect drying thereof, and means responsive to the moisture content of the paper web for controlling the application of said infra-red radiation to said felt.

4. A paper making machine comprising a drying section having heated drums and at least one felt for pressing a paper web against the drums, means for subjecting said felt to infra-red radiation to effect drying thereof, and means responsive to the electrical resistivity of the paper web for controlling the application of said infra-red radiation to said felt.

5. The method of making paper comprising drying a sheeted web of paper by passage between heated drums and at least one felt, and subjecting said felt to infra-red radiation to substantially in the range of 6500 to 14,000 Angstrom units to effect drying thereof.

6. The method of making paper comprising drying a sheeted web of paper by passage between heated drums and at least one felt, and subjecting said felt to adjustable infra-red radiation to substantially in the range of 6500 to 14,000 Angstrom units to effect selective drying thereof transversely of its length.

7. The method of making paper comprising drying a sheeted web of paper by passage between heated drums and at least one felt, and subjecting said felt to infra-red radiation substantially in the range of 6500 to 14,000 Angstrom units to effect selective drying thereof in accordance with the moisture content of the finished web.

8. A paper making machine comprising a drying section having heated drums and at least one felt for pressing a paper web against the drums, means for subjecting said felt to infra-red radiation substantially in the range of 6500 to 14,000 Angstrom units to effect drying thereof, and means for controlling the last mentioned means to vary the intensity of said radiation transversely of the felt.

9. The method of making paper comprising drying a sheeted web of paper by passage between heated drums and at least one felt, and subjecting said felt to adjustable infra-red radiation substantially in the range of 6500 to 14,000 Angstrom units to effect selective drying thereof, said radiation varying in intensity transversely of the felt.

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