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2,725,640

METHOD OF DRY CREPING

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2 Sheets-Sheet 1

Fig. 1.

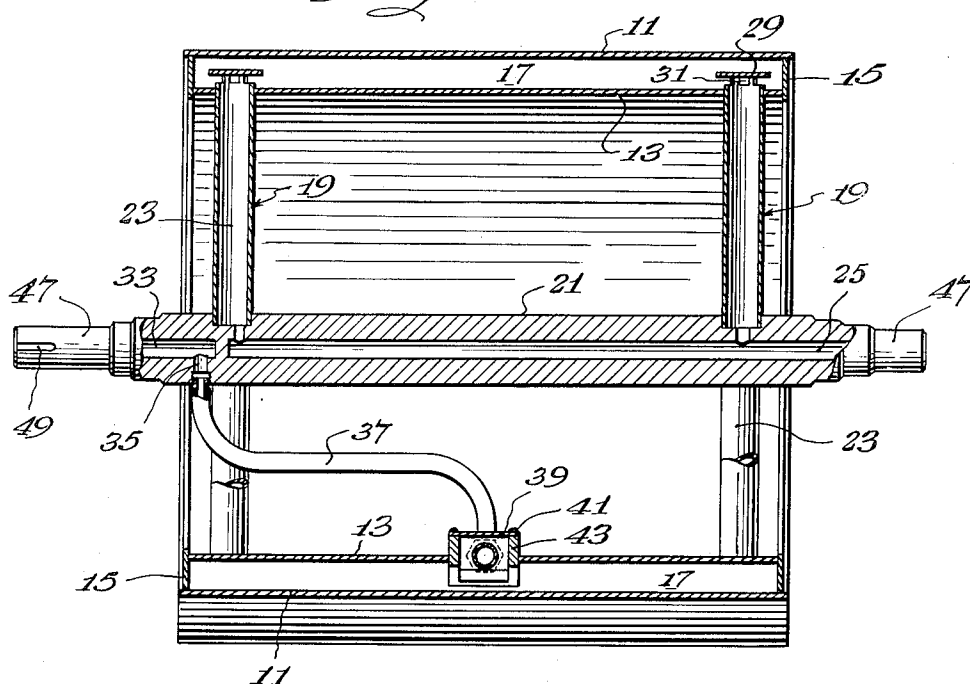
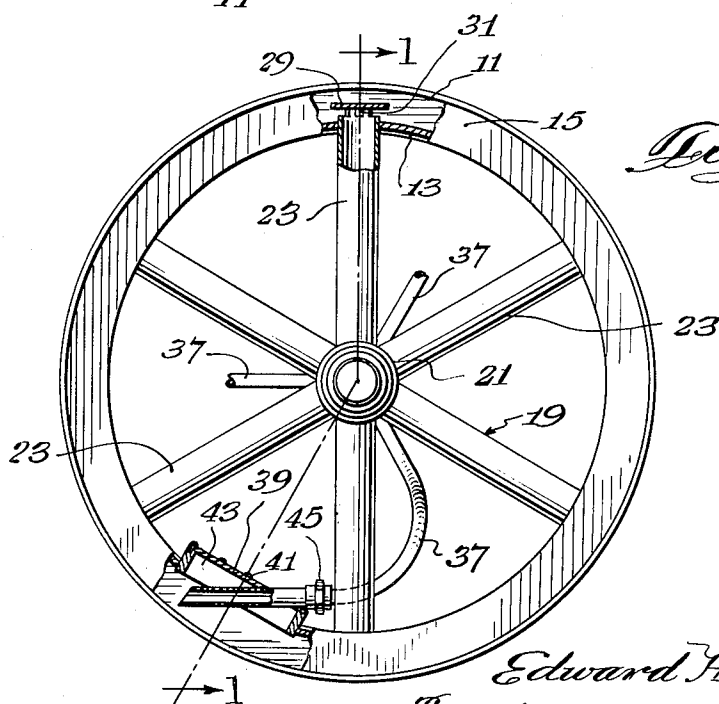


Fig. 2.



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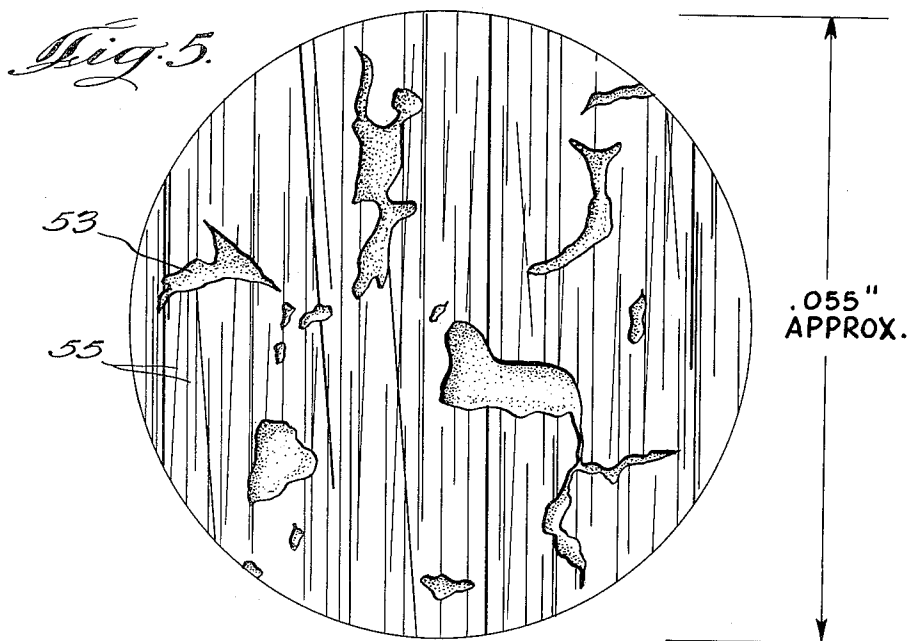
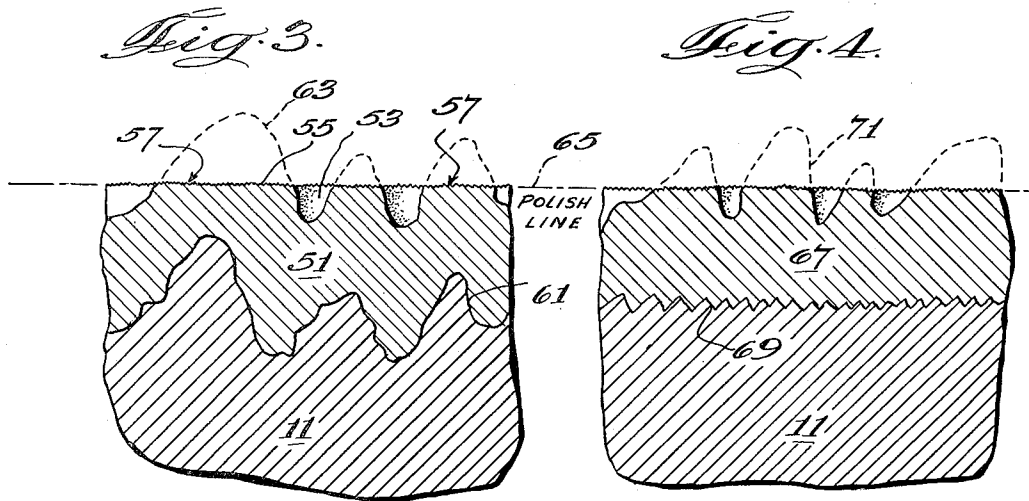
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METHOD OF DRY CREPING

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3 Claims. (Cl. 34—41)

The present invention relates to the manufacture of paper and is addressed particularly to the manufacture of creped tissue or creped wadding by the so-called "dry-creping" process.

The dry-creping of paper tissue may be carried out either as an "on-the-machine" process, that is, as part of the operation of the machine which initially produces the paper, or as an "off-the-machine" or conversion operation.

The type of paper-making machine on which the "on-the-machine" dry-creping process is usually effected is the so-called Yankee type machine. In this type of machine the wet web, after being couched from the forming wire and partially dewatered between felts, is pressed onto the surface of a large, heated drying cylinder and dried to the desired final moisture content in a single revolution of this drying cylinder. This is in contrast to the more common Fourdrinier type of paper-making machine in which the paper web is dried to the desired moisture content by simply passing it around a progression of smaller drying rolls. In the "off-the-machine" creping process, the dry paper web is moistened and pressed onto a creping cylinder in much the same way as this is done in the "on-the-machine" process.

In the dry-creping of paper, whether "on-the-machine" or "off-the-machine," the paper web at the point of creping usually has a moisture content of from about five to nine per cent, based upon the bone-dry weight of the web. The paper web, which is pressed onto the drying cylinder when quite wet and subsequently dried to the indicated degree, adheres more or less firmly to the surface of the drying cylinder and is removed therefrom by the scraping action of a doctor blade which is urged against the surface of the cylinder, and which crepes or crinkles the web as an incident to its removal from the dryer surface.

In the past, the cylindrical shells of these dryers which, in the case of the "Yankee" machines may be as large as 15 feet or more in diameter and equally as long, have been almost universally made from a single casting of cast iron. The true and accurate cylindrical surfaces necessary for the dry-creping of relatively thin tissue webs can be produced on these cylinders by grinding to the proper degree of smoothness, and the type of surface so produced permits the successful dry-creping at high speeds, that is, at cylinder surface speeds upwards of 1000 F. P. M., of webs made from several types of pulp materials. Moreover, the surfaces which are produced by grinding cast iron have satisfactory wearing properties, although the abrading action of the doctor blade at the desirable higher operating speeds, and the corrosive effect of certain materials which may be added to the paper web, necessitate that these cylinders be periodically resurfaced or otherwise restored to their initial degree of finish and accuracy. This is particularly true where the doctor blade which is employed with the drying cylinder is formed of hardened steel or special alloy, a practice which has been found desirable in order to maintain the

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shape of the doctor blade, which determines to a large extent the degree and character of the creping. However, notwithstanding the nature of the blade material, it is necessary to change blades frequently to maintain proper control.

Although drying cylinders made from cast iron are the most widely used types in the manufacture of creped wadding, bare cast iron cylinders have certain operational and structural disadvantages which tend to restrict the speed and flexibility of this paper making operation. In the first place, a successful dry-creping operation presupposes a certain degree of adhesion between the paper web and the surface of the drying cylinder, and it has been discovered that paper webs produced from furnishes which vary as to the nature of the constituent pulp, show markedly different tendencies to adhere to the surface of a cast iron cylinder. Some webs adhere too tenaciously to be creped off at the low moisture content necessary to assure retention of the desired amount of crepe, whereas, certain other webs do not adhere sufficiently to develop the desired amount of crepe as an incident to removal by the doctor blade. While the adhesion of these various webs to a polished cast iron surface can be controlled to a certain extent in various ways, the effects of known control methods upon the resulting creped tissue sheet may be considered objectionable in certain types of products manufactured from the tissue. As a result, the production of creped tissue for such purposes has been substantially limited to sheets made from those furnishes which exhibit a natural tendency to adhere satisfactorily to a bare polished cast iron surface of the type, and under the operating conditions, above described.

Furthermore, it will be appreciated that inasmuch as the moisture content of the paper web is reduced from about 60 per cent or more to from about five to nine per cent in less than one revolution of the drying cylinder, a substantial amount of heat is required for the removal by vaporization of this amount of moisture. This heat is usually supplied by steam introduced into the interior of the cylinder, and the temperature at which this heat is available, being directly related to the steam pressure within the cylinder, is limited by code requirements and by the ability of the cylinder to withstand the stresses caused by the pressure roll which applies the wet web to the cylinder, as well as the stresses caused by temperature differential in the cylinder shell. Moreover, the rate of heat transfer through the shell of the cylinder, in addition to being directly proportional to the temperature differential between its inner and outer surfaces, is also inversely proportional to the shell thickness, so that as the shell thickness is increased to permit higher steam pressures, and hence higher temperatures, the advantage of higher temperature is in some degree nullified. These factors dictate an optimum value of shell thickness which limits the operation of cast-iron drying cylinders, particularly those of the Yankee type, to steam pressures of about 125 p. s. i.

For these reasons, it would be desirable to make these cylinders of metals having more favorable tensile strength characteristics so that thinner shells could be used and higher rates of heat transfer, and hence higher operational speeds, could be obtained than are now realized. Mild steel, for example, while having a slightly lower coefficient of thermal conductivity than cast iron, will permit the construction of thinner drying cylinder shells which, at steam pressures commonly used today in cast iron drying cylinders of the Yankee type, would exhibit substantially higher rates of heat transfer. Or conversely, a steel shell of equivalent thickness is able to withstand much higher pressures and hence may be operated at higher temperatures so that the rate of heat transfer and the rate of removal of water from the paper web is cor-

respondingly increased. In either case, the machine operation speed, if limited by the drying capacity, could be substantially increased.

As applied to the high-speed dry-creping of paper tissue, however, steel drying cylinders have very definite drawbacks which, until the present invention, have generally limited the use of steel as a shell material for drying cylinders for the dry-creping of paper. It was pointed out above that, because of the abrasive effect of the cylinder upon the doctor blade which scrapes the paper from the cylinder, the blades are desirably made of hardened steel or special alloys. However, when a steel blade is used against the surface of a steel drying cylinder, there is a marked tendency of the steel blade to seize the steel surface of the cylinder and to produce, in a relatively short time, a series of abrasions, scratches, and score marks, which, upon close examination, reveal that portions of the metal are literally torn from the surface of the cylinder. Therefore, to be maintained operational in a high-speed dry-creping process, bare steel cylinders require resurfacing more often than is economically feasible, when high quality of product is an important factor.

To some extent, the "seizing" problem has been met by the use of a dissimilar metal for the doctor blade, for example, aluminum- and phosphor-bronzes, but these alloys being relatively soft, tend to wear rapidly. As earlier mentioned, the quality of the crepe which is produced, that is, the number and size of the rugosities in a specified length of the product, has been found to be dependent, to a large extent, upon the shape of the doctor blade, so that if a blade is used which will not maintain the desired shape for an appreciable period which, in any practical papermaking operation must be at least several hours, the quality of the creped tissue which is produced will necessarily be detrimentally affected. Furthermore, it has been found that when blades of the softer, non-ferrous metals are used, the surface of the cylinder soon becomes coated with a film of the doctor blade material, which in turn affects the adhesion characteristics of the paper web. These conditions limit the range of types of pulp furnishes which can be successfully dry-creped from a steel surface. As a result, bare steel drying cylinders with all their promise for higher operational speeds have not, until the present invention, been found practicable for a commercial high-speed dry-creping operation.

Accordingly, it is the principal object of this invention to provide an improved method and means for the high-speed dry-creping of paper. Another object of the invention is the provision of an improved drying cylinder surface for carrying out said creping method. It is a further object of the invention to provide a method of producing said improved creping cylinder surface which will permit the incorporation in said cylinder of all the operational advantages of a steel drying cylinder without any of the disadvantages which have heretofore been inherently associated therewith.

These objects are realized by providing on a drying cylinder of otherwise ordinary construction, a coating of chromium or other similar metal having its surface indented with minute depressions not normally discernible to the naked eye, but detectable with a suitable glass or microscope and readily measurable with a Brush Surface Analyzer. The Brush Analyzer is an instrument which measures and records the movement of a stylus as it traces a path across the surface being examined; it is commercially available and fairly well known. With this type of chromium coated cylinder, which will subsequently be described in detail, it has been found possible to successfully dry-crepe paper webs made from a greater variety of types of pulp furnishes than can be creped from a bare cast iron cylinder without special adhesion control means, and to fully utilize the operational advantages offered by a basic steel construction.

Other objects and advantages will appear, and the in-

vention will be better understood by reference to the following specification and to the accompanying drawings in which there is illustrated an improved dryer adapted for carrying out the method of the invention.

In the drawings:

Figure 1 is a sectional elevational view of a drying cylinder of the type having a basic, fabricated steel construction;

Figure 2 is an end elevational view, partly sectional, of the dryer illustrated in Fig. 1;

Figures 3 and 4 are fragmentary diagrammatic cross-sectional views, not to scale, of the outer shell of a drying cylinder, illustrating several methods of producing a creping surface in accordance with the invention;

Figure 5 is a magnified plan view of a portion of drying cylinder surface in accordance with Fig. 3 or Fig. 4.

The drying cylinder construction illustrated in Figures 1 and 2 is particularly suited for fabrication from steel plate, and the invention is described with particular reference to a steel drying cylinder because the greatest number of advantages are realized by employing the invention in connection with a steel dryer. It should be realized, however, that the invention can also be employed to advantage in connection with cast iron dryers, as will later be shown in detail.

The basic construction of the drying cylinder shown in the drawings is more or less conventional for drum dryers fabricated from steel. It includes an outer cylindrical shell 11 of steel plate and an inner concentric shell 13 connected to the outer shell by means of end rings 15 to which both shells are welded. The shells and end rings define between them an enclosed space 17 through which steam or other heating medium may be circulated to heat the outer shell.

The shells are supported adjacent their ends by spiders 19 mounted upon a central shaft 21. The individual spokes 23 of the spiders extend into this steam space 17 and are preferably tubular so as to perform the dual function of supporting the shells 11 and 13 and providing conduits for the steam or other heating medium. The supporting shaft 21 is bored centrally from one end for a distance substantially co-extensive with the face of the cylinder to form a central inlet passageway 25 for the steam and the shaft is provided with radially extending passageways 27 connecting the central passageway 25 with each of the radiating tubular spokes 23 of the spider. To prevent the formation of hot spots in the outer shell 11 of the drying cylinder, each of the tubular spokes 23 is provided at its outer end within the steam space 17 with a diffuser plate 29 which prevents the incoming steam from impinging directly against the outer shell 11, and guides its escape into the steam space through side-opening ports 31 provided at the ends of the spokes.

To effect the removal of condensate or cooled heating medium from the steam chamber, the shaft 21 is bored centrally from its other end to form an exit passageway 33 which is connected with the steam space 17 by radially extending passageways 35 in the shaft and by pipes 37 or other suitable conduits communicating with the steam space 17. The end of the condensate conduit 37 which is disposed within the steam space opens in the direction of rotation of the cylinder, and a number of such condensate removal conduits are desirably spaced equidistantly about the periphery of the cylinder, as indicated generally in Fig. 2. To facilitate assembly and disassembly for inspection and maintenance purposes, the intake end of the condensate conduit is mounted in a cover plate 39 removably secured by means of bolts 41 to a mounting flange 43 in the inner shell 13, and a union 45 is provided in the conduit 37, outwardly of the cover plate 39 to permit the removal of the intake end of the conduit.

The central shaft 21 is provided at either end with journals 47 for rotatably supporting the drying cylinder in bearings, not shown, and an extension of one of the journals is provided with a keyway 49 for the attachment

of a gear or pulley, depending upon the driving mechanism of the machine in which the cylinder is to be mounted.

The drying cylinder as thus far described is constructed in accordance with accepted practices in steel dryer construction and may be modified according to the requirements of any particular application. However, inasmuch as the invention is primarily concerned with the surface of the outer shell of a drying cylinder and is, therefore, applicable to drying cylinders of cast iron or other construction, it will be understood that the dryer construction as thus far described is illustrative only, and that variations in construction and compositions of metal to meet particular requirements as to pressures, temperatures, speeds of operation, etc., may be made within the scope of the invention. However, as previously stated, the greatest number of advantages are obtained by the use of the invention in connection with a drying cylinder having a basic steel construction. Specifically, it has been found that if the outer steel shell 11 is plated with a chromium layer 51 having certain surface characteristics, it is possible in a dry-creping operation to achieve not only the higher rates of heat transfer and higher operational speeds available from the use of a basic steel construction, but it is also possible to dry-crepe sheets made from a far wider range of types of furnishes than is possible with cast iron dryers.

The desired surface of the chromium layer 51 is one which may have an overall polished appearance but which actually contains many irregularly spaced and shaped depressions or crevices 53 of substantial magnitude so as to effect on closer scrutiny a textured or reticulated appearance. A surface of this kind is illustrated in plan in Fig. 5, which is of course greatly magnified as indicated by the dimension appearing along one side of the figure. At the scale of the illustration, the grinding or polishing marks 55 are quite easily discernible, but the pocks or crevices 53 predominate in determining the texture of the surface. These depressions are irregularly shaped, sized and spaced, and are of unequal depth as a result of certain of the methods which may be employed to produce them, as will later be described. These random depressions are found to occur with fairly uniform frequency in all directions, and it is believed that for satisfactory results, the surface should have at least 25 depressions per lineal inch, which might vary irregularly in depth from 5 to 200 microinches.

As an illustration, in one particularly successful surface, depressions of fifty (50) microinches or more in depth were found to occur with a frequency of from about 18 to 35 per lineal inch, and to have a maximum breadth at the cylinder surface of about ten thousandths inch (.010"). Lesser depressions of about twenty (20) microinches or greater but substantially less than 50 microinches, were found to occur at a rate of from about 10 to 50 per lineal inch. The depth and frequency of these depressions are given as determined by means of a Brush surface analyzer having a stylus with a spherical tip having a radius of 500 microinches. In view of the irregular shapes of these depressions, and because the Brush analyzer "reads" or detects along a substantially straight line, it will be understood that those depressions indicated as major depressions may have portions remote from that line which are substantially less deep, and which may appear as one or more minor depressions in adjacent traces of the instrument.

The "lands" or flat plateau-like areas 57 defined between the depressions were finished to a fineness of about 5 microinches, accounting for the overall polished appearance presented to the naked eye.

The open-grain finish of the chromed surface may be achieved in several ways, one of which will be apparent from Fig. 3. For example, the outer shell of the cylinder may be shot or sand-blasted to provide a pebbled surface 61 of the desired roughness, and the shell may then be plated with chromium, preferably to

a thickness of from three to eight thousandths inch (.003" to .008"). The outer surface 63 of the plated layer 55 will, of course, reflect the pebbled surface of the shell, as indicated in Fig. 3, inasmuch as the plating layer, which is normally deposited electrolytically, will be of substantially uniform thickness. The desired final surface may then be effected by grinding and polishing the plated cylinder to a predetermined depth represented by the "polish line" 65 of Fig. 3, to produce a surface which in plan appears as represented in Figure 5. Obviously, the size, depth and frequency of the depressions 53 will depend in the first instance on the degree of roughness which is achieved in abrading the surface of the base shell, and secondly, upon the depth to which the plated layer 51 is ground and polished.

The same or a similar surface may be produced by depositing a chromium layer 67 directly upon the machined surface 69 of the shell, as indicated in Fig. 4, and subsequently shot or sand-blasting the plated layer to produce a rough or pebbled surface 71 which may be ground and polished, as previously described, to the depth indicated by the "polish line" to produce a surface texture like that illustrated in Fig. 5.

The desired roughness of the chromium layer prior to polishing may also be accomplished by etching in one of several ways. For example, a plating layer of chromium may be deposited on the machined surface of the cylinder and etched after being prepared by the usual methods to selectively resist the etching acid in order to produce the desired surface pattern. The solid line portion of Fig. 4 is substantially representative of this method of forming the surface. As a further possibility, the machined surface of the shell may be etched prior to plating, and then subsequently plated and polished, in the same manner as though the shell had been initially shot-blasted (Fig. 3). On the other hand, it may be desirable in some instances to deposit an initial chromium layer on the machined surface of the shell, which may then be etched, and subsequently replated before polishing to produce the finished texture illustrated in Fig. 5. The preparation of the desired surface by etching is, of course, the most flexible method because of the unlimited variety of surface patterns which can be produced and because of the control which can be exercised over the size of the depressions independently of their depths.

Although the plating layer has been described as being deposited directly upon the surface of the cylinder shell, it will be understood that it may be desirable in certain instances to initially deposit one or more layers of dissimilar metals before the chromium layer or layers are deposited.

By the use of a chromium plated drying cylinder having the described surface characteristics in a high speed dry-creping operation employing a steel doctor blade, it was observed that there was no tendency toward seizure between the chromium surface and the steel doctor blade, and that the wearing qualities of the textured chromium surface are superior to those exhibited by polished cast iron, both being "doctored" by a hardened steel blade. Furthermore, such wear as does occur is uniformly distributed about the surface of the cylinder which does not exhibit the tendency to form local irregularities, as is sometimes the case with bare polished cast iron.

In addition to these advantages, the application of steel dryers to a dry-creping operation made possible on a practicable basis by the invention permits the fabrication of cylinders which, because of their greater strength, may be made much lighter in weight for comparable operating conditions so that high rates of heat transfer, and hence higher speeds of operation may be realized than was possible with the standard cast iron cylinders.

More important, however, is the discovery that with

a grained chromium surface of the type described, it is possible to successfully dry-crepe webs made from most types of pulp furnishes currently used in the production of paper. This is particularly important when it is appreciated that with the use of present standard equipment and methods, that is, by the use of a polished cast iron dry-creping cylinder, it has thus far been impractical to crepe webs made from furnishes which include, for example, a major portion of bleached northern kraft, bleached or unbleached southern kraft, or furnishes containing a large percentage of ground wood. These cling too tenaciously to polished cast iron to permit their removal in a successful dry-creping process without special treatment which may, in many instances, be objectionable from the standpoint of the use to which the paper products are put. However, paper webs formed from the enumerated furnishes adhere to a pebbled chromium surface of the described texture with markedly less force and may be successfully creped therefrom at the desired low moisture content necessary for satisfactory retention of the crepe. Furthermore, it has also been found possible to successfully crepe webs formed of unbleached sulfite pulp from the above described chromium surface, whereas webs made from this furnish cannot be successfully creped from a polished cast iron dryer without the addition of glue or other adhesives to the furnish because of their tendency to "flare" or prematurely separate from the surface of a cast iron cylinder.

In all cases of the enumerated pulp furnishes, the paper webs creped from the chromium plated cylinder were dried to the usual five to nine per cent moisture content based on the bone-dry weight of the fiber, which is considered the usual range of moisture content for dry-creping; but it was further discovered that sufficient adherence of certain of these webs to the chromium surface was displayed to permit satisfactory dry-creping with moisture contents as high as 14 per cent. In all cases, the range of the basis weights of the tissue sheets made from the enumerated types of pulps extended downwardly from an upper limit of 15 lbs. per ream of 480 uncreped sheets, 24" x 36" and, therefore, included substantially the entire range of basis weights considered desirable for known applications of paper products of this type.

It will be apparent from the foregoing description that the present invention greatly increases the range of a paper-making operation which has heretofore been limited by known methods and materials to the dry-creping of paper webs made from a restricted group of furnishes, and definitely limited to operational speeds determined by the weight, pressure, and heat transfer properties of the cast-iron drying cylinder. With the present invention, it is possible not only to dry-crepe webs made from a wide variety of pulp furnishes than has heretofore been possible, but also when the invention is applied to a steel cylinder, to achieve higher rates of heat transfer and hence higher operational speeds than are now being realized.

Various features of the invention which are believed to be new and patentable are set forth in the appended claims.

I claim:

1. The method of dry-creping paper tissue which comprises applying a continuous wet web of said tissue to a heated rotating drying cylinder having thereon an outer layer of chromium the surface of which is indented with at least 18 depressions of from 5 to 200 microinches in depth per lineal inch of said surface in any direction but is relatively smooth between said depressions, and scraping said web from said surface by means of a blade urged against said surface in the zone thereof at which the moisture content of said web is less than 14 per cent of the dry weight of said web.

2. The method of dry-creping paper tissue having a basis weight of 15 pounds or less per ream of 480 uncreped sheets 24 by 36 inches, said method comprising applying a continuous wet web of said tissue to a heated rotating drying cylinder plated with a chromium layer the surface of which is indented with at least 18 depressions of from 5 to 200 microinches in depth per lineal inch of said surface in any direction but is relatively smooth between said depressions, and scraping said web from said surface by means of a steel blade urged against said surface in the zone thereof at which the moisture content of said web is less than 14 per cent of the dry weight of said web.

3. The method of making an improved dry-creped paper tissue which comprises the steps of forming a continuous tissue web from a furnish having a pulp content which includes a major portion of pulp selected from the group including bleached northern kraft, bleached or unbleached southern kraft, or ground wood, and which tissue web has a bone-dry basis weight of fifteen (15) pounds or less per ream of 480 uncreped sheets 24 x 36 inches, applying said web when wet to a heated rotating drying cylinder plated with a chromium layer the surface of which is indented with at least 18 depressions of from 5 to 200 microinches in depth per lineal inch of said surface in any direction but is relatively smooth between said depressions, and scraping said web from said surface by means of a doctor blade urged against said surface in the zone thereof at which the moisture content of said web is less than 14 per cent of the dry weight of said web.

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