United States Patent [19]

Ashby

[11] 3,763,729

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[54] **WEB EDGE MARKING APPARATUS AND METHOD**

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[52] **U.S. Cl.** **83/355,** 83/698, 74/25, 83/663

[51] **Int. Cl.** **B26d 5/20**

[58] **Field of Search** 93/58.4; 10/153; 83/345, 355, 670, 668, 663, 698; 74/25

[56] **References Cited**

UNITED STATES PATENTS

3,283,635	11/1966	Johnson	83/345
1,858,733	5/1932	Flachbart	10/153
1,784,494	12/1930	O'Neill	83/663

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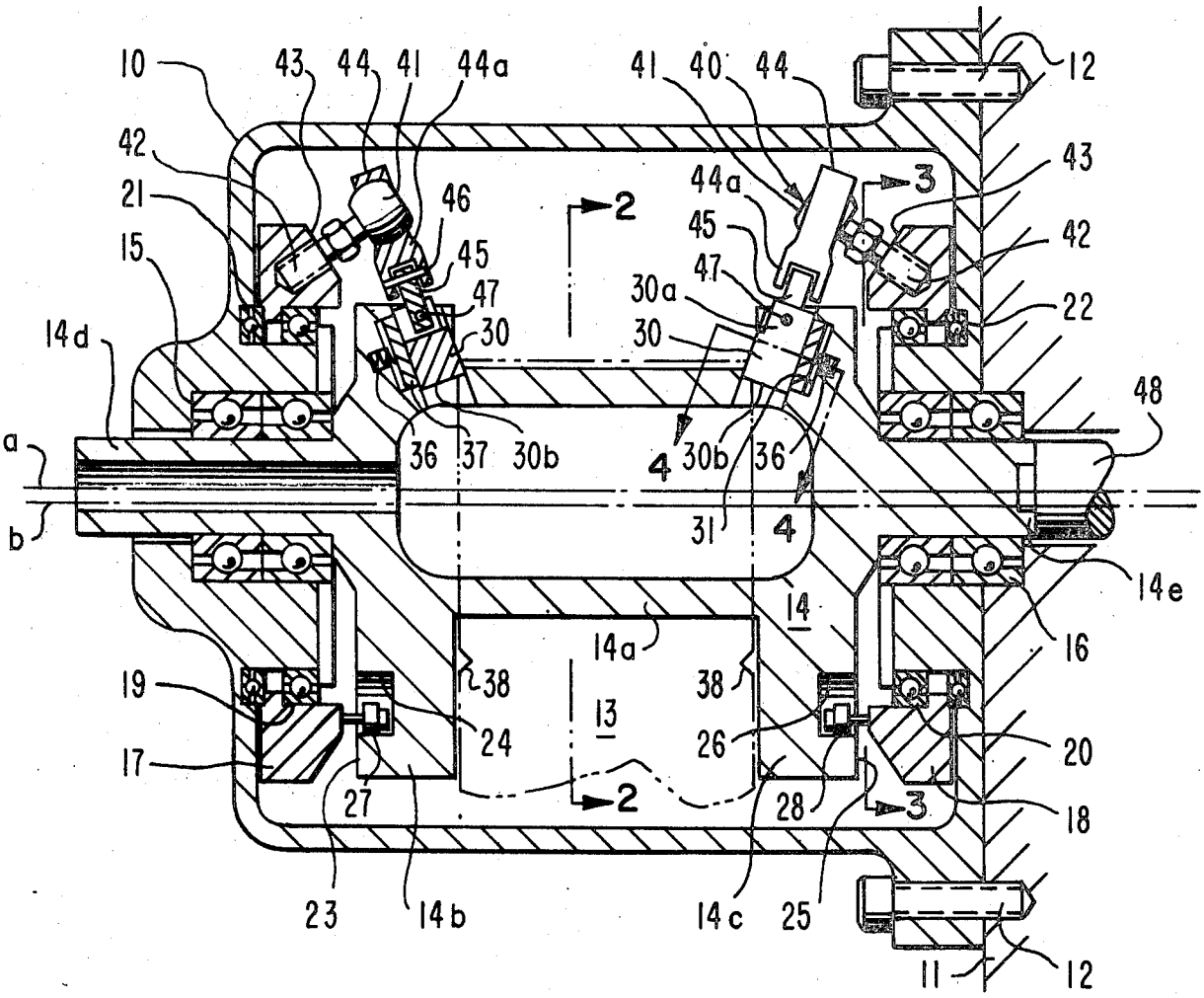
[57] **ABSTRACT**

Successive spaced cuts, notches, imprints or other marks are made along the edges of a moving web by members that are driven with harmonic motion by conversion of rotary motion to reciprocating motion. As the web moves onto and partially around a drive roll that carries the marking members, the latter are reciprocated in paths extending obliquely toward the roll axis from outboard of the web edges. At least one ring eccentrically encircling the roll outboard of the web is driven from the roll at constant angular velocity by cam and follower means. Each ring is connected by a ball-in-socket-like connection with the outer ends of the associated members to reciprocate the members with a stroke corresponding to the degree of eccentricity of the ring relative to the roll.

10 Claims, 6 Drawing Figures



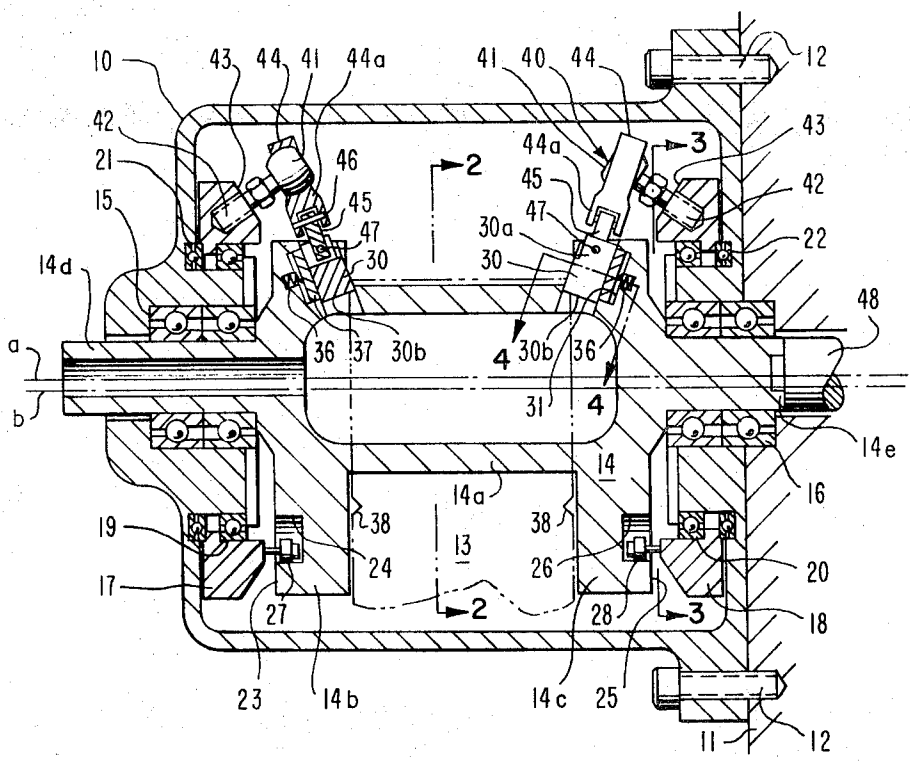


FIG. 1

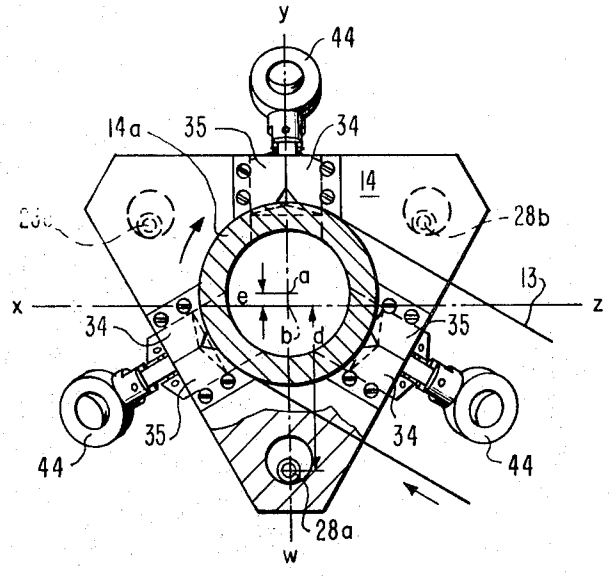


FIG. 2

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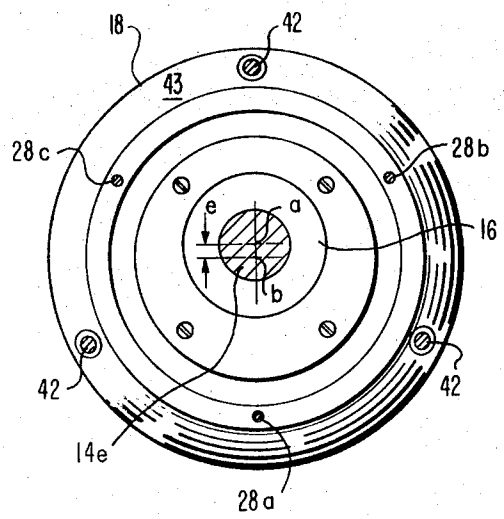

FIG. 3

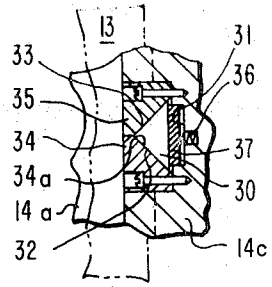

FIG. 4

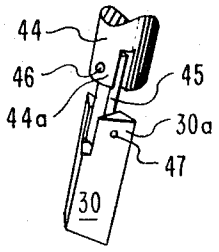

FIG. 5

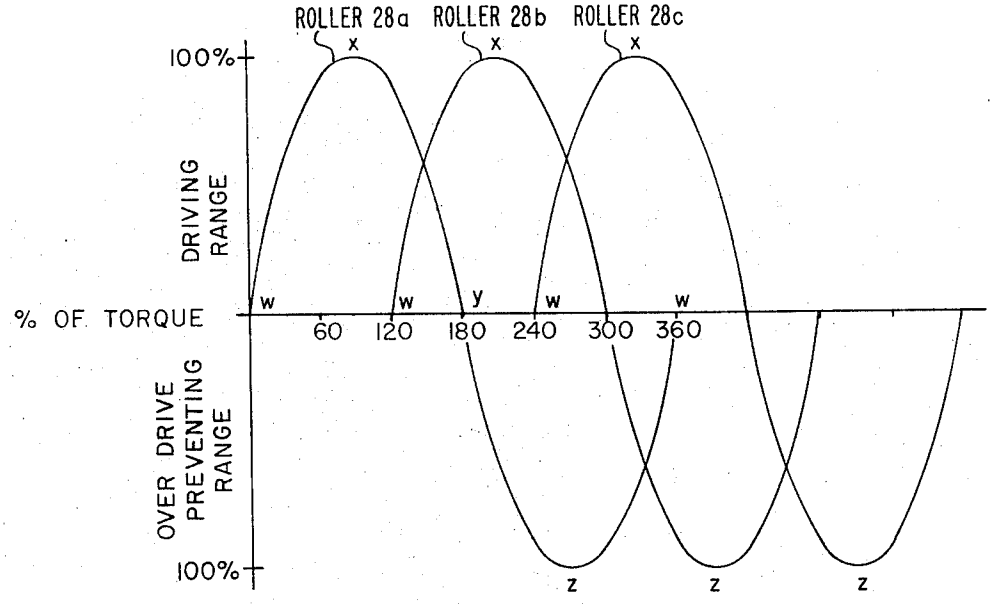

FIG. 6

WEB EDGE MARKING APPARATUS AND METHOD

This invention relates to apparatus and methods for providing notches, cuts, imprints, scores or other marks at uniformly spaced points along one or both edges of a fast moving web; the invention relates, more particularly, to such apparatus and methods employing at least one marking member that is reciprocated substantially with harmonic motion by a rotary to reciprocating motion conversion mechanism including at least one ring driven at constant angular velocity from a drive roll, to minimize acceleration and deceleration effects on each ring.

BACKGROUND OF THE INVENTION

In cutting or marking a web of cardstock or the like, rotary tooling permits the work operation to be performed while the web is moving at high speed. It is therefore preferable to flatbed-type reciprocating tooling where the web must be stopped when impacted by the tooling and hence must be moved incrementally at low overall throughput speeds. U.S. Pat. No. 3,283,635 discloses a rotary punch apparatus for making cuts in a web while it moves through the nip of a punch roll and die roll. These rolls have punch and die buttons adjustably inset in suitable slots in the periphery of the punch and die rolls, respectively, to cut the web with a scissor-like shearing action. Although this apparatus operates quite satisfactorily, it requires precise adjustment of the buttons. Wear life is considerably better than with pinch roll tooling, wherein a cuater blade projecting peripherally from one roll cuts into the web as it advances through the nip between said roll and a smooth, hard back-up roll. However, even with rotary punch and die rolls, the quality of the scissor-like shear cut and wear life are noticeably poorer than that achieved when a punch and die have mating honed flat surfaces that move reciprocally relative to each other with substantially zero clearance. On the other hand, with reciprocating tooling inertia effects increase dramatically during acceleration and deceleration and reversal of direction as attempts are made to increase reciprocation rate. If a reciprocating element is concurrently rotated, centrifugal force will increase the effective load on the element and further aggravate the acceleration/deceleration inertia effects during stroke reversal. For this reason, considerable difficulty has been experienced in developing a practical apparatus and method permitting use of a reciprocating puch or other marking member for use in a rotary press or the like.

There is a need for a relatively inexpensive and reliable apparatus and method embodying a punch which reciprocates with substantially zero clearance relative to a die in a rotary press environment to provide the excellent shear cuts achievable with reciprocating tooling while the web is moving at very high speed, while at the same time minimizing the undesirable inertia and centrifugal force effects.

SUMMARY OF THE INVENTION

Toward this end, and according to the invention, applicant has found that these objects can be achieved by employing a single drive roll and cutting or otherwise marking the edge of the web with a member that reciprocates with substantially zero clearance relative to at least one flat smooth die surface provided in or carried by the roll. The member reciprocates with substantially harmonic motion and is controlled to assume a retracted position as the marking member approaches the point where the web moves onto the roll, then to advance obliquely into marking contact with the edge of the web, and thereafter to retract as the member completes a full one-revolution cycle of operation. A rotatable member disposed eccentrically about the roll outboard of the edges of the web is driven from the roll at a constant angular velocity via at least three identical cam and follower units equally spaced to impart substantially harmonic motion to each marking member through a stroke corresponding to the degree of eccentricity at the rotatable member relative to the roll.

Other objects and advantages will become apparent from the following more detailed description of the invention and from the following drawings wherein:

FIG. 1 is an elevational sectional view of a web edge cutting apparatus embodying the invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1, but partially broken away to show details of a cam bore and roller follower;

FIGS. 3 and 4 are sectional views taken along the lines 3—3 and 4—4, respectively, of FIG. 1;

FIG. 5 is a perspective view of a punch and certain associated parts that are shown in section in FIGS. 1 and 4; and

FIG. 6 is a timing diagram showing the driving and overdrive-preventing phases of staggered operation of the three cam and follower units.

DESCRIPTION

As illustrated in FIGS. 1 and 2, the apparatus embodying the invention comprises a hollow bell-shaped housing 10 secured to a stationary side plate 11 by screws 12. A web 13 of cardstock or the like enters through a suitable opening in housing 10 and is entrained onto and partially around the constant diameter central portion 14*a* of a center roll 14. The web moves between and is retained against lateral shifting by two radial flange portions 14*b*,14*c* of roll 14, which has outboard of said portions two hub portions 14*d*,14*e*. Portion 14*d* is journaled in a bearing 15 retained within housng 10; and portion 14*e* is journaled in a bearing 16 retained within the housing and side plate 11.

Outboard of web 13 and encircling the hubs 14*d*,14*e* are rings 17,18. These rings 17,18 are rotatably supported by bearings 19,20 and thrust bearings 21,22, respectively, carried on annular bosses provided on housing 10 and projecting inwardly toward the flange portions 14*b*,14*c*. Formed in outer end face 23 of flange portion 14*b* is a set of three cam-surface-providing bores 24, each of the same diameter and spaced at equal radial and angular distances. In outer end face 25 of flange portion 14*c* is an identical set of bores 26, the bores 24 and 26 being coaxially aligned. A set of three roller followers 27 and another set of three roller followers 28 project into the respective bores 24,26 and have rolling contact with the walls thereof. The axis of rotation a (FIG. 3) of center roll 14 is displaced radially from the axis of rotation b of rings 17,18 by an eccentricity *e*. The diameter of each bore 24,26 is equal to twice the eccentricity e plus the diameter of the respective roller 27 or 28, for reasons which will become apparent presently.

As illustrated in FIGS. 1, 4 and 5, two sets of three punches 30 of triangular cross section are disposed in

openings 31 spaced 120° apart in roll 14 adjacent each side of the web. More specifically, each punch 30 has two flat honed hardened intersecting cutting faces 32,33 that are adapted to reciprocate in sliding contact with corresponding hardened honed flat surfaces 34*a*,35*a*, each provided by complementary parts 34,35 respectively, of a two-part die block 34,35 secured by screws to flange portions 14*c* (or 14*b*, as the case may be). A spring 36 acting through a plate 37 resiliently biases the faces 32,33 of each punch 30 into zero clearance contact with surfaces 34*a*,35*a* as the punches are reciprocated in the manner presently to be described.

The punches 30 extend from the outer periphery of the respective flange portion 14*c* or 14*b*, generally radially toward the roll's rotational axis a but at an oblique angle such that the innermost ends of each cutting face 32,33 can move from a position radially outward of the central portion 14*a* and outboard of the web angularly into intersection with and through the outer edge of the web and into the central portion 14*a*. In doing so, each punch will cleanly shear a V-shaped chip from the web to produce a corresponding V-shaped notch 38 (FIG. 1) at uniformly spaced points at each edge of the web.

Reciprocation of each punch 30 is controlled by a respective ball-joint assembly 40 connected to the associated ring 17 or 18. Each ball-joint assembly comprises a ball 41 secured to a stud 42 that is screw-threaded at substantially a 45° angle into a chamfered surface 43 of each ring 17,18 adjacent the respective edges of the web. Each ball 41 is accommodated in a socket member 44 that has a depending clevis-like portion 44*a*. Each punch 30 has a clevis-like non-working end portion 30*a* providing a slot at right angles to the slot in clevis-like portion 44a. A "universal link" 45 projects into both said slots and is connected to socket portion 44*a* by a pin 46 and to punch portion 30*a* by a pin 47 disposed at right angles to pin 46 to provide a universal-like connection; said connection permits limited relative movement corresponding to a misalignment of up to about 10° between each punch and socket member resulting from the eccentricity of the rings 17,18 relative to roll 14.

OPERATION

In operation, a shaft 48 coaxially connected to hub portion 14*e* drives center roll 14 for advancing web 13 clockwise as viewed in FIG. 2. Meanwhile, as drive shaft 48 rotates center roll 14 at a constant angular velocity, rings 17 and 18 despite their eccentricity will also be driven at the same constant angular velocity by transmission of driving force sequentially from the wall of each bore 24,26 to the corresponding roller follower 27,28. Meantime, as rings 17,18 are thus driven, they drive the balls 41 of assemblies 40 in a perfectly circular path; and hence, although members 44 will rock slightly relative to pin 45, they will remain at essentially a constant fixed distance from the axis of rotation b of rings 17,18. Thus, each die 34,35 does not move; but since the rings 17,18 are eccentric to center roll 14, each punch 30 reciprocates relative to die 34,35 as the center roll rotates. The working edges 30*b* (see FIG. 1) of each punch reciprocate toward and away from the roll's rotational axis a but angularly transversely of the web, completing their greatest penetration of the web at *c* and thereby providng the longitudinally spaced notches 38 in the edges of the web.

Note that at least three roller followers 27 and a like numer of roller followers 28 should be employed, all at equal radii from the axis of ring 17 or 18, as the case may be. With this arrangement, when the follower-carrying rings 17,18 are offset so that their axes b are below the axis a of rotation of drive roll 14, as illustrated, the roller followers 27,28 will always contact the bottom of the respectve bores 24,26, as shown in FIGS. 1 and 2. With the arrangement illustrated, each ring 17,18 will be driven at a constant angular velocity, which is the same as the angular velocity of the drive roll 14; and the power transmitted from the drive roll to the rings will be proportional to the distance d (FIG. 2) from the axis of the corresponding roller follower to the axis of the corresponding ring.

As best seen in FIGS. 2 and 6, power will be transmitted from drive roll 14 to ring 18 via roller follower 28*a*,28*b*,28*c* during that period each follower is moving from *w* to *x* to *y*, with power transmission increasing from *w* to *x* and decreasing from *x* to *y*. After each follower passes through the dead spot *y* (zero power transmission) and moves from *y* to *z* back to dead spot *w*, it will (by contact with the leading rather than trailing side of the wall of its bore 26) prevent overdriving of the associated ring; this overdrive preventing force will increase from *y* to *z* and decrease to zero from *z* to *w*. Thus, by employing three roller followers 27*a*,*b*,*c*, and 28*a*,*b*,*c* per ring, as illustrated, power is transmitted continuously without backlash; each follower goes through the dead spots *w*,*y* at different times and during each successive one-revolution cycle of operation passes systematically through a driving range, a dead spot, an overdrive preventing range, and dead spot. By way of contrast, if only two roller followers (each 180° apart) were employed per ring, both followers would pass through dead spots at the same time.

Note that each punch 30 is thus reciprocating with substantially harmonic motion relative to the center roll 14 because each punch is linked to one of the rings 17,18, and the rings and center roll rotate at the same constant angular velocity. The motion is not pure harmonic because of the universal-like connection afforded by link 45 and pins 46,47, which permit the outer end of socket member 44 at times to tilt in both forward/backward and transverse directions, as necessary, relative to the axis of punch 30. The relative motion of each punch and die will thus be a slightly modified harmonic, with the motion being closer to pure harmonic as the pins 46,47 are moved farther apart, and the degree of tilt reducing as eccentricity of axis a relative to axis *b* decreases. As a result, reciprocation of each punch relative to its die 34,35 and the center roll 14 is achieved without any significant acceleration or deceleration inertia effects on the rings 17,18.

While the invention has been illustrated embodied in a rotary punch for cardstock or the like, it will be apparent that the invention may be employed to control reciprocating members other than punches. Accordingly, the term "marking member" as used in the claims is intended generically to cover any type of member that is reciprocable with substantially harmonic motion to perform a work operation on a fast moving web; e.g., a needle, a print element, a cutting blade; and the scope of the invention is therefore to be limited only as specified in the claims.

I claim:

1. Apparatus for making successive longitudinally spaced marks along at least one edge of a moving web, said apparatus comprising

a roll for driving the web as it moves onto and partially around the periphery of the roll,

at least one ring disposed eccentrically and rotatably about the roll outboard of the web,

cam and follower means interconnecting the roll and each ring for causing the roll to drive each ring,

a least one reciprocable marking member carried by the roll for movement in a path generally radially toward the roll axis, but inclined obliquely to angularly intercept the edge of the web when moving toward said axis, and

means including a ball-in-socket-like interconnection between each ring and each marking member associated therewith for causing each member to be initially retracted as the web moves onto the roll and then be reciprocated into marking contact with the web while the latter is against the roll, and again retracted during each revolution of the roll.

2. Apparatus according to claim 1, wherein

said means including a ball-in-socket-like interconnection causes each marking member to be reciprocated with substantially harmonic motion.

3. Apparatus according to claim 1, wherein said cam and follower means comprises, for each ring,

at least three cam bores of identical diameter formed in an end face of the roll at equal radial and angular distances, and

one roller follower projecting laterally into each bore to make rolling contact with the bore surface, each follower being carried by one such ring and having a diameter substantially smaller than that of such bore, whereby each follwer in turn will transmit driving torque to the ring while the other followers pass through dead spots or serve to prevent overdriving, thereby to assure that each ring despite its eccentricity will be driven at a constant angular velocity equal to that of the roll.

4. Apparatus according to claim 3, wherein

the diameter of each said bores is equal to twice the magnitude of the eccentricity plus the diameter of the associated roller follower.

5. Apparatus according to claim 3, wherein

each ring carries three roller followers,

each follower passing through a torque transmitting phase of increasing magnitude to a maximum then decreasing magnitude to zero during the first and second 90° of rotation, respectively, then through an overdrive preventing phase of increasing magnitude to a maximum and decreasing magnitude to zero during the third and fourth 90° of rotation, respectively,

each follower being driven 120° out of phase with respect to the other two followers, so that as one of said followers is approaching or moving through a dead spot of zero magnitude torque transmission or overdrive prevention, another will be transmitting torque and the third will be preventing overdrive to eliminate backlash.

6. Apparatus according to claim 1, wherein

each marking member is punch having cutting faces for removing a notch-like chip at uniformly spaced longitudinal points along the edge of the web.

7. Apparatus according to claim 1, wherein

each marking member is a punch having a working end and a non-working end, and

said means including a ball-in-socket-like interconnection includes means providing a universal-like connection between said non-working end and the ball-in-socket means for permitting tilting of the last-mentioned means, as necessary, relative to the axis of the punch.

8. Apparatus according to claim 1, wherein

each ring is driven by the cam and follower means at a constant angular velocity equal to that of said roll to minimize acceleration and deceleration effects on such ring.

9. Apparatus according to claim 1, including

a shaft for driving said roll,

said roll having journals coaxial with said shaft and to each side of a web-contacting central portion of constant outside diameter, and

one such ring being rotatably supported on each journal.

10. The method of making a series of marks along the edge of a moving web, comprising the steps of

directing the web onto and partially around a roll,

providing at least one reciprocable marking member that is retracted to a position outboard of the edges of the web at the point where the web moves onto the roll and then advanced in an oblique path generally radially inward toward the roll axis to intercept the edge of the web during its period of contact with the roll and thereafter retracted to complete a cycle of operation,

providing a rotatable member eccentrically disposed about the roll outboard of the edges of the web, and

driving the rotatable member from the roll at constant angular velocity via means imparting substantially harmonic motion to each marking member through a stroke corresponding to the degree of eccentricity of the rotatable member relative to the roll.

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