

**A DRIVE SYSTEM
FOR A PRINTING MACHINE**

THIS INVENTION concerns a drive system, for a printing machine of the kind used for printing a design or information onto paperboard box blanks and including a print cylinder and an impression roll rotatable on parallel axes and forming a nip for the introduction of a blank upon which the design or information is to be printed, and an anilox roll rotatable in engagement with the print cylinder to apply a printing medium thereto.

Conventionally, in a typical machine line for the production of printed paperboard blanks, there is provided an in-feed conveyor, one or more flexographic printing machines, a rotary die cutter and a machine for folding and gluing the blanks to produce formed and collapsed paperboard boxes. The machine line may include several flexographic printing machines arranged in series in the line, and it has been common practice until recently to provide a single large DC electric motor with thyristor drive, and a spur gear train running through the entire machine line thus to synchronise the drive to the various machines. Such an arrangement suffers from the disadvantage that spur gears are noisy in operation and cannot achieve high accuracy of drive register. Also, the use of spur gears when printing fine grade substrates, tends to produce so-called "barring marks" and poor dot gain owing to the somewhat unsinooth operation of the machines when driven through a spur gear train.

Such conventional machines have been used for producing

box blanks with simple printing requirements where accurate register is not essential. The blanks pass through a line of machinery of this kind typically at speeds in the region of 300 metres per minute.

Therefore, where close register fine printed corrugated cases were required it was necessary to produce pre-printed liners using a flat bed printer and then to bond the liners subsequently to the box blanks.

More recently, a drive system was developed for continuous flexographic printing machinery in which each printing machine in a line was driven by a separate microprocessor-controlled brushless DC servo motor driving three rotary members through a train of helical gears thus facilitating smoother and more accurate register control. In general, barring marks and poor dot gain were overcome by the use of this improved drive system but a further disadvantage remained in that the three rotary members of each machine are geared together at a fixed ratio. It is known that the corrugated board upon which the impression is to be made can vary in thickness, and the printing plates or stereotypes which carry the image to be printed can change after a period of use. Other factors can determine the effective thickness of the printing plates on the cylinders such as the double-sided adhesive tape commonly used to attach the plates to the cylinder.

These varying or changing parameters can affect the peripheral speeds at key points in the machine so that, for example, if



the printing stereo thickness reduces, then its peripheral speed will reduce with respect to that of the impression or conveying roller, resulting in a shorter print length on the board. Also, when the distance between the rotational axes of the impression roller and printing cylinder require adjustment owing to a different board thickness, then again the peripheral speeds within the machine are not matched to board speed, resulting an incorrect print length being produced.

An object of the present invention is to provide a drive system for a printing machine including interactive rotary print cylinder, impression roll and anilox roll, in which the aforementioned disadvantages and problems are substantially avoided and overcome.

According to the present invention there is provided a printing machine having rotary members including a printing cylinder and an impression roll rotatable on parallel axes and forming a nip for the introduction of a sheet of material upon which a design or information is to be printed, and an anilox roll rotatable in engagement with the print cylinder to apply a printing medium thereto; characterised in that a drive system for the machine includes separate drive motors connected individually to the print cylinder, the impression roll and the anilox roll respectively; and in that each motor is further connected to a separate speed controller.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which:-

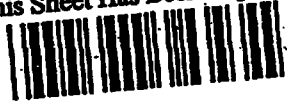


Fig. 1 shows a typical machine line for producing formed but collapsed paperboard boxes.

Fig. 2 illustrates a known form of drive system for a flexographic printing machine of the type which may be included in the machine line illustrated in Fig. 1.

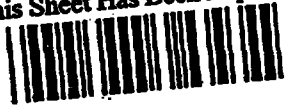
and Fig. 3 is of similar view to Fig. 2 but showing a drive system made in accordance with the present invention.

In a typical machine line there may be provided an in-feed or conveying unit 10 having a pair of rolls 11 forming a nip to transfer successive board blanks to a first flexographic print unit 12 which includes a printing cylinder 13, an impression roll 14 and an anilox inking roll 15.

The production line may then include one or more further flexographic print units such as that illustrated at 16.

After the final print unit there is placed a rotary die cutter 17 for cutting and/or creasing the printed blanks, and having a rotary die drum 18 and an anvil cylinder 19. Finally a machine 20 may be provided for folding and gluing the flaps of the blanks to enable them to be formed into formed but collapsed boxes.

Referring now to Fig. 2, a known drive system for a

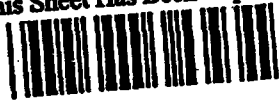


flexographic printing unit might consist of a single brushless DC servo motor 21 controlled by an analogue DC servo drive unit 22 under the command of a microprocessor control system 23.

The motor 21 may drive, through a train of gears, the shaft 24 of the print cylinder 13. At the other end of the cylinder its shaft is connected via a further gear train 25 to the drive shafts of the impression roll 14 and the anilox roll 15.

In accordance with the invention, an improved drive system for a flexographic print unit comprises three separate "frameless" brushless DC servo motors 30, 31 and 32 each connected directly to the shaft of one of the rotary members 13, 14 and 15. No drive transmission gears are required since each motor shaft is directly coupled to its respective cylinder/roll shaft. Each motor is connected to a separate digital speed controller 33 all of which are under the command of a microprocessor control system 34. Preferably, an optical fibre communication network represented by lines 35 will exist such that the microprocessor of control system 34 will maintain control of all of the flexographic printing machines and indeed all of the other machines in the line such that the operation is synchronised to optimise performance. The microprocessor control system will produce real time position demand information for each brushless DC servo drive, via the high speed fibre optic communications link 35.

The DSP-based digital drive will also be used to provide accurate position way points allowing the anilox rolls to be raised to



printing position at precisely controlled instants in time, thus permitting accurate single or double stereo ink-ups.

The DSP in each digital DC servo drive will use this information to control its own local position control system, thus providing accurate register control. The control system has the ability to vary infinitely the position demands sent to individual drives so that, in effect, an "electronic gearbox" is introduced allowing the operator to set the speed relationships of the separate drives individually to a virtual master reference.

The intelligent control system will automatically switch the operating mode of the anilox roll drives between an idle mode and a velocity-synchronisation mode as the machine passes through a pre-defined crawl speed. Therefore, below this crawl speed, the anilox roll will idle so that the ink does not dry on the anilox roll. Above this crawl speed the anilox roll will be velocity-synchronised to the virtual master.

Since each rotary member of each printing machine is separately driven by an independent motor, electronic speed control may be imposed upon each member, and its specific speed of rotation may be set by the microprocessor control system. In operation, the speed of the print cylinder is predetermined, and those of the impression roll and anilox roll are set accordingly to compensate for any deviation in board thickness or printing plate thickness.



The use of separate frameless motors and digital drives in a flexographic printing machine will ensure increased register accuracy and much greater machine flexibility due to the precise independent speed control of the impression and anilox rolls. Greater register accuracy will be obtained owing to the use of digital servo drives permitting higher position loop proportional gains.

An operator will be able to adjust the impression roll and anilox roll speeds by a simple data entry on the microprocessor control system. Data will be entered representing the actual printed length and the required printed length, and the computer will calculate and determine the speeds of the impression and anilox rolls accordingly.

Furthermore, the use of frameless motors without gear or other drive transmission means simplifies the manufacturing process of the machinery since expensive gears are avoided and replaced by simple bearings. Also, the avoidance of gears overcomes the problems of backlash and unsmooth and noisy operation.

In a line of machines such as illustrated in Fig. 1, the print cylinders of the several print units will be operated under positional control, i.e. phase synchronised thus to ensure registration between the machines, whilst the impression and anilox rolls will be operated under velocity control, i.e. velocity synchronised and as such will rotate at a velocity to match that of the printing cylinders.

As can be seen from Fig. 1, an entire machine line may

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be controlled by a single microprocessor control system 50 conveniently connected by optical fibres to the plurality of digital speed controllers generally indicated at 51, each controllably connected to one of the several drive motors within the system. The system provides flexible operator control and extremely accurate print registration previously not possible with single motors drivingly connected to several rotary members.

Whilst the invention is particularly applicable to flexographic printing machines, it can nevertheless be applied to any machine in which several rotary members are provided which must interact one with another and/or with a substrate to be processed.

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CLAIMS

1. A printing machine having rotary members including a printing cylinder and an impression roll rotatable on parallel axes and forming a nip for the introduction of a sheet of material upon which a design or information is to be printed, and an anilox roll rotatable in engagement with the print cylinder to apply a printing medium thereto; characterised in that a drive system for the machine includes separate drive motors connected to the print cylinder, the impression roll and the anilox roll respectively; and in that each motor is further connected to a separate speed controller.

2. A printing machine according to Claim 1, further characterised in that said separate drive motors are frameless brushless DC servo motors each connected directly to the shaft of one of the rotary members.

3. A printing machine according to Claim 1 or Claim 2, wherein each said speed controller is a digital speed controller, and all of which are connected for operation to a micro-processor control system.

4. A printing machine according to any preceding claim, being one of a plurality of printing machines in a line of machinery wherein each machine is connected to a separate digital speed controller each of which is connected to a common micro-processor control system adapted to control and synchronise the operation of





the plurality of machines.

5. A printing machine according to Claim 3 or Claim 4, wherein said micro-processor control system is connected to said plurality of digital speed controllers by optical fibres.

6. A printing machine according to any one of Claims 3 to 5, wherein said micro-processor control system is adapted to produce real time position demand information for each of the separate drive motors such that this information may be used by each motor to control its own local position control system, thus providing accurate register control.

7. A printing machine according to Claim 6, wherein the micro-processor control system is adapted to vary infinitely the position demands sent to each individual drive motor whereby an operator can set the speed relationships of the separate drive motors individually to a virtual master reference.

8. A printing machine according to any one of Claims 3 to 7, wherein the micro-processor control system is adapted to switch the operating mode of the anilox roll automatically between an idle mode and a velocity-synchronisation mode such that a crawl speed the anilox roll will continue to rotate at a slow speed thus preventing ink from drying on the roll, and whereby above a predetermined crawl speed the anilox roll will become velocity synchronised to the virtual master.



9. A printing machine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



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