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(54) **Mosaic printing head with cross-talk prevention means.**

(57) A mosaic printing head with cross talk prevention means comprises a plurality of electromagnetic structure formed by magnetic circuits (39), each coupled to a coil (41) and closed by a movable armature (43), which at rest leave an air gap in the magnetic circuit.

The magnetic circuits are radially distributed on a supporting member, very closely together at least with a certain portion.

The flux leakage which occurs in these portions, due to the proximity of such portions, is avoided by using conductive non magnetic shields (42) partially surrounding such portions.

The shields dynamically limit flux leakage transients, i.e. during the attraction of the armature, due to the eddy currents induced by flux leakage.

The shields are designed in order to be coupled with flux leakages and not with the main flux in the magnetic circuit.

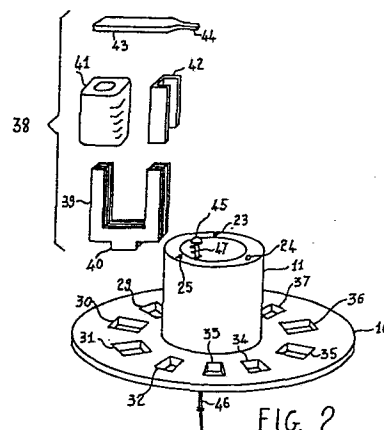


FIG. 2

Mosaic printing head with cross-talk prevention means.

The present invention relates to a mosaic printing head with cross-talk preventing means in the electromagnetic structures of the printing head, the cross-talk limiting the printing speed.

A mosaic printing head generally comprises a needle guide assembly
5 and a plurality of electromagnetic structures coupled to the guide assembly.

The electromagnetic structures are mounted on an electromagnetic support and each structure includes a magnetic circuit formed by two pole pieces connected by a yoke and by a movable armature which completes the magnetic circuit. It further includes at least a coil wound
10 around one of the two pole pieces.

Each of the electromagnetic structures acts as an activator for one of the printing needles. To this purpose, each movable armature is provided with at least an arm which protudes externally to the electromagnetic structure and operates as an actuating arm for the associated
15 needle.

Generally the electromagnetic structures are radially arranged on the electromagnetic support preferably constituted by a ring member.

One of the two pole pieces of each magnetic circuit is arranged proximate to the internal periphery of the support ring, whilst the other is arranged in proximity to the external periphery of it (from now on the pole pieces will be named internal or external pole piece).

The radial arrangement of the magnetic circuits involves that the in-

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ternal pole pieces are closer together than the external pole pieces. Besides, the internal pole piece is generally that one which attracts the free end of the armature: therefore an air gap exists at rest between such pole piece and the armature.

5 When an electromagnet is excited, the magnetic field produced in the magnetic circuit has a leakage in correspondence of the initially open air gap: the more the ratio between the open air gap length and the adjacent pole piece distance increases, the more the flux lines tend to link with adjacent internal pole pieces.

10 As a consequence of such leakage, the magnetic circuits adjacent to an excited magnetic circuit steal to this last one magnetic energy in the air gap zone.

The armature of the excited electromagnet is attracted as soon as the attraction force exerted on it by the magnetic field exceeds the va
15 lue of the resisting force produced by a spring which determines at rest the opening of the magnetic circuit.

As the attraction force on the movable armature is directly proportio
nal to the value of the magnetic energy in the air gap, owing to the stealing of magnetic energy in the air gap from the adjacent magnetic
20 circuits, the armature of the excited magnetic circuit is attracted with a certain delay compared with the ideal case when there is no leakage or stolen flux.

It is to be noted that, if the two magnetic circuits adjacent to the one under consideration are excited at the same time, their magnetic
25 fields oppose to that of the intermediate one and tend to compensate its leakage near the air gap.

In such case the magnetic energy stolen to the magnetic examination circuit tends to become null, hence the delay in the armature attrac
tion tends to decrease.

30 As a consequence, in a mosaic printing head of such type, the actua-

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tion time of a printing needle changes according to whether the elec
tromagnets near to the one associated to the needle are excited or
not.

This problem limits the printing speed of the head as the upper limit
5 of such speed is imposed by the maximum flying time of the needles.
Besides that it causes misalignment in the printing operations due to
the fact that such operations do not occur in steady printing head
conditions but when the head is moving along the printing line.

In fact, as the excitation command is given to the electromagnets
10 when the printing head is in predetermined positions, the effective
actuation of the several needles simultaneously excited occurs with a
variable delay and therefore the resulting impression is variably off
set as to the predetermined position, owing to such cross-talk.

A solution to reduce the above mentioned inconvenients could be the
15 one of increasing the diameter of the circular support of the electro
magnetic structures, so that the open air gap width is much lesser
than the distance between the internal pole pieces of two adjacent ma
gnetic circuits.

Such solution, however, requires an unacceptable increase in the prin
20 ting head size.

The cross-talk phenomenon among electromagnetic structures occurs in
line printers too.

A solution used for line printers, described in the U.S. Patent N.
2.940.385, involves the use of magnetic shields for the actuator elec
25 tromagnets of the printing hammers, in order to avoid differences in
hammer flying time.

Magnetic shields could be used for mosaic printing heads to, but such
solution would however involve leakage fluxes and performance degra-
dation.

30 Besides it would still require an unacceptable size increase.

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Such inconvenients are avoided by the cross-talk prevention means of the present invention, which provide a "dynamic" shielding against the leakage fluxes instead of the static shielding achievable by means of the magnetic shields.

- 5 These means, consisting in shields of non magnetic conductor material (for instance copper), partially shield the magnetic circuit of an electromagnetic structure in the portion of the magnetic circuit where the path of the magnetic field is more critical.

The critical portion of the magnetic circuit in a matrix printing
10 head is, as already mentioned, the pole piece arranged in proximity to the internal periphery of the electromagnetic support, because of the air gap existing at rest between such pole piece and the armature. If such pole piece is shielded by conductive material, the magnetic flux of the magnetic circuit including such pole piece is prevented
15 from linking to the internal pole pieces of the adjacent magnetic circuits. Therefore the conductor material shield confines the flux within the appropriate magnetic circuit.

The shield effect is explained by the well known eddy current phenomenon.

- 20 In fact the variable magnetic flux tending to cross the metallic shield during the electromagnet initial excitation phase induces eddy currents within it. Such eddy currents generate a magnetic field opposing the inducing one.

The induced magnetic field causes a flux concentration inside the air
25 gap and a leakage flux reduction.

By means of such conductive shield a simple and unexpensive reduction of the cross-talk is obtained without causing a substantial reduction of the magnetic flux acting on the armature.

- These and other features will appear clearer from the following description of a preferred embodiment of the invention and from the at
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tached drawings where:

- Figure 1 shows in side view a simplified printing head already known in the prior art;

- Figure 2 shows in perspective exploded view some elements forming the electromagnetic assembly of a printing head according to the present invention;

Referring to fig. 1, it shows in side view an example of mosaic printing head structure.

Similar and more detailed structures of such printing heads are described in numerous patents/applications, as for instance British Patent N. 1.477.661, U.S. Patent N. 4.051.941 and Italian Patent Application N. 27496 A/78 filed by the same applicant.

The printing head of fig. 1 comprises a needle guide assembly 2 and an electromagnetic assembly 3.

The needle guide assembly comprises a frame 4 having a bracket 6, fixed to the frame by a screw 5, which supports a guide for the printing ends of the needles generally formed by a pair of suitably-shaped ruby plates 7.

The needle guide assembly 2 is fixed to electromagnetic assembly 3 by means of two screws (in fig. 1 the head 8 of one of such screws is visible) which lock two brackets formed on the sides of frame 4 against the electromagnetic assembly 3 (in fig. 1 one of such two brackets, evidenced by 9, is visible).

The electromagnetic assembly 3 comprises a supporting disk 10, to which a suitable number of electromagnets, such as 12, 13, 14, ...18, are fixed, an internal bushing (11, Fig. 2) fixed by calking or shrinkage in a central opening of disk 10 (in alternative the bushing and the disk may form a unitary, sintered, casted, or molded body), an armature retainer 19 and a central cap 20.

The armature retainer 19 is fixed to the bushing (reference 11 in fig.

2) by means of the central cap 20.

Central cap is provided in proximity of its external periphery with openings, each one receiving a screw (in fig. 1 only two screws 21, 22 are visible).

5 Such screws insert into corresponding openings present in the armature retainer 19 and engage in corresponding threaded holes (references 23, 24, 25 in fig. 2) of the bushing.

For purposes of completeness, fig. 1 also shows that the external surface of the ruby plates 7 is placed at a certain distance from a platen 26 of the printer.

A paper printing support 27 and an inked ribbon 28 are interposed between platen 26 and ruby plates 7.

Even though it is not shown in fig. 1, it is clear that such a printing head is intended to be mounted on a printing carriage of a printer.

15 Fig. 2 shows in exploded view some of the elements forming the electromagnetic assembly 3.

The supporting disk 10, in form of annular element having a central opening where the bushing 11 is engaged, has a suitable number of rectangular openings (in fig. 2 nine openings 29, 30,37 are visible) intended to restrain an extension which each magnetic circuit is provided with.

These openings are radially arranged around the disk center and uniformly distributed near the disk periphery.

For purposes of drawing clearness, fig. 2 shows a single electromagnetic structure as example of the plurality of electromagnetic structures generally included in the electromagnetic assembly 3.

Electromagnet 38 comprises a magnetic core 39 formed by a pack of U shaped magnetic sheets provided in correspondence of the yoke with an extension 40 for insertion in one of the rectangular openings of disk 10, for instance opening 30.

A coil 41 is wound around one of the two pole pieces of the core 39, and precisely around the one arranged in proximity of the external periphery of disk 10 (the external pole piece).

The internal pole piece of the magnetic core 39 is partially surrounded by a conductive, non magnetic shield 42 (for instance copper) having C cross section.

The electromagnet 38 is completed by a movable armature 43 closing the magnetic circuit.

The armature 43 has an extended arm 44 which acts as an activator arm on the head 45 of a needle 46 associated to such armature.

At rest, the magnetic circuit formed by core 39 and armature 43 has an air gap in correspondence of the internal pole piece, owing to the action of a spring 47 on arm 44 of armature 43 through head 45.

The armature retainer 19 (fig. 1) keeps the armature 43 in contact with the external pole piece of magnetic core 39.

A detailed description of armature retainer 19, as well as of central cap 20, is omitted, since it is not required for the purpose of the present invention.

However examples of such elements are described in the already cited Italian Patent Application N. 20717 A/80, same applicant.

As already said, the characteristic object of the present invention is the conductive non magnetic shield 42 which partially surrounds the internal pole piece of the magnetic core 39.

A similar arrangement is provided for all the other magnetic circuits of the electromagnetic assembly.

It is to be noted that shield 42 does not cover the pole piece face leaning against bushing 11: the shielding effect on such face may be carried out by the same bushing, which can be made in aluminium.

It is also to be noted that the shield 42 must not be in contact with bushing 11, if such last is of conductor material.

In fact, the open turn or C section of shield 42 is essential to avoid that such shield be linked with the main path of the magnetic flux, as it would occur in case of a closed ring.

In such way the shield is only crossed by possible leakage fluxes and
5 its action only concerns such fluxes in variable or dynamic condition. It has been found by testing that the conductive non magnetic shielding of the internal pole pieces of the electromagnets allows to minimize the difference among the flying times of the several printing needles without causing any appreciable delays in comparison with an
10 identical electromagnet where the leakage fluxes are minimized because of the absence of high permeability elements arranged in the vicinity.

The conductive non magnetic shields of the magnetic circuits in the electromagnetic structures of a mosaic printing head may clearly have
15 shapes other than the described one, without departing from the scope of the invention.

Claims.

1. An impact mosaic printing head with cross talk prevention means of the type including a needle guiding assembly having a plurality of
5 needles and an electromagnet assembly, said electromagnet assembly comprising a plurality of electromagnetic structures radially distributed each one adjacent to the other on a supporting ring member, each of said plurality of electromagnetic structures including a magnetic core formed by an inner pole piece, an outer pole
10 piece and a yoke, and an armature, said armature having a lever arm acting on one of said plurality of needles to drive said needle towards a platen, characterized by that each of said plurality of electromagnetic structures is magnetically decoupled from the adjacent electromagnetic structures by means of a non magnetic
15 conductive shield partially surrounding each of said inner pole piece.
2. An impact mosaic printing head as claimed in claim 1 wherein each
20 of said shields has an open turn or C section embracing one of said inner pole pieces.

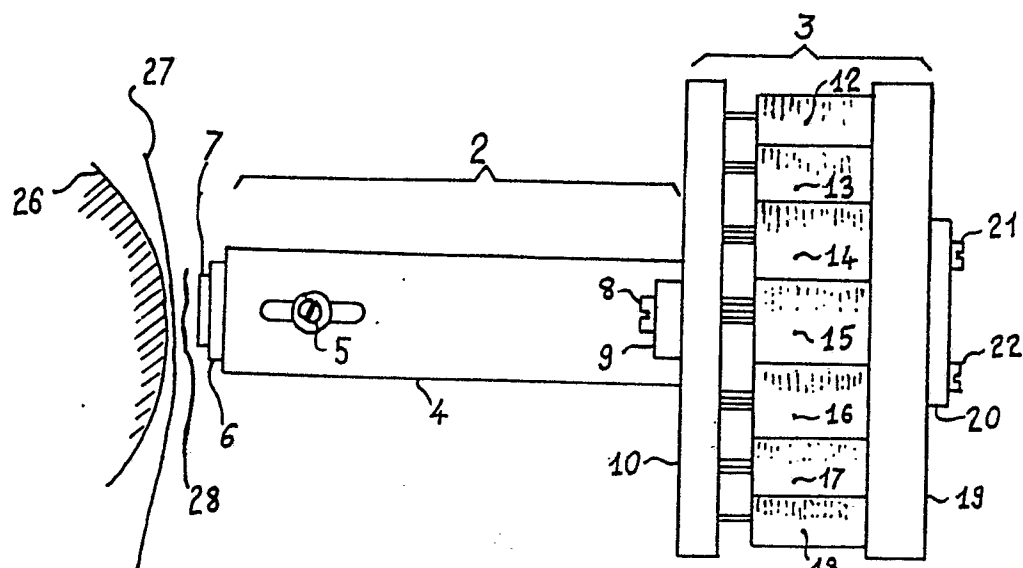


FIG. 1

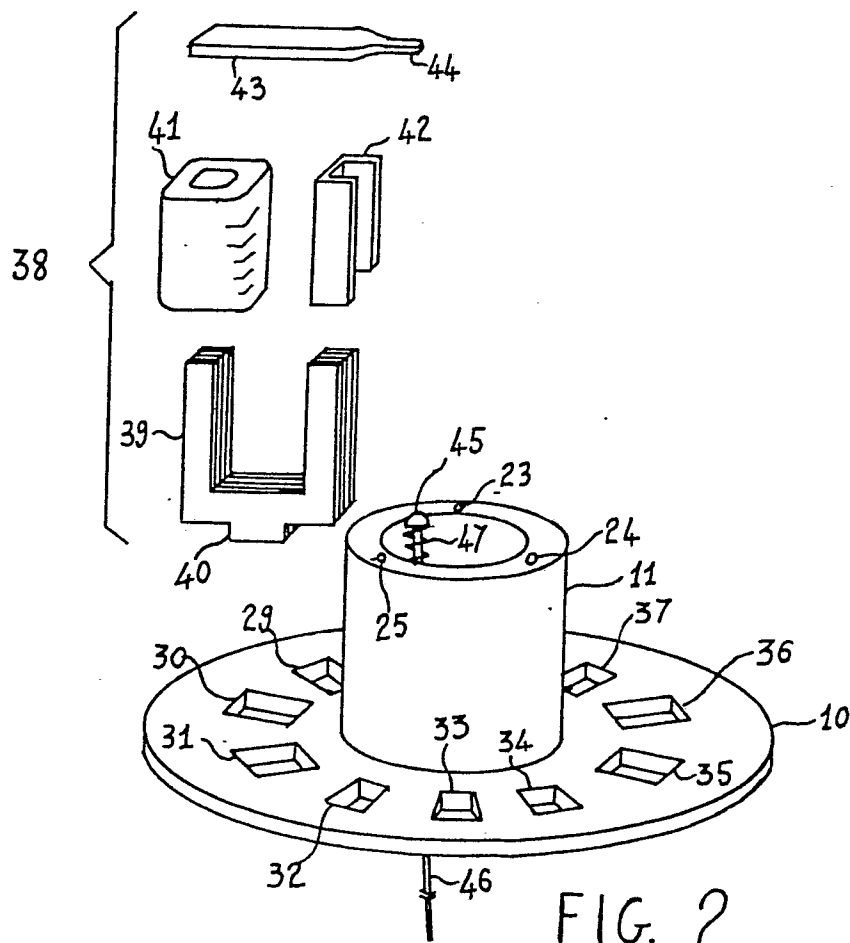


FIG. 2