Feb. 16, 1937. E. W. SMITH 2,070,757

METHOD AND MEANS OF MAKING PAPER

Filed Aug. 1, 1935 3 Sheets-Sheet 1

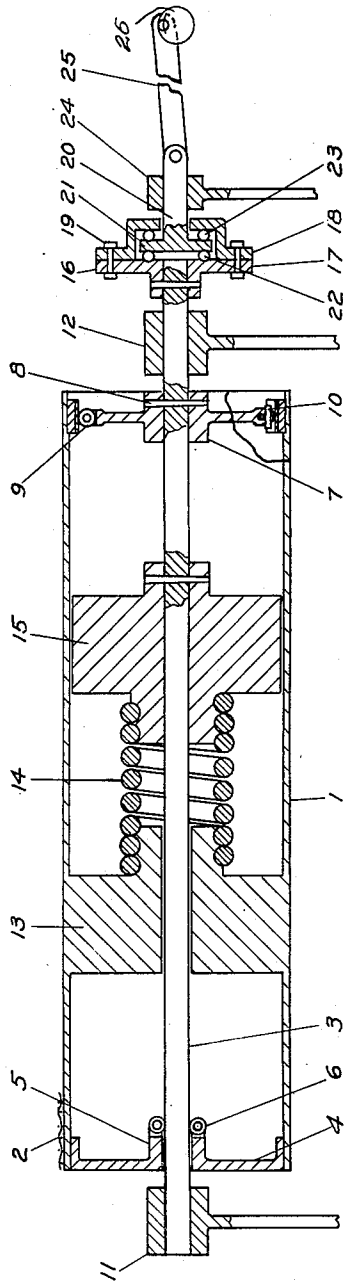



FIG. 1

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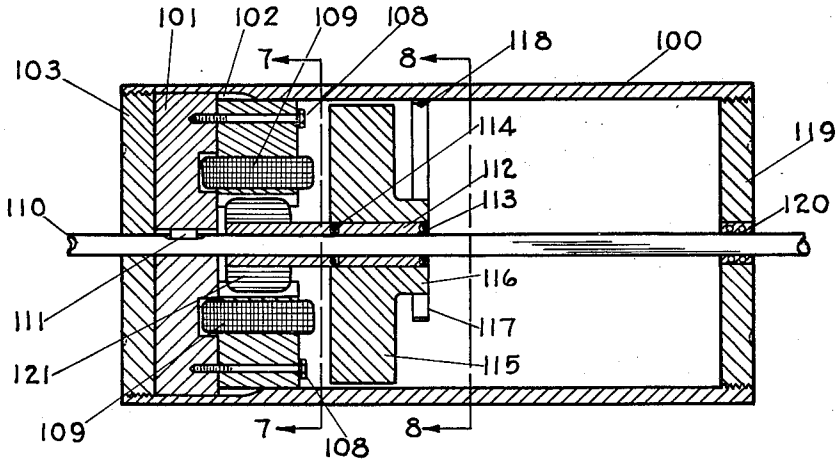



FIG. 6

FIG. 7

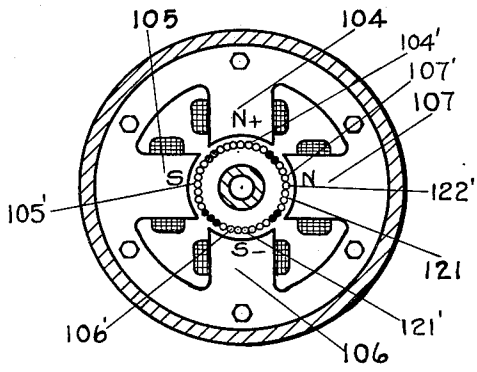
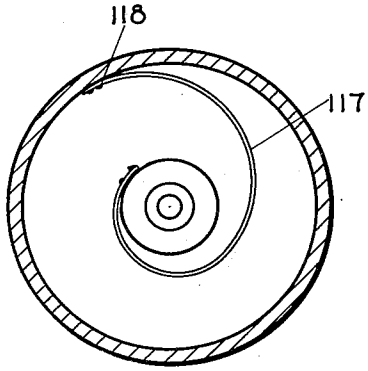



FIG. 8



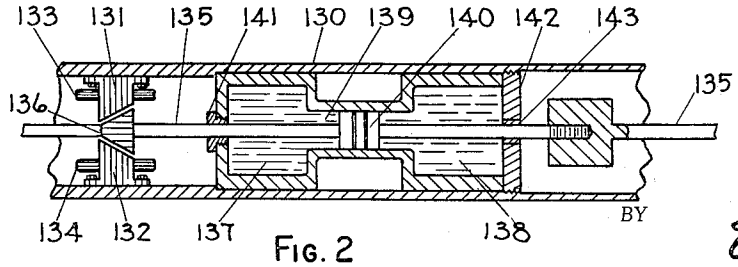




FIG. 2

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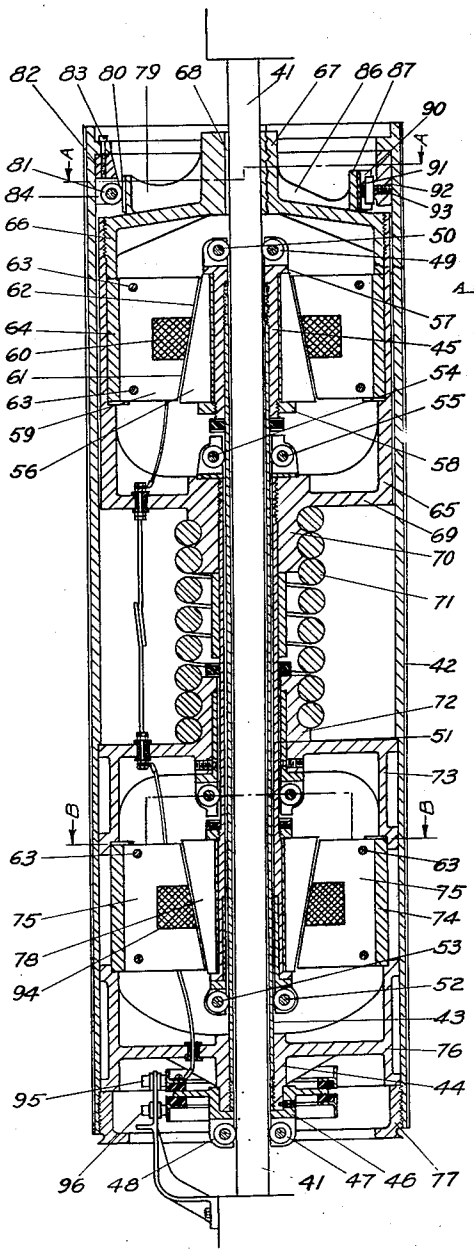
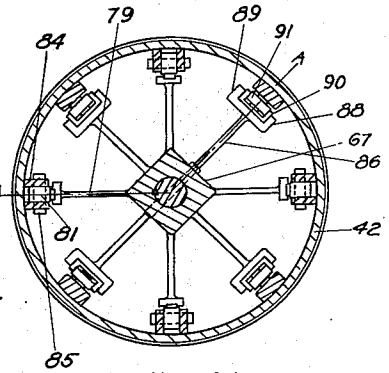
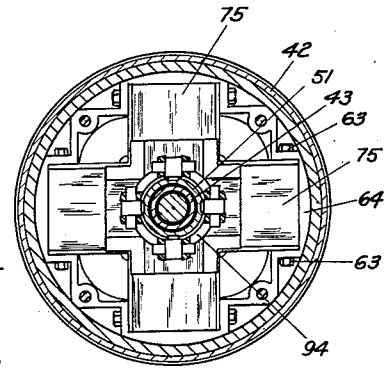



Fig. 3




Section A-A

Fig. 4




Section B-B

Fig. 5

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Patented Feb. 16, 1937

2,070,757

# UNITED STATES PATENT OFFICE

2,070,757

## METHOD AND MEANS OF MAKING PAPER

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Application August 1, 1935, Serial No. 34,211

39 Claims. (Cl. 92—45)

The present invention relates to the manufacture of paper and also to the apparatus and means used in the manufacture of the paper, and more particularly to methods and means for vibrating various parts of the wire upon which the paper is formed and made.

Various types of paper machines are used in which the so-called wire or screen carries the pulp as the water is drained from it. Probably the most generally used is the so-called Fourdrinier machine in which the pulp is flowed over the wire at the so-called breast roll and leaves the wire at the so-called couch roll. In machines of this type the screen is moved at various rates of travel ranging from 400 feet per minute up to 1200 feet per minute and even higher. The pulp and water delivered to the screen at the breast roll is usually of a rather thin consistency and, further, may be deposited in a rather deep layer upon the wire ranging anywhere from a quarter to a half inch and upward. Under these conditions there is a natural tendency for a shearing action to take place between the liquid next to the wire and the liquid layers on top, and it is believed that this shearing action has a tendency to draw the fibers out in the direction of the travel of the screen itself and therefore tends to produce a paper which will tear quite readily along the direction of the fibers.

This fact has, in fact, been recognized but apparently no suitable method of dispersing the fibers in the direction other than in the motion of the screen has been devised. Attempts have been made to produce a shaking action at various parts of the screen but such means have not operated to produce such results as will materially increase the strength of the paper. It is believed for the most part that the failure in the methods that have been employed is due to the inability of the apparatus to shake at fast enough rates or with great enough magnitudes to overcome the natural tendency of the fibers to lay in the direction of the travel of the wire.

It will be appreciated on considering the size of the ordihary paper machine and the weight of the various rolls, screens and pulp that are associated with it that it is practically impossible under the means that have been used to produce any kind of shaking action of large magnitudes except at fairly low speeds of the moving screen. In fact, as speeds above 400 or 500 feet per minute, shaking of the screen has not been attempted.

In the present invention means have been devised for producing adequate shaking at low and at higher speeds of the wire screen and not only is it possible to produce a shaking of the screen in a transverse direction to the motion of the wire itself, but it is also possible to produce a vibration in the direction of motion, thus substantially eliminating the shearing action between various layers of pulp and water and making it more difficult for the fibers to line up in the direction of motion of the wire.

In the present system there is, in general, employed two masses which are coupled together through an elastic element or means providing a restoring force, and energy may be supplied either between the two masses or to one of the masses from which the energy is tranferred to the other by the elastic force in accordance with the principles of coupled masses. In this system the roll is made a part of one of the masses, and other masses are provided to which the mass of the roll may be coupled through some elastic or restoring force. The principle may be applied to produce both a transverse vibration of the roll itself and also a vibration of the roll in the direction of the rotation of the roll and opposite thereto. By employing the principle of coupled masses it is possible to produce relatively large vibrations with ordinary mechanical forces, and, further, it is possible to so balance the mechanical system that external elements as, for instance, the foundation or floor of the building upon which the machine rests will not be subject to excessive forces.

The invention will be more clearly understood in connection with the drawings showing an embodiment of the same in which Fig. 1 shows in sectional view one form of the invention as applied to a roll of a Fourdrinier machine; Fig. 2 shows a modification of the invention illustrated in Fig. 1, showing a different method of obtaining the restoring force and a different means of producing the mechanical vibration; Fig. 3 shows a modification of the device shown in Fig. 1; Fig. 4 shows a section on the line A—A of Fig. 3; Fig. 5 shows a section on the line B—B of Fig. 3; Fig. 6 shows a further modification of the modification shown in Fig. 1 in which a torsional vibration is obtained by the same principle; Fig. 7 shows a section on the line 7—7 of Fig. 6; and Fig. 8 shows a section on the line 8—8 of Fig. 6.

In Fig. 1 there is indicated a roll 1 upon which the wire or screen 2 moves. The roll may be separately driven or it may be driven by the movement of the screen 2 over it. The roll itself is mounted upon a shaft 3 to which, however, it is

not rigidly attached, as will be noted from the description. The roll 1 carries an end plate 4 which has a hub 5 carrying roller bearings 6 which support the weight of the roll 1 upon the shaft 3. At the other end of the shaft 3 there is positioned a bearing plate 7 which is pinned to the shaft by means of the pin 8. This plate 7 carries a group of bearings 9 and 10. The bearing 9 is of the type to operate with a longitudinal motion of the roll 1 while the bearing 10 is of the type to support rotational motion of the roll 1. These bearings are described more clearly in connection with Figs. 3 and 4 the description of which is given later. The shaft 3 is supported on two external bearings 11 and 12 and extends through the latter bearing to the means whereby longitudinal vibration of the shaft is produced, as will be presently described.

Supported within the roll 1 is a mass 13, the size of which depends upon the weight of the roll itself and that of the screen and also upon other factors relating to the frequency of vibration and the relations of the restoring force supplied by the elastic element 14, which as shown in Fig. 1 is a helical spring, and the mass 15 which is coupled to the shaft 3. The elastic element or helical spring 14 is secured at one end to a collar on the mass 13 and at the other end to a collar on the mass 15. Vibration of the roll 1 is produced through mechanical vibrations applied to the shaft 3 through the coupling element 16 which may be composed of a plate 17 on which is mounted a housing or frame 18 which may be attached to the plate by means of bolts or rivets 19. The housing 18 encases a shaft 20 at the end of which is formed a plate 21 which has at both front and rear surfaces ball-bearing elements 22 and 23, the bearing elements 22 facing plate 17 and the bearing element 23 resting between the disc 21 and the inner side of the housing 18. The shaft 20 is pivoted beyond the bearing 24 to a crank 25 which is carried as an eccentric upon the shaft 26. One revolution of the shaft 26 produces a cycle of movement back and forth of the shaft 3 and this, operating on the mass 15 which is coupled to the mass 13 through the spring 14, produces a vibration of the masses that is transmitted to the roll 1. By properly apportioning the mass of the roll and the mass 13 to that of the mass 15, a resonance may be produced for a definitely chosen elastic force and frequency of operation, and it is preferable to provide this relation to obtain the greatest amplitude of vibration.

Fig. 2 shows an alternative method of obtaining the proper restoring force to produce resonance in the vibrating system when the masses are of such magnitude as to make the use of metallic spring types of restoring force undesirable or inconvenient. In this modification the roll 130 may be provided with an electrical system for producing longitudinal motion of the roll in the same manner as shown in Fig. 1 or 3. There is shown in Fig. 2 the electromagnetic driving mechanism including the poles 131 and 132 energized by the coils 133 and 134, respectively. The shaft 135, upon which the roll may be supported, carries the armature 136 which is oscillated back and forth by the current passing through the coils 133 and 134. Instead of the construction shown in Fig. 1, two oil chambers 137 and 138 are provided through which the shaft 135 may pass. The chambers 137 and 138 are connected in a narrow neck portion 139 in which is positioned a piston 140. The shaft 135 passes into the chamber 137 through a liquid-tight joint 141. The shaft 135 may also extend through the back wall 142 of the chamber 138 in a similar liquid-tight joint 143. The chambers 137 and 138 are preferably filled with oil or some similar compressible medium and furnishes the restoring force for the armature 136. In the arrangement shown in Fig. 2 it will be noted that whatever leakage might occur through the piston simply provides more liquid in one of the chambers than in the other, and, therefore, when the pressure of this chamber arrives at the proper level, no further leakage can take place and an equilibrium is established. Oscillation of the system in an axial direction tends to compress the oil in chamber 137 and then in chamber 138. The system thus provides in liquid form the equivalent of the compression and elongation of spring 71 in Fig. 3 or 14 of Fig. 1.

In Fig. 3 a modification is shown in which the electrical forces are so applied that a larger pull may be obtained between the place of action of the restoring forces. In this modification there is provided a shaft 41 which goes centrally through the whole roll 42. Mounted on the shaft 41 is a sleeve 43 which at one end threads into a collar or hub 44 and at the other end into an elongated collar 45. The collar 44 on its external side fits into an element 46 which contains bearing supports 47 and 48 for the sleeve 43, the bearing supports themselves running on hardened steel inserts in shaft 41. Similarly, at the other end of the shaft the bearings 49 and 50 support the sleeve 43 upon the shaft so that there is a rolling contact between sleeve 43 and shaft 41. Externally of the sleeve 43 is a second sleeve 51 which is concentric with the first sleeve and the shaft 41 and which bears upon the sleeve 43 in the bearings 52 and 53 at one end of this sleeve and 54 and 55 at the other end. The sleeve 43 at one end carries the armature 56 of the electromagnet solenoid formed at that end. This armature 56 may be in the form of a truncated prism with the sides sloping at an angle as indicated. This may be built up of a group of laminations which fit into the recess formed by the element 45 which has a flange 57 at its upper end and a collar 58 at its lower end which retains the armature element in place.

The magnetic field in which this element works is made up in the manner similar to that indicated in Fig. 5. This is formed with a group of U-shaped laminations cut on an angle to match the angle of the armature element. The laminations are put together preferably in four blocks, as indicated in Fig. 5, and the coil 60 may be circular or rectangular and positioned to pass through all of the laminated blocks in the centers. The magnetic flux produced by this coil then exerts a pull between the two poles 61 and 62.

The laminations 59 are held by bolts or rivets 63 to a frame 64 which sets into a cylindrical supporting element 65 and is retained there by means of the end clamp or cap 66 which is provided with a hub 67 having a key 68 locking the hub to the shaft 41. The cylindrical element 65 carrying the frame 64 and the laminated poles 59 has at its other end an end plate 69 with a hub 70 in which the third cylinder 51 is threaded. The hub 70 is formed with helical grooves to receive the helical spring 71, the other end of which threads into a similar hub 72 formed as an integral part to the supporting frame 73 which rests against a shoulder in the roll 42 and is held firmly in place by means of the frame 74 holding the magnetic pole element 75 which, in turn, is retained by the supporting piece 76 carrying the

hub 44 as a part of it to which the sleeve 43 is firmly fastened. The supporting piece 76 is held in position by means of the collar 77 which threads into the end of the roll 42.

It will be noted that the hub 72, the pole elements 75 and the sleeve 43 are all rigidly held to the roll 42 and also the armature element 56 at the upper end of the figure as seen in Fig. 3. It will also be noted that the hub 70, the supporting cylinder 65, the frame 64 and the magnetic poles 59 are all held fast to the shaft 41. It should also be noted that the armature element 78 at the lower end of the roll is held fast to the same system by being attached to the sleeve 51. In the system, therefore, one group of elements is held fast to the shaft 41 while the other group of elements is held fast to the roll 42. The armature at one end of the system and the electromagnetic poles at the opposite ends of the system act together and the two hubs between which the helical spring is supported are each at opposite ends of the system.

The roll 42 is, however, freely supported upon the shaft 41. To this end there is provided upon the hub 67 two different groups of bearing surfaces. The hub 67 is provided with a plurality of extending webs 79, one set carrying a flat plate 80 at their ends upon which the roller 81 bears. The roller 81 is mounted in a support 82 fastened to the roll by the bolts 83. This support is provided with two bracket or forked elements 84 through which passes the pin 85 supporting the roll 81. Roller 81 is therefore free to roll in a direction parallel to shaft 41 on the track provided by the flat plate 80. At the other web 86 there is provided a plate 87 with two extending side pieces 88 and 89 in which a U-shaped frame 90 rests and against which the ball-bearing face 91 supported in the supporting element 92 by means of the pin 93 is free to roll in a direction perpendicular to the plane of the drawings.

In the operation of the system as shown in Figs. 3, 4 and 5 the current is passed to the coils 60 and 94 through the terminals 95 and 96 and this, in turn, tends to compress the helical spring 70, one end of which is held fast to the field piece 59 and the other to the electromagnet 75. The field piece 75 and the armature 56 act together while the field piece 59 and the armature 78 act together. The system thus consists essentially of the masses coupled together by a restoring force so that as alternating current is applied to the coils, a longitudinal vibration will be set up, the roll 42 forming a portion of one mass and the elements 59, 78 and 41 forming a substantial portion of the other mass. A vibration of the cylinder 42 in an axial direction at an amplitude which at resonance is proportional to the magnitude of the current in the coils and at a frequency which is determined by the masses of the two main elements of the vibrating system and the strength of the spring is obtained, which vibration is transmitted to the Fourdrinier wire which may be carried over the cylinder 42.

In Figs. 7 and 8 the roll 100 carries at one end a large mass 101 which fits firmly in the roll in a groove 102 and is held in position by means of a back plate 103 which is screwed into the end of the roll. A group of four pole pieces 104, 105, 106 and 107 are formed by laminations held fast to the plate 101 by bolts 108. Each one of the pole pieces may be surrounded with a coil 109 by which the magnetic circuit is energized.

The mass 101 is also fixed to the shaft 110 through the key 111 which rests in a groove in the shaft. Concentric with the shaft 110 is a sleeve 112 which is freely supported on the shaft through the ball bearings 113 and 114. The sleeve 112 carries a mass 115 which is formed in a neck portion 116 at the rear end. To this neck portion is fastened a spiral spring 117, the other end of which is fastened to the roll 100 by means of the rivets 118 or other suitable means. The roll 100 may also be supported on the shaft 110 in the end plate 119 which may be provided with a proper ball bearing 120. The sleeve 112 extends within the poles 104, 105, 106 and 107 and is provided with an armature 121 which, as shown in Fig. 7, is circular in shape as are the pole faces, and is separated from the poles 104, 105, 106 and 107 by an airgap of suitable dimensions.

The armature 121 may be conveniently provided with two windings which are disposed axially around the armature and which are at right angles to one another.

It will be clear from Fig. 7 that if the coils 109 on the poles 104, 105, 106 and 107 are properly connected together, the direction of flow of the flux can be made to be from poles 104 and 107 to poles 105 and 106 with a given direction of flow of the current through the windings.

Similarly, it will be clear that when current flows through the portion of winding 104' nearest to pole 104 in a direction perpendicular and toward the plane of the paper, it will be flowing in a direction perpendicular to and away from the plane of the paper in that portion of it which is nearest pole 106. Thus, when the direction of the flux in poles 104 and 107 is through the armature 121 and toward poles 105 and 106, the passage of current in the direction indicated in coil 121' will tend to produce a counter clockwise rotation of the armature 121.

A similar tendency toward rotation and in the same direction will take place when the current in that portion 107' of coil 122' which is nearest pole 107 is in a direction perpendicular to and toward the plane of the paper, and, furthermore, a tendency toward counter clockwise rotation of armature 121 will also be brought about by the flow away from the plane of the paper and perpendicular to it of the current in that portion 105' of coil 122' which is nearest to pole 105.

If the armature coils 121' and 122' are properly connected in series with the coils on poles 104, 105, 106 and 107, the tendency toward rotation about the axis 110 brought about by the flow of alternating current through the system will always be such as to tend to produce a counter clockwise rotation of armature 121. This force will, of course, be such as will tend to wind up spring 117 somewhat which will set up an oscillatory vibration of the two masses in the system about the axis 110 and in opposite directions, the amplitude of this vibration at resonance being proportional to the magnitude of the current in the windings and the frequency of the vibration being dependent upon the masses of the two major elements of the system and the strength of the spring.

This oscillatory motion about the axis of the shaft 110 would, of course, be transmitted to the Fourdrinier wire if the wire passes over this roll even though the roll were being rotated continually about the axis 110 due to the drive of the screen passing over it. Insofar as the motion of the screen is concerned, the oscillation of the roll about the axis 110 will give the effect of

alternately speeding up and slowing down the travel of the Fourdrinier wire as the wire is traveling towards the couch roll.

In any one of the modifications shown in the drawings the elements coupled by the elastic member are considered as having effectively separate masses, in one case this mass being made up by the effective mass of the roll and that portion of the screen which moves as a mass with it and any other masses in the system that are united to the roll before being coupled to the elastic element. If the mass associated on one side of the elastic system is equivalent to the mass associated on the other side of the elastic system, then the maximum transfer of energy will occur, and at the frequency of resonance for which the system is designed, the maximum vibratory energy at maximum amplitude will be transmitted to the roll and screen. This condition, while not always possible, is preferable and may be employed in the adjustment of the masses in any one of the modifications of the present invention.

Having now described my invention, I claim:

1. In a Fourdrinier paper machine, means for applying vibrations to the wire screen comprising a hollow roll, means including said roll forming two separate masses, one of said masses being within the roll, means providing elastic restoring force between said masses and means for applying mechanical vibrations to said system.

2. In a Fourdrinier paper machine, a roll adapted to be vibrated, a shaft on which said roll is supported, a plurality of masses, one of said masses having a portion including said roll and being attached therewith, means coupling said roll with another mass, means fixing said other mass to said shaft, means elastically coupling said masses together and means for applying vibrational energy to said shaft.

3. In a Fourdrinier paper machine, a roll, a shaft, means supporting said roll on said shaft, means elastically coupling said roll to said shaft and means applying vibrational energy to said shaft.

4. In a Fourdrinier paper machine, a roll, a shaft, means supporting said roll upon said shaft, means providing separate masses, one associated with said roll and the other with said shaft, means elastically coupling said masses together and means applying vibrational energy to one of said masses.

5. In a mechanism for vibrating a Fourdrinier wire horizontally and perpendicularly to the direction of travel of the wire, a vibrating system comprising a roll adapted to carry said wire, a mass, means adapted to provide elastic axial coupling between said roll and said mass and means adapted to energize said system.

6. In a mechanism for vibrating a Fourdrinier wire horizontally and perpendicularly to the direction of travel of the wire, a vibrating system comprising a roll adapted to carry said wire, a mass, means adapted to provide elastic axial coupling between said roll and said mass and means adapted to energize said system, said elastic coupling being adapted to insure resonance with said masses at the desired frequency of vibration.

7. In a mechanism for vibrating a Fourdrinier wire horizontally and perpendicularly to the direction of travel of the wire, a vibrating system comprising a roll adapted to carry said wire, a mass, means adapted to provide elastic axial coupling between said roll and said mass and electromagnetic means acting between said roll and said mass and adapted to energize said system.

8. The method of vibrating the wire in a Fourdrinier machine having a large mass which comprises providing means adapted to engage said wire, means adapted to elastically couple said wire-engaging means and said mass so as to form a vibrating system, and supplying energy to said system at the desired rate of vibration.

9. The method of vibrating a Fourdrinier wire in a direction along the line of travel of the wire which comprises engaging a portion of the wire with a roll adapted to oscillate about an axis parallel to the plane of and perpendicular to the line of travel of the wire and cause said roll to oscillate about said axis.

10. Means for effecting the torsional vibration of a mass about a given axis including a second mass adapted to vibrate about said axis, means adapted to provide elastic torsional coupling between said masses and means for energizing the system at the desired rate of vibration.

11. A method of effecting torsional vibration of a mass about a given axis, which comprises causing a second mass to oscillate about said axis, elastically coupling said second mass to said mass so as to form a vibrating system and supplying energy to said system at the desired rate of vibration.

12. In a Fourdrinier paper machine, a roll, a shaft, means freely supporting said roll upon said shaft, means providing two separate masses, means joining one of said masses to said roll, means joining the other of said masses to said shaft, means external of said roll for applying vibrational energy to said shaft.

13. In a Fourdrinier paper machine, a roll, a shaft, means freely supporting said roll on said shaft, means providing a mass attached to said roll, elastic means coupling said mass to said roll, means for producing vibrational motion and means coupling said means to said shaft, said means allowing free rotational motion of said shaft.

14. In a paper machine, means for applying vibrations to the wire screen comprising a roll having a shaft concentric therewith, means freely supporting said roll upon said shaft, electromagnetic means, means attaching one portion of said means to said roll, means attaching the other portion thereof to said shaft and means providing elastic axial coupling between said parts of said electromagetic means whereby the vibration of the roll is obtained axially thereof.

15. In a paper machine, means for applying vibrations to the wire screen comprising a roll, a shaft positioned concentric with said roll, means supporting said roll freely on said shaft to allow axial motion thereof, electromagntic means comprising in part pole elements and armature elements, means firmly securing one of said pole elements to the roll and means securing the other of said armature elements to the shaft and means having a restoring force coupling said electromagnetic means for setting up longitudinal vibrations of said roll.

16. In a paper machine, means for applying vibrations to the wire screen comprising a vibratory roll, means contained within said roll for vibrating the same comprising a shaft, means mounting said roll freely on said shaft, two sleeves mounted concentric with said shaft and one upon the other, two individual electromagnetic means each having an armature and a pole element, means rigidly uniting a pole element of one elec-

tromagnetic means and an armature of the other with each of said sleeves, means having restoring force coupling the parts of said electromagnetic means, means uniting one of said sleeves to said roll and means uniting the other of said sleeves to said shaft.

17. In a paper machine, a roll, a shaft concentric with said roll, means supported at one end of said roll having free bearing elements working on said shaft and means supported at the other end of said shaft providing a plurality of bearing surfaces, a plurality of free bearing elements mounted within said roll and adapted to engage said bearing surfaces and means contained within said roll for axially vibrating the same.

18. In a paper machine, a roll, a shaft positioned concentric with said roll, means for supporting said roll upon said shaft comprising means carried on said shaft having free bearing elements movable on said shaft, means carried at the other end of said shaft providing a plurality of individual bearing surfaces close to said roll and a plurality of free bearing elements mounted on said roll and adapted to engage said bearing surfaces, one group of said bearing surfaces of the roll and shaft being positioned to provide for longitudinal bearing elements and the other group for transverse bearing elements.

19. In a paper machine of the type described, a roll, a shaft positioned within said roll and concentric therewith, means freely supporting said roll on said shaft and means positioned within said roll for vibrating the same longitudinally of the shaft, a pair of electromagnetic elements comprising armatures and pole pieces positioned within said roll, means concentric with the shaft for connecting the armature of one pair with the pole of another pair of said electromagnetic elements, a helical spring and means supporting said helical spring between the connected elements.

20. In a paper machine of the type described, a roll having an end plate of a large mass, a shaft concentric with said roll and fixed thereto in said end mass, means forming a plurality of magnetic poles attached to said mass, an armature positioned within said poles, a sleeve mounted freely on said shaft supporting said armature, said sleeve having at one end a large mass and a spring element connecting said mass to said shaft.

21. In a paper machine of the type described, a roll, a plurality of masses positioned within said roll, one of said masses rigidly fixed thereto and means fixing the other of said masses to said roll through an elastic element and electromagnetic means positioned to act between said masses for exerting periodically rotational forces.

22. In a paper machine of the type described, a roll adapted to be rotated continuously, a plurality of masses positioned within said roll, means fixing one of said masses rigidly to said roll, means attaching the other of said masses to said roll through an elastic element, electromagnetic means providing a plurality of pole elements and an armature concentric therewith, means attaching one of said elements to the mass attached to said roll and means attaching the other of said elements to the mass indirectly attached to said roll.

23. In a paper machine of the type described, a roll adapted to be rotated continuously, a shaft supporting said roll, a plurality of masses positioned within said roll, means securing one of said masses to said roll, means securing a plurality of pole elements to said mass, an armature positioned to form an airgap concentric with said shaft, means securing said armature to another of said masses and elastic means attaching said mass to said roll.

24. In a Fourdrinier paper machine, means for applying vibrations to a wire screen comprising a roll, two masses free to be vibrated in at least one direction one of which may include said roll, means providing elastic restoring force coupled between said masses, said masses being of equal magnitude and means for applying mechanical vibrations to said system.

25. In a Fourdrinier paper machine, means for applying vibrations to a wire screen comprising a roll, two masses free to be vibrated at least in one direction, one mass of which may include said roll, means mechanically connecting said masses together including elastic means attached to each of said masses, said masses being of equal magnitudes and means for applying mechanical vibrations to said system.

26. In a paper machine, a roll, a shaft upon which said roll is mounted, means mounting the roll upon the shaft comprising end plates, one of said end plates being fixed to said shaft and being provided with bearing surfaces adjacent the roll and means attached to the roll for bearing on said bearing surfaces, some of said means providing bearing surfaces for longitudinal motion of the roll and some for rotational motion of the roll, the other of said end plates being attached to the roll and providing similar bearing surfaces on said shaft.

27. In a paper machine, a roll, a shaft concentric with the roll, a plurality of similar electromagnetic means comprising an armature surrounding the shaft and sloped at an angle thereto, a solenoid having an opening corresponding thereto, a coil positioned in the solenoid surrounding the armature, the armature of one electromagnetic means and the solenoid of the other being connected together, and one of said means being coupled to the shaft.

28. In a paper machine, a roll, a shaft concentric with said roll, a plurality of electromagnetic means positioned within the roll, said electromagnetic means comprising an armature and a solenoid surrounding the same, the solenoid of one means and the armature of the other means being rigidly connected as a unit and elastic means coupling the units together and means attaching one of the units to the roll.

29. In a paper machine, a roll, a shaft concentric with said roll, a plurality of electromagnetic means positioned within the roll, said electromagnetic means comprising an armature and a solenoid surrounding the same and both having the same axis as said shaft, the solenoid of one means and the armature of the other means being rigidly connected as a unit and elastic means coupling the units together and means attaching one of the units to the roll.

30. In a paper machine, a roll, a shaft concentric with the roll, a plurality of sleeves mounted concentric with said shaft, means supporting said first sleeve freely on the shaft and means supporting said second sleeve freely on the first, a plurality of electromagnetic means formed with a solenoid and an armature working therein, means including each of said sleeves for joining in a unit the armature of one electromagnetic means and the solenoid of the other electromagnetic means, means coupling one of said units to

the roll and elastic means coupling said units together.

31. In a paper machine, a roll, a shaft concentric with said roll, a plurality of electromagnetic means positioned within said roll, each comprising a solenoid and an armature having the same axis as said roll, a plurality of sleeves mounted concentric with said roll, each of said sleeves serving to join the armature of one of said electromagnetic means with the solenoid of the other, said electromagnetic means being positioned to effect longitudinal motion of said sleeve.

32. In a paper machine, a roll, a shaft concentric with said roll, a plurality of electromagnetic means positioned within said roll, each comprising a solenoid and an armature having the same axis as said roll, a plurality of sleeves mounted concentric with said roll, each of said sleeves serving to join the armature of one of said electromagnetic means with the solenoid of the other, said electromagnetic means being positioned to effect longitudinal motion of said sleeve, means joining one of said electromagnetic means to the roll and means freely mounting the other of said means on the shaft.

33. In a paper machine, a roll, a shaft concentric with said roll, a mass supported independently of said roll, elastic means coupling said mass with said shaft forming a vibratory sytem and means external thereof for supplying vibratory energy to the system in a direction longitudinal with said shaft.

34. In a system for vibrating a Fourdrinier paper machine, a roll over which the wire of said machine may pass, a shaft supporting said roll, a mass supported independently of said roll, elastic means coupling the roll and said mass forming a vibratory system, means for supplying energy to said vibratory system including a rotary driving means and a crank shaft eccentrically mounted with said driving means coupled to the vibratory system.

35. In a system for vibrating a Fourdrinier paper machine, a roll over which the wire of said machine may pass, a shaft supporting said roll, a mass supported independently of said roll, elastic means coupling the roll and said mass forming a vibratory system, means for vibrating said vibratory system including a rotary driving means, eccentric mounted therewith and a crank shaft connecting said eccentric with said vibratory system.

36. In a Fourdrinier paper machine, a roll adapted to be vibrated, a shaft concentric with said roll, a mass positioned independent of said roll but concentric with the same, elastic means coupling said mass with said roll, means coupling said roll with said shaft, means supplying rotary energy, an eccentric operated thereby, a crank shaft connecting said shaft with said eccentric for driving the same.

37. In a Fourdrinier paper machine, a roll adapted to be vibrated, electromagnetic means positioned in said roll including a solenoid fixed to said roll and an armature fixed to said shaft, means positioned within said roll adapted to provide a restoring force including a liquid container positioned within the roll and secured thereby, means formed in connection with said liquid container including a cylinder and a piston connected to be positioned to move within said cylinder and adapted to be reciprocated by said electromagnetic means.

38. In a paper making machine, a roll, means mounted to produce an oscillation of said roll including electromagnetic means having an armature and pole pieces adapted to produce a rotational motion, a mass coupling with one of said members and elastic coupling means joining said members together, one of said members being attached to said roll.

39. In a paper making machine, a roll, means mounted at the end of said roll including electromagnetic structure having pairs of opposite poles positioned concentrically, an armature mounted mounted therein concentric with said poles, a mass positioned normally to said armature and elastic coupling means comprising a leaf spring having one end attached to said mass and the other end to said roll.

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