This invention relates to the grooving of roll surfaces and specifically relates to the continuous cutting of equally spaced and uniformly shaped helical grooves in the outer surfaces of crowned rolls used in the papermaking industry.

One of the important uses for strong, tough grades of paper is the manufacture of multi-wall bags. These bags are generally favored for flowable, particulate materials. A 100-pound multiwall bag, for instance, when filled with such material and placed on its side, tends to become relatively flat and thin and of generally rectangular shape.

It is customary and logical to lay these bags horizontally one upon another to form stacks which may be, as when palletized and stored in a warehouse, as much as twenty feet high. High stacks of filled multiwall paper bags are often necessary in storing and transporting very large quantities of cement, fertilizer, sugar, and chemicals, for example, by ship, railroad boxcar, and truck.

It is obviously of great practical importance that these high stacks of heavy bags do not fall when being transported or otherwise handled. Because the filled bags conformably compress those below in the same stack, there is a large and fairly irregular area of contact between each bag and the one below upon which it rests. However, paper is generally relatively smooth and the resultant coefficient of friction may not create enough frictional force to prevent bags in a stack from slipping sidewise and causing the stack to topple.

A successful means of overcoming this behavior is to increase the coefficient of friction of the paper forming the outer bag layer. One inexpensive and useful method of doing so is to create very small grooves in the paper surface by passing the paper between a rubber-covered roll and a grooved metal roll. Paper impressed with a pattern of small parallel grooves is called "embossed" paper. This method obviates any need for using matching metal rolls possessing circumferential, non-spiral grooves.

The machining of small, uniformly-shaped helical grooves in the surface of a metallic roll over its full length is not easy. When the roll is large, such as 40 inches in diameter and 270 inches in length, and is curved or crowned from ends to middle, such as having 0.070 inch greater diameter in the center, this problem becomes very difficult. As is well known in the machinery art, when a roll of this size is placed in a large lathe, the very slow travelling speed of the carriage causes the carriage to stick intermittently in the lathe bed. Machinists use the term, "stick-slip", to describe this erratic arrestment or grabbing of the carriage by the lathe bed which apparently results from displacement of oil between the metal surfaces by essentially vertical pressures. Because the lathe lead screw is attempting to pull the carriage at a uniform rate, each small but abrupt stoppage creates torsional deflection in the lathe lead screw whereby sufficient energy is stored therein to disengage the carriage from the lathe bed a very short time after each stoppage has occurred.

The practical consequence is that the cutting assembly progresses unevenly along the lathe lead screw, thereby causing grooves to be cut irregularly in the large roll being grooved.

The object of this invention is to enable very small, closely spaced, substantially uniform helical grooves of a desired groove form and depth to be cut into the surface of a generally cylindrical roll of large and non-uniform diameter when this roll is mounted on an ordinary large lathe and the groove-cutting assembly is mounted on the lathe lead screw.

The instant invention achieves the desired result by providing a means for a tangentially-aligned groove-cutting tool to "float" or drift as necessary while substantially disengaged from the lathe lead screw as it movement parallel to the roll axis but only partially disengaged as to movement perpendicular to this axis. While thus disengaged from the lathe lead screw, the groove-cutting tool and accessory depth-controlling means are propelled forwardly, from one end of the roll to the other end and in a direction parallel to the roll axis, by engagement of tracking teeth, which are immediately adjacent to and following the cutting teeth, in the grooves already cut.

At the same time, the base portions of the groove-cutting assembly are propelled, in the same direction and approximately at the same speed, by the lathe lead screw while the groove-cutting tool is biased toward the roll surface by pressure-maintaining means. This mounting and propulsion method prevents small discontinuities in the forward propulsion imparted by the lathe lead screw from being translated into groove irregularities in the surface of the large roll. Further, any accumulative differences in forward motion between the lathe lead screw propulsion and the tracking teeth propulsion are accumulated in the mounting means for the groove-cutting tool without being transmitted to the groove-cutting tool. The invention will become more clearly apparent by inspection of the accompanying drawings.

FIGURE 1 is an isometric view of the groove-cutting assembly.

FIGURE 2 is a top view of the groove-cutting assembly.

FIGURE 3 is a side view of the groove-cutting assembly with an inserted cross-sectional view of the internal spring which biases the cutting tool toward the roll surface and maintains a constant pressure thereupon during the cutting operation.

FIGURE 4 is a front view of the groove-cutting assembly.

FIGURE 5 is a cross section of the tangential grooving tool, taken at A-A in FIGURE 3, which consists of teeth that can perform both groove-cutting and groove-tracking functions and of holding and clamping means for this tool.

FIGURE 6 is an enlarged top view of the upper part of the tangential grooving tool.

FIGURE 7 is an enlarged front view of the upper part of the tangential grooving tool.

Referring to the drawings, the groove-cutting assembly is supported by the lathe compound rest 21 to which the stationary base 22 is rigidly attached. The radial sliding base 20 is able to slide toward or away from the large roll to be grooved because it is slideably connected to the stationary base 22 by means of the radial dovetail slide 39 which is adjusted to a smoothly sliding fit by the radial dovetail gib 33 and the slotted, threaded shafts 32 and radial adjusting nuts 32. Upon one end of the radial sliding base 20, the axial sliding base 18 is mounted. It is able to slide in a direction that is perpendicular to the radial sliding direction of the radial sliding tool that is parallel to the axis of the large roll to be grooved whereby the floating or drifting capability for the groove-cutting tool is achieved, as discussed herebefore. The axial sliding base 18 moves along the axial dovetail slide 40 slideably connecting this axial base 18 to the radial base 20. This slide 40 is adjusted to a smoothly-sliding fit by the axial dovetail gib 34 and the slotted, threaded
shafts 35 and axial adjusting nuts 35. Movement of the axial sliding base 18 can be restrained as desired by tightening the knurled locking nuts 31 on the threaded locking screws 29 against the axial sliding base stops 30.

The axial sliding base 18 supports the tangential grooving tool holder 16 which is rigidly attached thereto. The tangential grooving tool holder 16, as is evident in FIGURES 2 and 3, is aligned radially with regard to the roll 1 to be grooved and supports the tangential grooving tool 11. Rollying is mounted on the extended end of the holder 16. As is clearly shown in FIGURE 5, the tool 11 is slidably locked into place in a partially keyed slot in the front end of the holder 16 by the tangential grooving tool clamp 14 which is rigidly fastened to the holder 16. Vertical movement of the tool 11 is accomplished by adjusting the elevation adjusting screw 15. The tangential grooving tool 11 is divided into a full-length portion and shorter portion, as shown in FIGURE 7, which comprise the tracking means and groove-cutting means respectively. The full-length portion consists of the tracking teeth 12, and the shorter portion consists of the tracking teeth 13. The sharp upper edges of the cutting teeth 13, as shown in FIGURES 6 and 7, contact the bare metal surface of the roll along the line of tangential contact therewith and progressively cut grooves of the desired groove form and depth therein. The tracking teeth 12 contact and engage the grooves already cut along the line of tangential contact somewhat as a flat plane touches a cylinder, and help to clean the grooves while forwardly propelling the cutting teeth 13, the tangential grooving tool clamp 14, the elevation adjusting screw 15, the tangential grooving tool holder 16, means for controlling the depth of the grooves to be cut, and the axial sliding base 18.

The accessory depth-controlling means, also supported by the tangential grooving tool holder 16, comprise a depth gage roller 23 which contacts the roll surface, depth gage roller holder 24, depth gage adjusting screw 25, depth gage adjusting screw locking nuts 26, and depth gage adjusting screw support 27. Other parts of the depth-controlling means, as shown in FIGURE 3, are the radial loading spring 36 and the radial sliding base pin 37. This pin 37 is rigidly keyed into the bottom of the radial sliding base 20 and is no greater in width than the diameter of the radial loading spring 36 that is fitted into a slot in the stationary base 22 as shown in FIGURE 4.

Because the depth gage roller 23 contacts the roll surface at a lower level than the cutting edges of the cutting teeth 13, the width of the roller 23 must project outwardly beyond the cutting teeth 13. The smaller the diameter of the roll to be grooved, the more the roller 23 must be projected.

Relatively large variations in roll diameter and relatively very minor variations in desired groove depth can be compensated for by moving the depth gage adjusting screw 25 within the limits allowed by the adjusting slot 38 through which a bolt passes to retain the depth gage roller holder 24 in its slot in the holder 16. This retaining bolt and its washer are not shown in FIGURE 1. A slot of the proportions illustrated in FIGURE 1 and shown by dotted lines in FIGURE 2 permitted cutting of small grooves in rolls varying from ten inches to forty inches in diameter.

When beginning to cut helical grooves of a selected groove form and depth into the surface of a large crowned steel roll which has been mounted in a large lathe, the grooves or helical roll are assembled so that it is mounted on the lathe compound rest 21, as shown in the drawings, in such a manner that the cutting teeth 13 of the tangential grooving tool 11 are in forcible contact with the roll surface at the very end of the roll so that the tracking teeth 12 project beyond the end of the roll and are disengaged therefrom. Pressure on the cutting teeth 13 is selectively maintained by partially compressing the radial sliding base loading spring 36 when positioning the stationary base 22 on the lathe compound rest 21 which is attached to the lathe carriage 19. The depth of cutting is then regulated by adjustment of the depth gage adjusting screw 25 and depth gage adjusting screw locking nuts 26 to bring the depth gage roller 23 into contact with the surface of the large roll to be grooved; variations in roll diameter are thus automatically compensated for. Before rotating the lathe, however, the axial sliding base 18 must be released from drifting by tightening both of the knurled locking nuts 31 on the threaded locking screws 29 against the axial sliding base stops 30.

After the lathe has made at least one complete revolution and the cutting teeth 13 of the tangential grooving tool 11 have formed a complete spiral ring consisting of a row of grooves of the desired form and depth, the tracking teeth 12 become tangentially engaged by these newly-formed grooves. When all of the tracking teeth 12 have become engaged, the knurled locking nuts 31 are loosened, permitting the axial sliding base 18 to slide forwards or backwards upon its dovetail slide 40 as may be necessary to compensate for differences in advancement of the upper portion of the groove-cutting assembly and the lower portion which is simultaneously being propelled by the lathe lead screw. At times during the traverse of the entire large roll, it may be that accumulating differences in pitch or in groove characteristics somewhat as a flat plane touches a cylinder, and help to clean the grooves while forwardly propelling the cutting teeth 13, the tangential grooving tool clamp 14, the elevation adjusting screw 15, the tangential grooving tool holder 16, means for controlling the depth of the grooves to be cut, and the axial sliding base 18 to reach the limit of its travel in one direction. The lathe must then be stopped, and the lower portion of the groove-cutting assembly must be approximately centered on the lathe lead screw beneath the tangential grooving tool 11 so that the upper portion containing the groove-cutting tool and accessory depth-controlling means are again free to float or drift independently of the base portion which is propelled by the lathe lead screw when the lathe is started again. In this manner, grooves of the desired form and depth may be cut from one end of a large roll to the other, the sliding movement of the groove-cutting means being merely controlled by the groove-track ing means.

1. A groove-cutting assembly adapted for cutting closely-spaced helical grooves in substantially cylindrical rolls of large diameter when said rolls are mounted in a lathe, comprising a tangential grooving tool having cutting teeth adjacent to a desired groove form and tracking teeth adapted to track in previously formed grooves, means for controlling groove depth, and a mounting assembly adapted to permit said tangential grooving tool to float in a direction parallel to the longitudinal axis of said large-diameter roll independently of the propelling action of the lathe lead screw.

2. A groove-cutting assembly adapted for cutting substantially uniform, closely spaced helical grooves of a desired groove form and depth into the surface of a roll which is non-uniform in diameter throughout its length and too large for accurate manipulation when mounted in a lathe, said assembly comprising a tangential grooving tool, groove-cutting means, groove-tracking means, means for sensing the surface of the roll, means for regulating the groove depth in cooperation with the surface sensing means, means for mounting the groove-cutting tool in a tool holder permitting linear sliding movement for the tool holder only in directions substantially parallel to and perpendicular to the longitudinal axis of the roll, and means for selectively restricting sliding movement parallel to said longitudinal axis while initial groove cutting proceeds under control of the lathe lead screw and for permitting said sliding movement while subsequent groove cutting proceeds under control of the groove-tracking means.
3. A groove-cutting assembly supporting a tangential groove-cutting tool having cutting and tracking teeth milled to the required groove form to cut and subsequently engage substantially uniform, closely-spaced, helical grooves in the surface of a crowned roll which is too large for accurate machine work when the roll is mounted in a lathe, comprising an adjustable roller contacting the roll surface to regulate groove cutting depth, a spring biased to urge said tangential groove-cutting tool as close to the roll surface as the adjustable roller permits, means for mounting base portions of said groove-cutting assembly upon the lathe lead screw by means of a dovetail slide and gib to permit sliding movements perpendicular to the longitudinal axis of said roll, and means for mounting said tool holder upon said base portions by means of a dovetail slide and gib to permit selectively controllable sliding movements parallel to said roll axis during the groove-cutting operation whereby, as to movement parallel to the roll axis, the tool holder is controlled by the lathe lead screw while cutting the initial grooves and by the groove-cutting tool, through engagement of the tracking teeth with the previously-formed grooves, while cutting the remaining grooves.

4. A groove-cutting assembly adapted to cut very small, closely-spaced, substantially uniform helical grooves of a desired groove form and depth into the surface of a cylindrical roll of large and non-uniform diameter when said roll is mounted on an ordinary large lathe and the groove-cutting assembly is mounted on the lathe lead screw, comprising:

(a) a tangentially-aligned groove-cutting tool, having cutting teeth and tracking teeth milled to the desired groove form, which is mounted upon a tool holder containing:

(b) means to sense the roll surface,

(c) an elevation adjusting screw whereby the tangentially-aligned groove-cutting tool may be raised or lowered;

(d) means to regulate the cutting depth,

(e) means to control the cutting direction parallel to the longitudinal axis of the roll;

(f) an axial sliding base, rigidly attached to and supporting said tool holder, which selectively slides freely in a direction parallel to the longitudinal axis of the roll;

(g) a radial sliding base, slideably attached to and supporting said axial base, which slides in a direction perpendicular to said longitudinal axis;

(h) a radial sliding base pin which is rigidly attached to, and protrudes beneath, said radial sliding base;

(i) a fixed base which is rigidly attached to the lathe lead screw and is slideably attached to and supports said radial sliding base;

(j) a compressed spring, beneath the radial sliding base in a slot in said fixed base, which is aligned parallel with said radial sliding base and compressibly contacts said radial sliding base pin, whereby pressure is maintained on said radial sliding base to bias said groove-cutting tool toward the roll surface; and

(k) locking units and screws on opposite sides of the axial sliding base to restrict sliding movements of the axial sliding base during initial groove-cutting and to permit sliding movements of the axial sliding base during subsequent groove-cutting, whereby may be equalized any differential movement between the linear propulsion imparted to said fixed base and said radial sliding base by the lathe lead screw and the linear propulsion imparted to said tool holder by engagement of the tracking teeth with the previously-formed grooves.

No references cited.