United States Patent

[11] 3,592,311

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[73] Assignee **International Business Machines Corporation**
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[54] **WIRE PRINTING HEAD**
13 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **197/1,** 101/93
[51] **Int. Cl.** **B41j 3/10**
[50] **Field of Search** 197/1; 101/93

[56] **References Cited**

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Attorney—Hanifin and Jancin

ABSTRACT: A wire printing head comprising a plurality of magnetic actuators mounted on a single frame and having movable armatures to which is fixed a wire extending to the record medium. Each armature is spring-biased in one direction such that with a change in the magnetic field the armature is moved to actuate the associated wire longitudinally for impacting the medium. By the proper selection of the wires actuated at each print position, characters are printed.

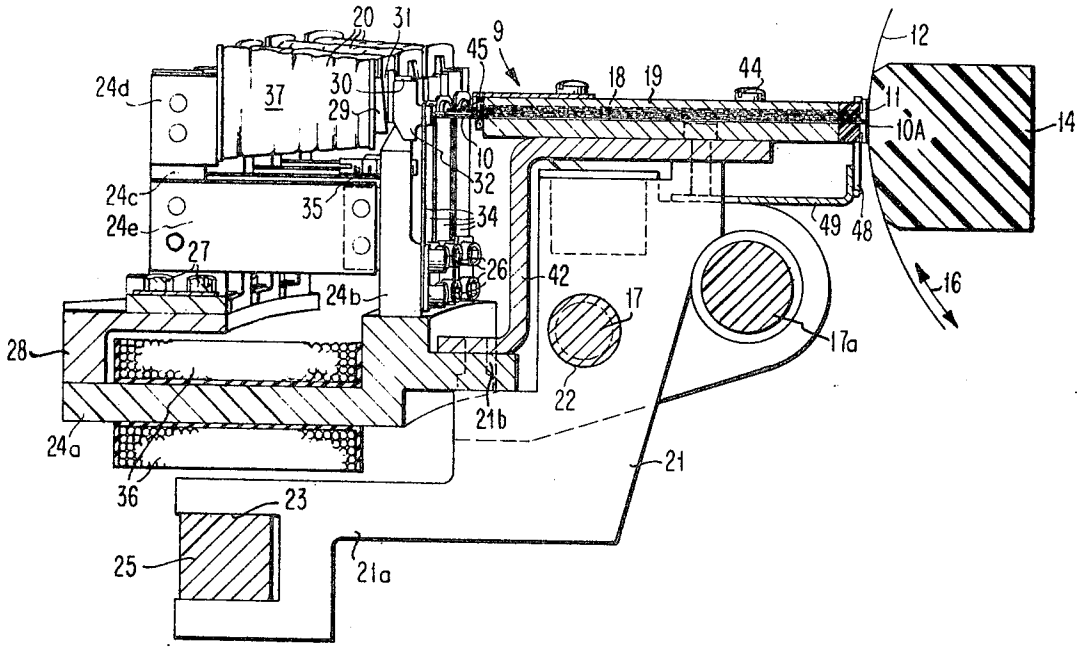


FIG. 1

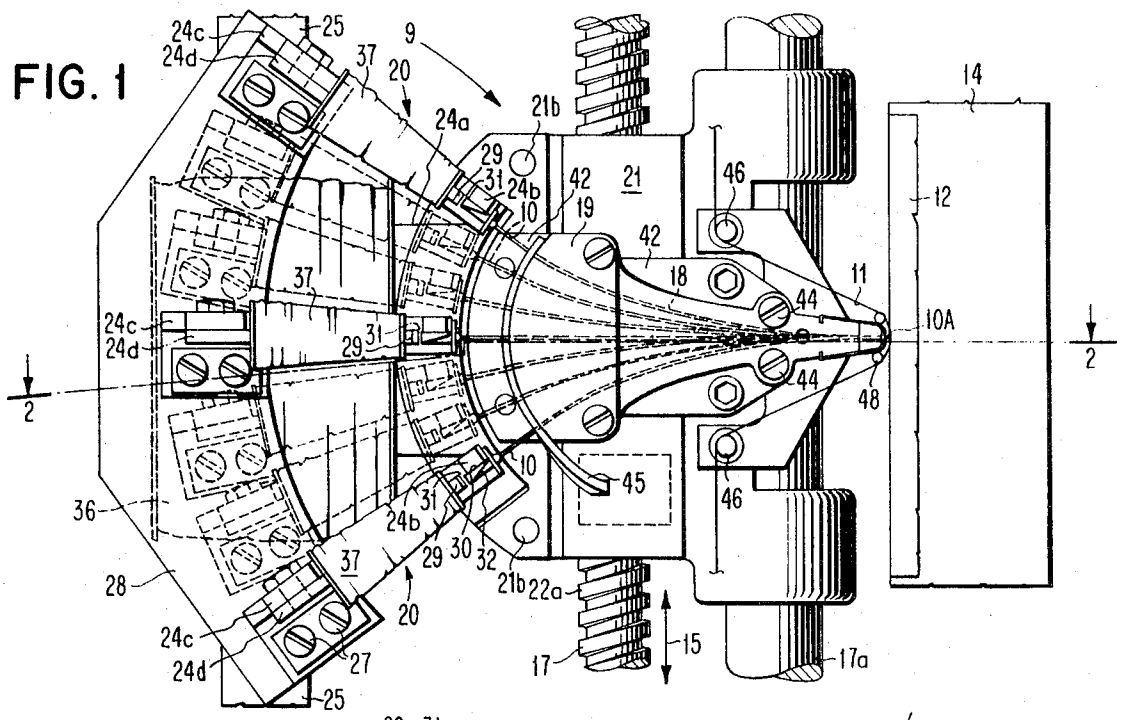


FIG. 2

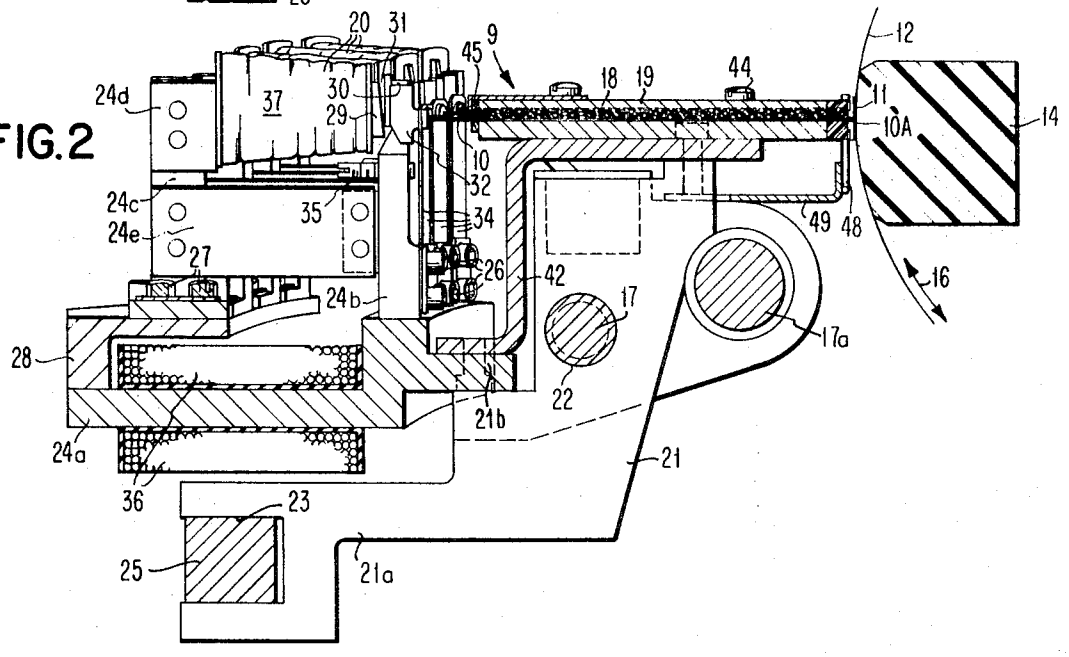
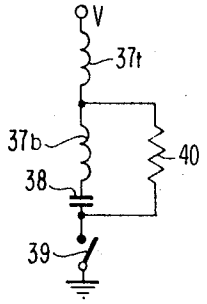


FIG. 3



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WIRE PRINTING HEAD

CROSS-REFERENCES TO RELATED APPLICATIONS

This printing head utilizes an actuator which is described in U.S. Pat. No. 3,460,469, entitled Print Hammer Actuator, filed on Dec. 30, 1966, with E. A. Brown, A. S. Chou, and R. H. Darling as inventors and assigned to the same assignee as this application.

A control circuit suitable for use with the subject invention is described in U.S. Pat. No. 3,449,639, entitled Actuator Driver Circuit, filed on Dec. 30, 1966 with E. A. Brown and R. H. Darling as inventors and assigned to the same assignee.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to printing machines in general, and specifically describes a print head assembly for a wire printer.

2. Description of the Prior Art

In wire printing apparatus, individual wires are actuated to impact the record medium for forming a portion of the image to be recorded. Usually, individual electromagnetic actuators are used for each wire and such actuators have to move the wire a significant distance and with sufficient force to impact the medium. Thus, it has been necessary for the actuator to be of a sufficient size to provide the necessary actuating force thereby preventing its location close to the point of impact with the medium. Naturally, as the cycle rate of the actuator is increased the actuator must be even larger to withstand a temperature buildup resulting from the greater actuating current necessary.

As the wire is made longer to reach a sufficient distance and accommodate the space necessary for the inclusion of several actuators, the force and stroke to actuate the wires becomes even greater. The problem is compounded further in that the wires bend or give during actuation requiring that the actuator actually move the adjacent end of the wire much further than necessary for printing at the other wire end. To partially offset this problem, individual guides in the form of tubes have been used to limit the flexing of the wire. However, these tubes in themselves are made of more expensive materials to withstand the corrosive inks and also present resistance to the longitudinal shifting of the wire thereby requiring a larger actuator force to move the wire. Thus, the design of a printing head has been a vicious circle wherein longer wires are needed to accommodate larger actuators and larger actuators in turn have required the use of longer wires. It is not uncommon for the printing wires to be 12 to 30 inches in length in presently used machines.

In these machines also, the actuator frequently is not linked directly to the wire to permit a striking on the wire end for imparting a greater force for printing. It is common knowledge, however, that when two bodies come together which are of unequal weight, the transference of energy usually is no greater than 80 percent and, if the differential in weight is sufficiently large, can be as little as 20 percent. Thus, such structures in themselves have required the use of larger actuators.

A primary object of the present invention to provide a novel and compact printing head by utilizing actuators mounted directly on the head frame close to the point of impact with short length wires extending to the record medium thereby minimizing the masses to be accelerated and the forces necessary for printing.

A further object of this invention to provide a highly efficient wire printing head which is fast acting and requires a small energy signal for actuation.

Still a further object of this invention to provide a single moving part printing mechanism which can be recycled at very high rates.

SUMMARY OF THE INVENTION

A wire printing head comprising a frame supporting a pair of pole pieces having spaced and offset faces between which is positioned a magnetic member for sliding movement relative to one face and in a direction towards and away from the other face. Fixed directly to the magnetic member is a wire extending toward the record medium and positioned to contact the medium when the magnetic member is in one position. The magnetic member in moving away from the one face experiences essentially no magnetic forces and therefore is considered in free flight, but on returning toward that face experiences large magnetic forces and some frictional force so as to be choked in movement, thereby achieving the desired control of the wire during the printing operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is the top view of a printing head embodying the subject inventive features.

FIG. 2 is a cross-sectional view taken along the Line 2–2 of FIG. 1.

FIG. 3 is a schematic drawing of a control circuit suitable for use with the subject printing head.

DESCRIPTION OF A PREFERRED EMBODIMENT

In FIGS. 1 and 2 is shown a printing head 9 which functions to actuate the projecting ends 10A of a series of wires 10 into contact with an inking ribbon 11 for pressing it against a record element 12 (which in this instance is paper) held against a backing platen 14. In this manner, the printing of a desired image on the paper is achieved. The printing head is translated in the direction of the arrow 15 (FIG. 1) for printing lines across the paper. After the completion of a line, the paper is shifted in the direction of the arrow 16 (FIG. 2) for printing the next adjacent line. The head is supported on shafts 17 and 17*a* and preferably is translated by interfitting screw threads on the head and the rotating shaft 17.

In accordance with the present invention, the head 9 is constructed in a compact manner such that the actuator and wire assembly are a single rigid construction supported wholly adjacent the printing position on the paper and needing only an electrical connection for energizing the actuator in response to the incoming data for printing the desired images. Thus, the head includes a series of seven wires 10 positioned in an aligned configuration at the point of impact with the paper in a plane extending normal to the direction of head translation. Each of the wires extends through an individual opening 18 in the wire guide 19 to one of several actuator assemblies 20 positioned side by side in a fan configuration. The guide 19 is canted (FIG. 2) relative to the actuators 20 so each wire extends in one plane from the actuator to the opening 18 receiving that wire. The head is supported on a frame member 21 through which the shafts 17 and 17*a* pass with interlocking threads 22 on the frame opening interfitting with threads 22*a* on the shaft for translating the head in the direction of the arrow 15 as the shaft is turned by power means not shown. On the frame is an extending arm 21*a* including a slot 23 having two way surfaces which slide along a way 25 extending parallel to the shaft 17 for preventing rotation of the head about the shaft.

The actuators 20 each comprise a central magnetic core 24*a* which is fixed to the frame 21 by bolts 21*b*. The segment 28 extends from the frame with the segments 24*b* and 24*c* being fastened thereto by a nonmagnetic structure member 24*e*. The segment 24*c* is fixed by bolts 27 threaded into the fan-shaped magnetic member 28. Extending between the projecting ends of the segments 24*b* and 24*c* is the segment 24*d* which partially closes the magnetic path of the actuator. The segment 24*d* is mounted directly to the segment 24*c* and extends towards but does not contact the projecting end of the segment 24*b* thereby forming pole pieces. Thus, the adjacent segments 24*d* and 24*b* form spaced pole pieces having faces 29

and 30 from each other and offset 90° to form an airgap 31 therebetween.

In sliding engagement with the face 30 is an armature 32 formed of magnetic material and fixed to the end of the wire 10 associated with that actuator and projecting from the back of the wire guide 19. The armature 32 is supported on the projecting end of a leaf spring 34 extending parallel to the magnetic segment 24*b* and fixed thereto by the bolts 26 threaded into that segment. Thus, by flexing the leaf spring about an adjusting screw 35 threaded into the segment 24*b* at a point intermediate the ends of the spring, the armature 32 can be slid along the face 30 in a direction towards and away from the face 29 of the magnetic core. Such action is caused by a change in the magnetic flux within the core which extends across the airgap and serves to attract the armature towards the face 29.

When the armature is butting the face 29 of the magnetic core, the wire is held in the retracted or ready position. Upon release of the armature, the spring 34 moves the armature and wire forward thereby driving the wire end 10A beyond the end of the guide and into contact with the ink ribbon and paper for printing. To hold the armature in the ready position just described, a central coil 36 is provided for supplying flux through all of the actuators. As shown in FIG. 1, the core portion 28 extends laterally in a fan configuration beneath each of the actuators to carry the flux to the respective magnetic cores. Thus, with energization of the coil 36, the armatures are drawn across the airgap 31 into engagement with the core face 29 to hold the wires in the retracted or ready position. It should be noted the spring 34 retains the armature within the field of influence of the magnetic field across the airgap so that any time the core is energized, the armature immediately is drawn towards the pole face 29 to the ready position. To release the armature and allow the wire to be propelled into the print position, each of the actuators includes a coil 37 which when energized, sets up a counteracting flux in the associated magnetic core and airgap 31 in opposition to that of the coil 36 thereby to reduce the force on the armature and permit the spring 34 to drive the armature forward. Thus, by individually controlling the energization of each of the coils 37, the wires can be moved to either the ready or print positions. The armature remains in contact with the face 30 of the segment 24*b* at all times and therefore is under the influence of the flux field which serves to choke the action of the armature and therefore of the wire. As the magnetic field across the gap is strengthened to move the armature to the retracted position, the frictional engagement between the armature and the pole face 30 is increased thereby serving to choke movement of the armature and decrease the settling time for the moving assembly. Similarly, the frictional engagement between the face 30 and armature is lessened on forward movement allowing faster movement of the wire for printing. This choking action is important in lessening the settling time of the wire and armature during the printing cycle thereby permitting recycling between the ready and print positions at a much faster repetition rate. As shown in FIG. 1, the cross-sectional shape of the armature is triangular to reduce the mass thereby additionally increasing the cycle speed of the printer by minimizing the inertia of the movable parts of the printing head.

To control the energization of the coil 37 and thereby regulate the printing of the head, each coil 37 is provided with a control circuit as shown in FIG. 3. In this circuit, the winding 37 is tapped to form the coil portions 37*t* and 37*b*. A suitable voltage V is coupled across this winding in series connection with a capacitor 38 and switching means 39. In addition, a resistor 40 is coupled across the winding portion 37*b* and the capacitor 38.

In operation, the switching means 39 of the coil associated with the wire to be actuated is closed and the capacitor 38 starts charging to result in a current flow through both of the winding portions 37*b* and 37*t*. The current flow sets up a flux in the magnetic core of that actuator in opposition to that created by the coil 36 serving to release the armature for its forward-propelling movement to the print position. During such movement, the capacitor 38 becomes charged thereby reducing the current flow through the coil 37. After printing, the switch 39 is opened which results in the capacitor 38 discharging through the circuit including the resistor 40 and the coil portion 37*b*. Due to the direction of current flow in the coil, a magnetic field is created in the core by this coil which is additive to that created by the coil 36 and sets up a large magnetic field across the airgap 31 for quickly restoring the armature 32 back to the ready position in contact with the core face 29.

In the manner described, the individual wires 10 are actuated between the ready and print positions by control of the energization of the associated winding 37. The wires are permitted to slide through the molded wire guide 19 supported by the flange 42 held by the bolt 25 on the frame 21. Preferably, the guide is made of one-piece, molded construction and held in position by the bolts 44 threaded into the flange. An oil wick 45 is positioned at the rear of the guide for supplying lubrication to the wires as they are moved through the guide. By positioning the wires within close tolerance openings in the guide, only a slight lateral movement of each wire is possible as they are pushed by the armature and leaf spring to a print position for movement of the tip 10A to effect the printing on the paper. Thus, the printing stroke effected by the armature is less since most of the armature movement is transferred directly to the print tip 10A. In the past, the length to diameter ratios of the wires have been greater due to the greater distances between the actuator to the platen. As pointed out before, the greater distances were necessary to accommodate larger actuator sizes, etc. A typical wire length usable in the present invention is 2½inches with a diameter of 0.011 inches. Thus, a ratio of wire length to diameter of less than 240 is readily usable in a machine embodying the subject invention, a ratio very difficult if not impossible to provide in previously known printing machines.

The shorter wire further creates less friction with the guide thereby permitting use of a smaller actuator since a smaller actuating force is necessary. Due to the fact that the armature is connected directly to the wire and is choked against movement at all times due to the flux within the magnetic core, the wire tends not to vibrate or flex during the cycling which negates the need to allow for a settling time during the printing cycle. Because of these factors, printing is accomplished in a much quicker time, thereby speeding up the printing operation.

Also mounted on the flange 42 are a pair of post guides 46 around which the inking ribbon 11 extends. A wire guide 48 mounted on the flange 49 extending from the frame 21 holds the ribbon adjacent the guide 19.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be evident to those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention.

We claim as our invention:

1. In a wire printing device for printing on a record number, a print head comprising;

a frame,

a pair of magnetic pole pieces spaced from each other and having offset faces therebetween,

a moveable magnetic member positioned to slide in alternate directions along one pole face and towards and away from said other face,

means producing a magnetic field between said pole pieces for holding or returning said magnetic member against said other face,

a print wire having a predetermined length fixedly attached directly on said magnetic member for movement therewith and positioned to move into engagement with said record member when moved in one direction,

a wire guide rigidly held on the frame having an opening therein extending between positions close to each end of the wire for receiving and guiding said wire,

means for spring loading said magnetic member to urge movement thereof in one direction, and

control means to alter the magnetic field between said pole pieces to cause movement of said magnetic member and wire for effecting a printing action on said record member.

2. A print head as defined in claim 1 wherein the length to diameter ratio of the wire is less than 240.

3. A print head as defined in claim 1 wherein said spring-loading means comprises a leaf spring extending substantially normal to the direction of movement of the wire with one end held rigid on the head and the other end fixed to the armature for urging said wire into engagement with said record member.

4. A print head as defined in claim 3 wherein the leaf spring maintains the magnetic member within the influence of the magnetic field extending between the pole pieces.

5. A print head as defined in claim 3 including means for adjusting the tension forces impressed on the leaf spring by actuation of the armature.

6. A print head as defined in claim 5 wherein said leaf spring serves to move the magnetic member and wire into engagement with the record member.

7. A print head as defined in claim 6 wherein said control means maintains a magnetic field in the pole pieces during movement of the magnetic member away from the record member, said field being sufficient to choke the movement of the wire and armature.

8. In a wire printing device for printing on a record member, a print head comprising:

a frame,

a plurality of wires supported on the frame for movement from a ready to a print position whereby the printing ends are spaced from and into contact respectively with the record member,

an actuator for each wire comprising:

an armature fixedly attached directly on the associated wire and being movable in a direction parallel to the direction of movement of the wire,

a pair of pole pieces spaced from each other to form offset faces defining an airgap in which said armature is positioned, and

means for establishing a magnetic field between the pole pieces and extending across the airgap to attract and to hold the armature in contact with both pole faces,

spring means for exerting a force on the armature urging it along one pole face in a direction away from the other pole piece, and

control means for lowering the force of the magnetic field momentarily to permit the spring to move the associated wire into engagement with the record member for printing.

9. A print head as defined in claim 8 further comprising a single-piece wire guide having separate openings for receiving said wires extending from positions close to the armature to a point close to the record member for guiding the wire during movement, said wire guide and said actuators being mounted on said frame, whereby said actuators and wire guide move as a unit as said print head traverses the printline.

10. A print head as defined in claim 9 wherein the printing ends of the wires are aligned in one plane as they pass from the guide opening adjacent the record member.

11. A print head as defined in claim 10 wherein said spring means each comprises a leaf spring extending substantially normal to the direction of movement of the wire with one end held rigid on the head and the other end fixed to the armature.

12. A print head as defined in claim 11 including means for adjusting the tension forces impressed on the leaf spring by actuation of the armature.

13. A wire printing device comprising:

a print head,

translating means for moving said print head with respect to a record member along a printing line,

said print head comprising

a frame,

at least one print wire and magnetic actuator, each said magnetic actuator comprising

a pair of pole pieces spaced from each other and having offset faces therebetween,

means for producing a first magnetic field between said pole pieces,

a movable magnetic member positioned to slide in alternate directions along one pole face and towards and away from the other face,

spring means for spring loading said magnetic member to urge movement thereof away from said other face,

said first magnetic field acting on said magnetic member to restore or hold said member against said other face,

control means altering said first magnetic field between said pole pieces for causing said spring means to move said magnetic member away from said other face, and restoring said magnetic field for causing said magnetic member to return and hold against said other face;

each said print wire being fixedly attached directly on a corresponding magnetic member for movement therewith and positioned to move into engagement with said record member when moved in one direction;

a wire guide rigidly held on the frame having an opening therein for said print wire and extending between positions close to each end of said wire for receiving and guiding said wire;

whereby, as said first magnetic field is altered, said wire is moved into engagement with said record member to effect a printing action by said spring means, and then said first magnetic field is restored to return said wire to its original position ready for the next print cycle.