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(54) An apparatus and a method of printing a workpiece

(57) A printing apparatus is disclosed as including at least one printing pad (6) movable downward to print a workpiece (10), an electronic optical sensor (14) for measuring the speed of the printing pad (6) in the downward direction, an integrated circuit for comparing the average speed of the printing pad (6) in the downward direction through an initial first predetermined distance with the speed of the printing pad (6) in the downward direction beyond the first predetermined distance, and when the speed of the printing pad (6) in the downward direction beyond the first predetermined distance falls below the average speed, the printing pad (6) is movable further downward a second predetermined distance.

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Description

This invention relates to an apparatus and a method of printing a workpiece, and in particular a pad printing apparatus and a method of printing a workpiece with such a pad printing apparatus.

Conventional pad printing apparatus are set with a specific stroke depth (i.e. the distance travelled by the printing pad from its uppermost stationary position to the position when the printing action is complete) for each print task. When there is a new print task, the print stroke may have to be adjusted in order to suit the size or shape of the workpiece to be printed. If the quantity of each print task is not large, such may require frequent adjustments of the stroke depth, thus reducing the efficiency, and increasing the cost, of the printing process.

Ways have therefore been devised to provide pad printing apparatus with variable stroke depth, in the hope of addressing such a problem. In one such arrangement, the printing pad is engaged with a stationary part of the pad printing apparatus via a number of springs. Movement of the printing pad is sensed by a mechanical sensor. through a compressed spring. When the printing pad has moved through a predetermined distance, movement thereof is halted and reversed. Such an arrangement has to be manually adjusted every time there is a new print task. The performance of such a system also deteriorates rapidly by reason of mechanical failure of the springs through use.

A second arrangement is to arrange for an electronic pressure sensor to monitor the pressure within the pneumatic cylinder which drives the printing pad. Theoretically, the incoming and outgoing pressures of the pneumatic cylinder are the same such that there is no pressure difference. However, when the printing pad touches the workpiece to be printed, a back pressure is created which causes a difference in pressure, which is sensed by the pressure sensor. Corresponding signals are then transmitted to an integrated circuit which then causes the printing pad to reverse its direction of movement. Experience indicates that such an arrangement is not reliable and, in particular, the pressure sensor breaks down frequently.

It is therefore an object of the present invention to provide a printing apparatus and a method of printing a workpiece in which the aforesaid shortcomings are mitigated or at least to provide a useful alternative to the public.

According to a first aspect of the present invention, there is provided a printing apparatus comprising at least one printing member movable in a first direction to print a workpiece, characterized in that said printing apparatus further comprises sensing means for measuring the speed of said printing member in said first direction, comparing means for comparing the average speed of said printing member in said first direction through an initial first predetermined distance with the speed of said printing member in said first direction beyond said first predetermined distance, wherein when the speed of said printing member in said first direction beyond said first predetermined distance falls below said average speed, said printing member is movable further in said first direction a second predetermined distance.

According to a second aspect of the present invention, there is provided a method of printing a workpiece comprising the steps of (a) moving a printing member of a printing apparatus in a first direction towards said workpiece; characterized in that the method further comprises the steps of (b) measuring the speed of said printing member in said first direction; (c) calculating the average speed of said printing member in said first direction through an initial first predetermined distance; (d) comparing said average speed with the speed of said printing member in said first direction beyond said first predetermined distance; and (e) moving said printing member further in said first direction a second predetermined distance to print said workpiece when the speed of said printing member in said first direction beyond said first predetermined distance falls below said average speed.

An embodiment of the present invention will now be described by way of the accompanying drawings wherein: -

Fig. 1 is a side view of a part of a pad printing apparatus in which the printing pad is in its uppermost stationary position;

Fig. 2 is a further side view of the part of the pad printing apparatus shown in Fig. 1 in which the printing pad just touches a workpiece;

Fig. 3 is a further side view of the part of the pad printing apparatus shown in Fig. 1 in which the printing pad is at its lowermost position; and

Fig 4 is a side view corresponding to Fig. 1 with an ink source.

For clarity purposes, only a pertinent part of a pad printing apparatus is shown in Figs. 1 to 4. This pertinent part may be used in such pad printing apparatus as shown in GB 2305633 A1 to form a printing apparatus according to the present invention. In particular, this pertinent part may be used in pad printing apparatus which are pneumatically operated, hydraulically operated or motorized.

As shown in Fig. 1, a pneumatic cylinder 2 is fixedly engaged with a stationary platform 4. The pneumatic cylinder 2 is operable to move a printing pad 6 via a rod 8. Directly below the printing pad 6 is a target object 10, which may be a workpiece to be printed. The printing pad 6 is fixedly engaged with an optical scale 12 the movement of which is sensed by an optical sensor 14 connected to a central processing unit (CPU) (not shown), such as an integrated circuit (IC), which acts as

a controller. While a number of different microprocessors (integrated circuits) may be used as the controller, a possible choice is Model No. 89C52 of Intel Corporation of the US. In addition, while a number of different optical sensors may be used, a possible choice is Model No. EE-SX672 of Omron Industry of Japan.

The mode of operation of the pad printing apparatus is as follows. When the printing pad 6 descends from its uppermost position as shown in Fig. 1, it brings about a corresponding downward movement of the optical scale 12, which is sensed by the optical sensor 14. The optical sensor 14 then monitors the movement of the optical scale 12 through a first predetermined distance, e.g. 20mm, which is set by the manufacturer of the printing apparatus. The average velocity of the printing pad 6 through this initial 20mm will then be calculated by the CPU and stored as a reference speed. Through further downward movement of the printing pad 6, it will reach the position shown in Fig. 2 where it just touches the target object 10. In this position, due to the resistance of the target object 10, the speed of the downward movement of the printing pad 6 will drop significantly to below the reference speed.

Once the speed of the downward movement of the printing pad 6 is below the reference speed, such is sensed by the optical sensor 14 and a signal is sent to the controller. The controller will then send a signal which causes the printing pad 6 to move downward a second predetermined distance, which may be set by the user to suit the requirements of each print task. After travelling through the second predetermined distance, the printing pad 6 is retracted back to the position as shown in Fig. 1.

This clearly illustrates that provided the upper surface of the target object 10 is below the printing pad 6 by more than the first predetermined distance, i.e. 20mm in the above discussion, it is possible to arrange for the printing pad 6 to press against the target object 10 by a fixed distance, namely the second predetermined distance, irrespective of the actual distance of the target object 10 from the printing pad 6 when in its uppermost position. If the target object 10 is a workpiece to be printed, a consistent and uniform image may thereby be printed thereon irrespective of its distance from the printing pad 6.

As shown in Fig. 4, below the printing pad 6 is an ink source, e.g. an ink tray 16, which may be reciprocated in the directions of the arrows, between a first position in which it is below the printing pad 6 (as shown in dotted line), and a second position (as shown in solid line) in which the printing pad 6 may descend to print a workpiece 10. The ink tray 16, when in its first position, is more than 20mm below the printing pad 6. In this arrangement, the ink tray 16 is first moved to the first position, the printing pad 6 then descends to pick up an inked image from the ink tray 16, and then ascends back to the uppermost position. The ink tray 16 then moves to its second position, whereupon the printing pad 6 descends to print the workpiece 10 and then ascends back to its uppermost position, ready to start the cycle again. Due to the arrangement described in previous paragraphs, the image picked up from the ink tray 16 will be substantially identical to that printed on the workpiece 10, as the same pressure is applied when picking up the image and printing the workpiece 10.

It should be understood that the above only illustrates an embodiment in which the present invention may be carried out, and that various modifications and alterations may be made thereto without departing from the spirit of the invention.

Claims

1. A printing apparatus comprising at least one printing member movable in a first direction to print a workpiece, characterized in that said printing apparatus further comprises sensing means for measuring the speed of said printing member in said first direction, comparing means for comparing the average speed of said printing member in said first direction through an initial first predetermined distance with the speed of said printing member in said first direction beyond said first predetermined distance, wherein when the speed of said printing member in said first direction beyond said first predetermined distance falls below said average speed, said printing member is movable further in said first direction a second predetermined distance.

2. A printing apparatus according to Claim 1 further characterized in that said printing member is movable in a second direction after said further movement in said first direction through said second predetermined distance.

3. A printing apparatus according to Claim 2 further characterized in that said first direction is substantially opposite to said second direction.

4. A printing apparatus according to Claim 2 or 3 further characterized in that said first direction is substantially downward.

5. A printing apparatus according to any of the preceding claims further characterized in that said sensing means comprises an electronic optical sensor.

6. A printing apparatus according to any of the preceding claims further characterized in that said printing member is directly or indirectly fixedly engaged with a scale member.

7. A printing apparatus according to Claim 6 further characterized in that said sensing means measures

said speed of movement of said printing member by measuring the speed of movement of said scale member.

8. A printing apparatus according to any of the preceding claims further characterized in that said apparatus is pneumatically operated.

9. A printing apparatus according to any one of Claims 1 to 7 further characterized in that said apparatus is hydraulically operated.

10. A printing apparatus according to any one of Claims 1 to 7 further characterized in that said apparatus is motorized.

11. A printing apparatus according to any of the preceding claims further characterized in that said printing apparatus is a pad printing apparatus.

12. A method of printing a workpiece comprising the steps of:-

(a) moving a printing member of a printing apparatus in a first direction towards said workpiece;

characterized in that the method further comprises the steps of: -

(b) measuring the speed of said printing member in said first direction;

(c) calculating the average speed of said printing member in said first direction through an initial first predetermined distance;

(d) comparing said average speed with the speed of said printing member in said first direction beyond said first predetermined distance; and

(e) moving said printing member further in said first direction a second predetermined distance to print said workpiece when the speed of said printing member in said first direction beyond said first predetermined distance falls below said average speed.

13. A method according to Claim 12 further characterized in comprising the step of moving said printing member in a second direction after moving said printing member in said first direction said second predetermined distance.

14. A method according to Claim 13 further characterized in that said first direction is substantially opposite to said second direction.

15. A method according to Claim 12, 13 or 14 further characterized in that said first direction is substantially downward.

16. A method according to Claim 12, 13, 14 or 15 further characterized in comprising the steps of: -

(f) moving said printing member in said first direction towards an ink source;

(g) measuring the speed of said printing member in said first direction;

(h) calculating the average speed of the printing member in said first direction through said initial first predetermined distance;

(i) comparing said average speed with speed of said printing member in said first direction beyond said first predetermined distance; and

(j) moving said printing member further in said first direction said second predetermined distance to pick up said ink when the speed of said printing member in said first direction beyond said first predetermined distance falls below said average speed.

17. A method according to Claim 16 further characterized in comprising the step of moving said printing member in said second direction after moving said printing member in said first direction said second predetermined distance.

18. A method according to any one of Claims 12 to 17 further characterized in that the printing apparatus is a pad printing apparatus.

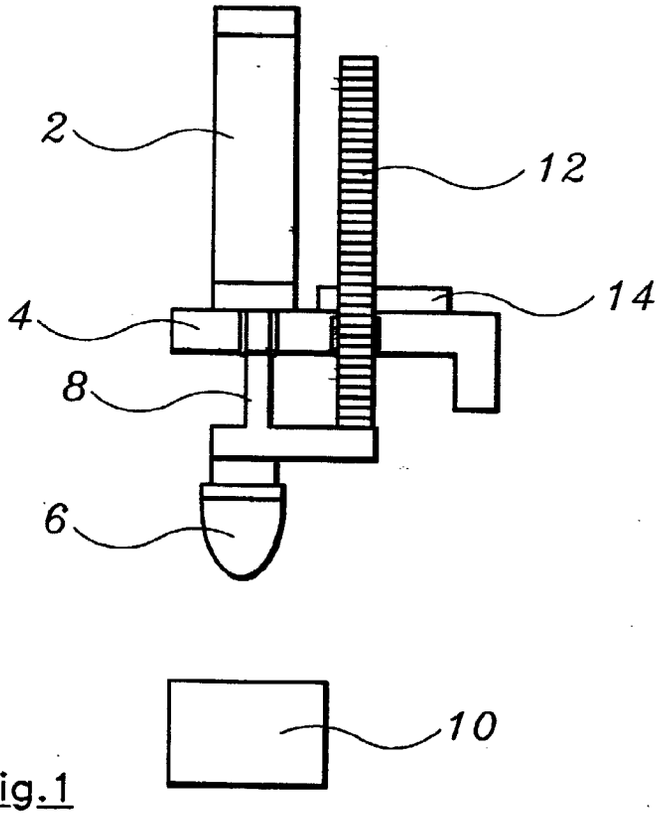

Fig.1

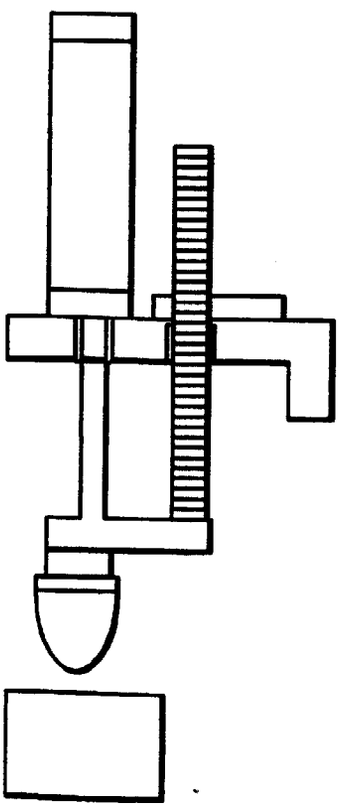

Fig.2

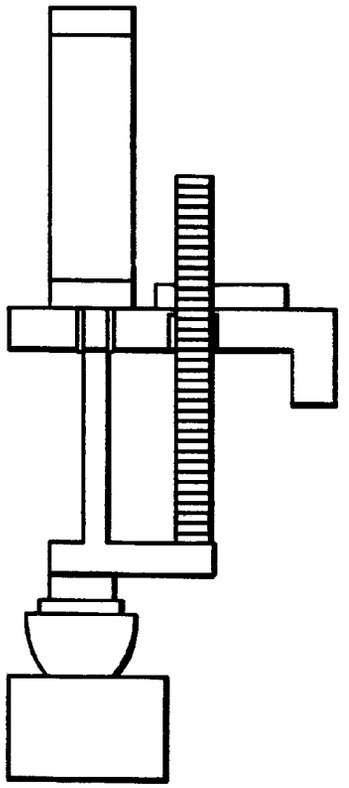

Fig.3

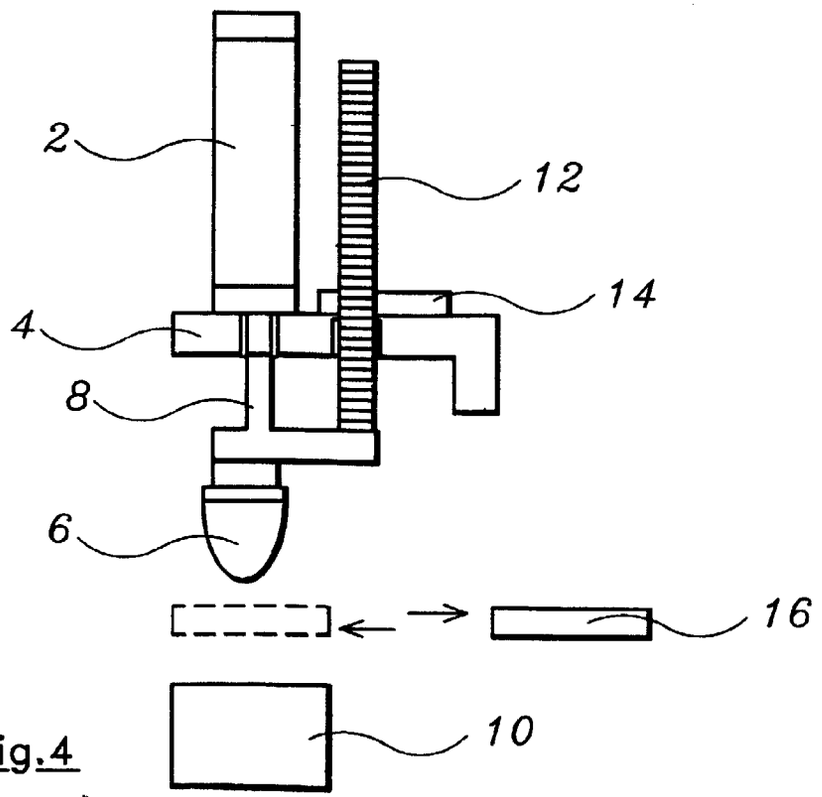

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 2411

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP 0 677 385 A (MÜHLHÄUSSER, ALEXANDER) 18 October 1995 see abstract * column 1, line 47 - column 4, line 19; claims 1-9; figures 1-5 *	1-18	B41F17/00
Y	EP 0 581 096 A (MARKEM CORPORATION) 2 February 1994 see abstract * page 1, line 3 - page 10, line 57 *	1-7, 10-15, 18	
Y	DE 21 54 671 A (RIDGWAY POTTERIES LTD.) 25 May 1972 * page 4, paragraph 2 - page 8, paragraph 2; figures 1-5 *	8,9	
Y	EP 0 472 021 A (PORZELLANFABRIK SCHIRNDING AG) 26 February 1992 see abstract * column 1, line 1 - column 12, line 29; figures 1-4 *	16,17	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	DE 195 10 677 A (MÜHLHÄUSSER, ALEXANDER) 2 October 1996 see abstract * column 1, line 3 - column 3, line 27; figures 1,2 *	1-18	B41F B41K
A,D	GB 2 305 633 A (WANG MAN DAVID HO) 16 April 1997 see abstract * page 6, line 1 - line 19; figures 1-3 *	1-18	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	31 August 1998	Greiner, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
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