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Yabe et al.

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[54] **ROLLER DRIVING SYSTEM FOR FEEDING SHEET MATERIALS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **271/272,** 198/127 R, 226/189, 354/321

[51] **Int. Cl.** **B65h 5/06**

[58] **Field of Search** ..... 271/51, 52, 53, 80, 272; 198/127 R; 226/189, 181; 354/317, 318, 321

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Assistant Examiner—James W. Miller
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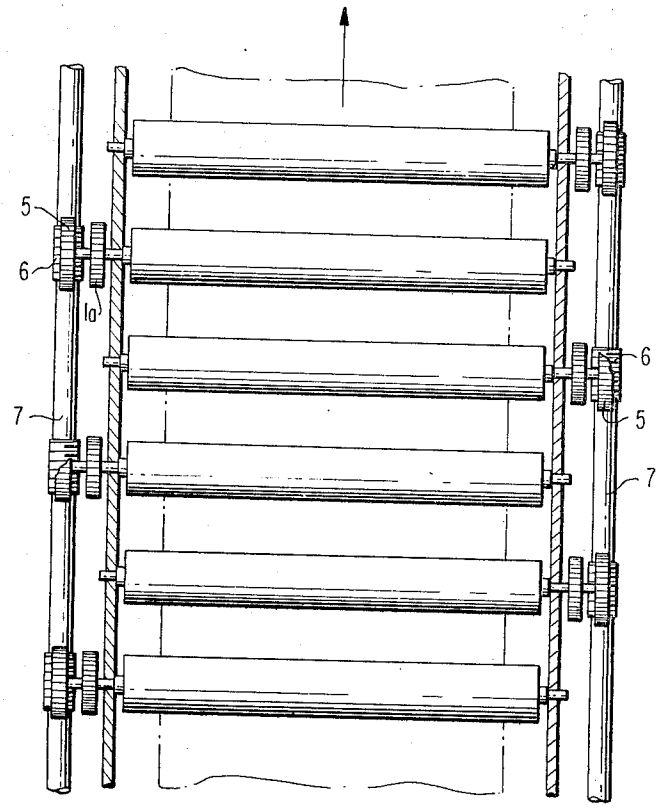
[57] **ABSTRACT**

In a roller driving system for feeding sheet materials comprising a plurality of roller pair units in series, the sheet material being passed from roller pair unit to roller pair unit by being nipped between the two rollers of a roller pair unit which are rotating in opposite directions with reference to each other, at least one roller of a roller pair being driven by driving means, the improvement wherein the number of the driving means on one side of at least a portion of the roller system is substantially the same as the number of driving means on the other side of the roller system, such that across any two alternate roller pair units the nipping pressure applied to the sheet material in a direction perpendicular to and across the direction of sheet material flow is substantially equal.

2 Claims, 7 Drawing Figures



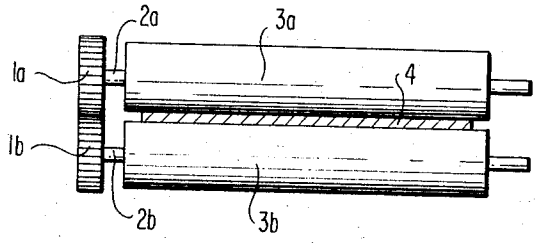
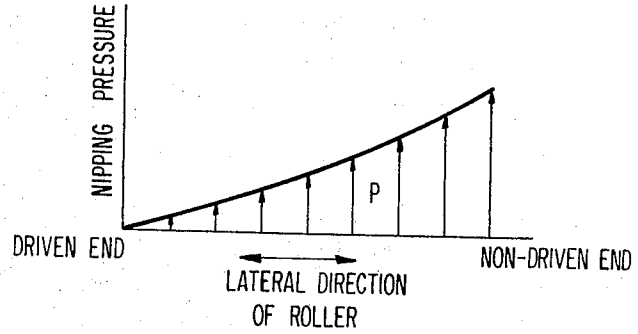


FIG. 1

FIG. 2



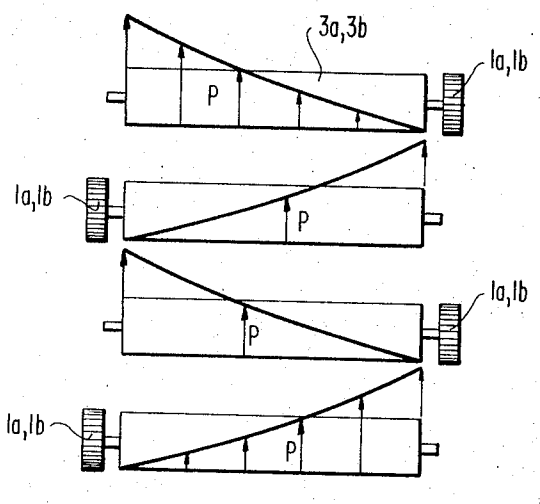


FIG. 3

FIG. 7

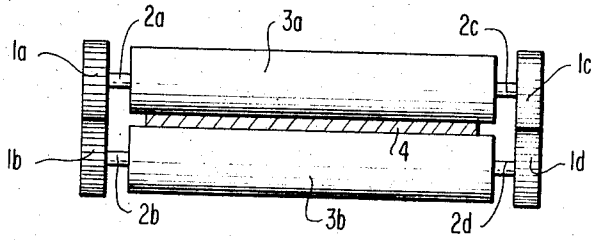


FIG 6

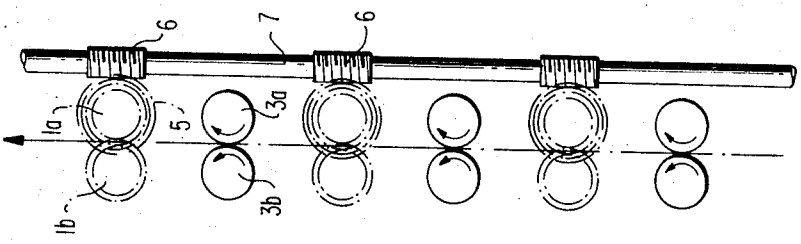


FIG 5

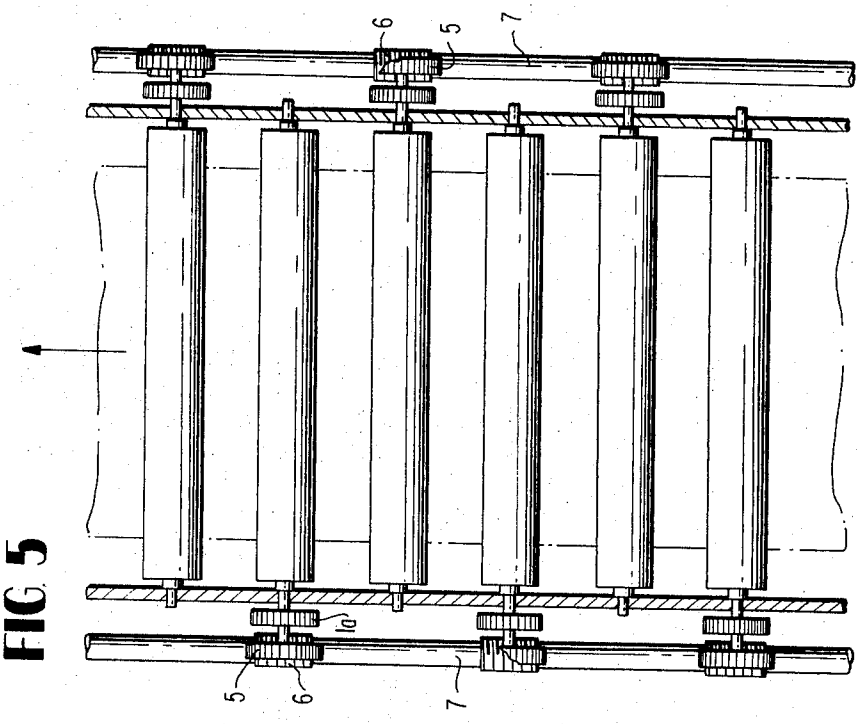
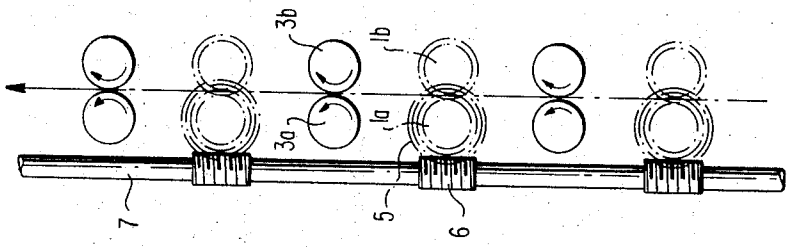


FIG 4



ROLLER DRIVING SYSTEM FOR FEEDING SHEET MATERIALS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a driving system for one or more pairs of rollers for feeding sheet materials, more particularly to an improved driving arrangement for one or more pair of rollers in a sheet material feeding system in which sheet materials as well as web materials (hereinafter all such materials are called "sheet material" in this specification) are fed for processing.

2. Description of the Prior Art

In a roller sheet material feeding system in which some pairs of rollers are arranged in parallel, the pressure of nipping by different pairs of rollers is not uniform from end to end. The individual rollers in a roller are rotated in opposite directions by driving means which usually consists of a pair of meshed gears, one of which is driven to drive the other. The gears are usually fixed to one end of the shafts of the rollers, the other end of the shafts being rotatably supported by supporting means. Usually in such systems the position of the supported end of the shafts is stationarily fixed. The pressure of nipping is higher at the stationarily fixed end of the shafts than at the driven end of the shafts, which is believed to be due to the fact that the pressure of nipping at the driven side of the rollers is lowered due to a repelling effect set up between the driving means, e.g., meshing gears.

Because of the nonuniformity in nipping pressure, a process such as an electrophotographic development process performed during the feeding operation of the sheet material cannot be uniformly conducted from side to side of the sheet material. This is a great disadvantage for roller sheet material feeding systems of the type described above.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a driving system for sheet material roller feeding systems in which the nipping pressure of the rollers is uniform across one or more roller pairs.

Another object of the present invention is to provide a driving system for sheet material roller feeding systems in which fluid application onto the sheet material can be performed uniformly from end to end of the sheet material.

The above objects of the present invention are met by apparatus wherein roller driving means are balanced across a pair of rollers, or adjacent pairs of rollers, so as to equalize the applied pressure in a direction along the long axis of the rollers over a pair of rollers or over adjacent pairs of rollers.

Other objects, features and advantages of the invention will be made more explicit from the following description of the preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view showing a pair of rollers nipping a sheet material.

FIG. **2** is a graphical representation showing the distribution of the nipping pressure between a pair of rollers and the lateral position of the rollers.

FIG. **3** is a plan view showing a pair of rollers with a driving system in accordance with the present invention illustrated together with complementary graphs showing the lateral distribution of the nipping pressure along the rollers.

FIG. **4** is a left side view of one embodiment of the invention.

FIG. **5** is a plan view of the embodiment of FIG. **4**.

FIG. **6** is a right side view of the embodiment of FIG. **6**.

FIG. **7** is a front view showing a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, a pair of gears **1**a and **1**b are fixed to an end of shafts **2***a* and **2***b* protruding from rollers **3***a* and **3***b*. A sheet material **4** is shown nipped therebetween. The other end of shafts **2***a* and **2***b* of the rollers are supported in stationary supporting means (not shown) such as bearings or holes provided in an end plate. The pressure of nipping exerted by the rollers on sheet material **4** has been proven to be as shown in the graph FIG. **2**, wherein the pressure (*p*) of nipping increases from the driven end of the rollers to the non-driven end of the rollers.

In the present invention, the roller pair **3***a* and **3***b* is arranged so that the total nipping pressure is equal from end to end, as shown in FIG. **3**, by changing the driven side of the roller in the roller pair. As will be readily seen from the graphs provided in FIG. **3**, the sum of the nipping pressure (*p*) at any one position along the nipping surface of the roller pair is substantially equal to the sum of the nipping pressure exerted at other positions along the nipping surface. The total nipping pressure exerted on any one position of the sheet material is made substantially equal to that exerted on any other positions by making the number of driving gears on one side of the roller pair equal to the number of driving gears on the other side of the roller pair.

In a preferred embodiment as is shown in FIGS. **4** to **6**, the end of the shaft of the roller is further provided with a worm wheel **5** at the driving gear side thereof. In this embodiment, shaft **2***a* or **2***b* is driven by the worm wheel **5** which is rotated by a worm **6** meshed therewith. The worm **6** is mounted on a drive shaft **7**. As shown in FIG. **5**, a pair of drive shafts **7** are arranged on both sides of the roller system and a plurality of worms **6** are mounted on each of the drive shafts **7**. The worm wheels **5** are mounted so as to engage the right and left ends of the shafts on an alternating basis. Accordingly, the number of the right side worm wheels **5** is equal to that of the left side worm wheels **5**. The non-driven roller is driven by frictional engagement with the driven roller, and is usually spring biased thereagainst. FIG. **7** shows yet another embodiment of the invention where a roller pair **3***a*, **3***b*, having a sheet material **4** nipped therebetween are shown driven not only by gears **1***a* and **1***b* via shafts **2***a* and **2***b*, but also by gears **1***c* and **1***d* via shafts **2***c* and **2***d*, respectively.

Although the above description has been made with reference to a particular embodiment of the invention, it will be understood that the present invention finds use where the roller shafts are driven by any type of driving means, i.e., the driving means need not be a worm or spur gear system, but can be any equivalent means such as frictionally engaged wheels, a belt drive, etc.

From the above description it will be apparent that the essential concept of the present invention involves balancing the driving means over a roller pair or roller pairs.

In the Examples described, driving occurs on alternative sides of the upper and lower roller in a roller pair, on alternate sides of one roller of adjacent pairs of rollers or driving occur from both sides of both rollers in a single roller pair. It will be clear to one skilled in the art that systems could be used where various embodiments as described above are combined in a single processing line.

It will further be apparent that where a balance of nipping pressure is required in only a certain part of the sheet material feeding system, the remainder of the system need not be balanced, but can be in accordance with prior art systems.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

What is claimed is:

1. In a roller driving system for feeding sheet materials comprising: a plurality of roller pair units in series, each roller pair unit comprising rollers on opposite sides of said sheet material, rotating in opposite directions with reference to each other and frictionally driving said sheet material by nipping said sheet material between the two rollers of said roller pair units to pass said sheet material from roller pair unit to roller pair unit, the improvement comprising: each of said roller pair units being driven from one side only with each roller of said roller pair units carrying a gear to the same side thereof and in mesh with one another with one roller of a given roller pair unit driven by the other, the axes of said rollers for each roller pair unit defining a plane which is at right angles to the plane of sheet material moving between the rollers of the roller pair units, drive shafts extending along the direction in which the sheet materials are fed on each side of the roller pair units, gears carried by said drive shafts at locations corresponding to given roller pair units and in mesh with a gear carried by one of said rollers for each roller pair unit, the improvement wherein: each of said roller pair units is driven from one side only, and said roller pair units are driven alternately from opposite sides by way of said drive shafts and the gears carried thereby such that the nipping pressure applied to said sheet material as it progresses through said system from roller pair unit to roller pair unit is balanced.

2. The roller driving system as claimed in claim **1**, wherein: said gears carried by said drive shaft comprise worms in mesh with the gear at the end of said given roller for each roller pair unit.

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