United States Patent [19]

Foster

[11] **3,929,267**

[45] **Dec. 30, 1975**

[54] **SHEET MATERIAL TRANSPORT**

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[22] Filed: **Sept. 21, 1973**

[21] Appl. No.: **397,471**

[30] **Foreign Application Priority Data**

Sept. 16, 1972 United Kingdom 43027/72

[52] **U.S. Cl.** **226/74**; 226/93; 226/170

[51] **Int. Cl.** **G03b 1/30**

[58] **Field of Search** 226/52, 74, 76, 93, 170, 226/171, 172, 173, 94

[56] **References Cited**

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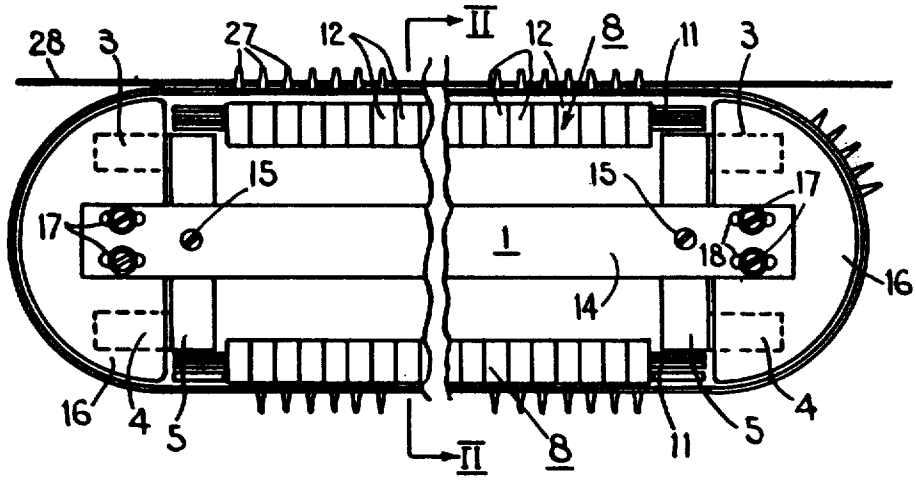
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[57] **ABSTRACT**

A tractor for feeding a paper web is disclosed in which the drive means forms an integral part of the tractor. A tractor belt is guided around a closed loop path and carries pins for engaging perforations in the web and magnetic elements which are acted on by a pattern of magnetic fields generated by a row of coils arranged alongside a portion of the path. The coils are energised in a manner to cause the pattern of fields to move in steps and thereby cause the magnetic elements, and hence the belt and pins, to move in steps.

8 Claims, 7 Drawing Figures



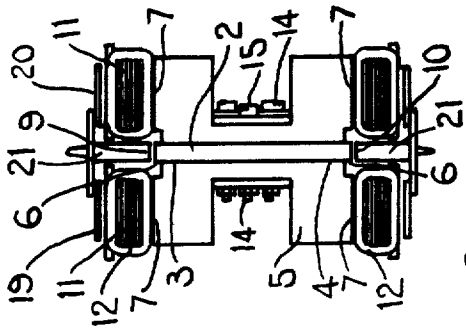


FIG.2.

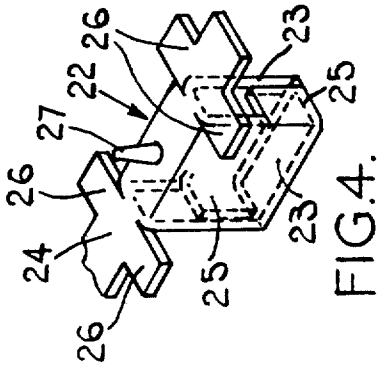


FIG.4.

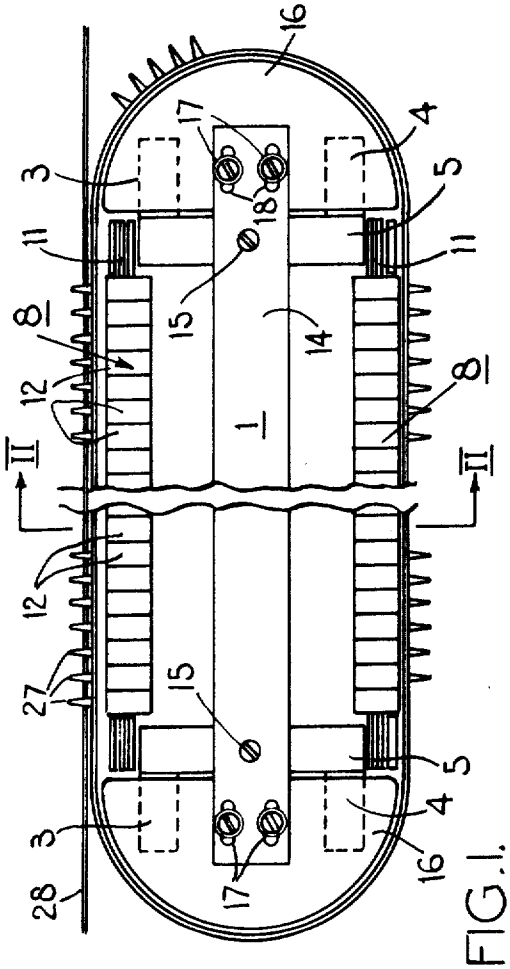


FIG.1.

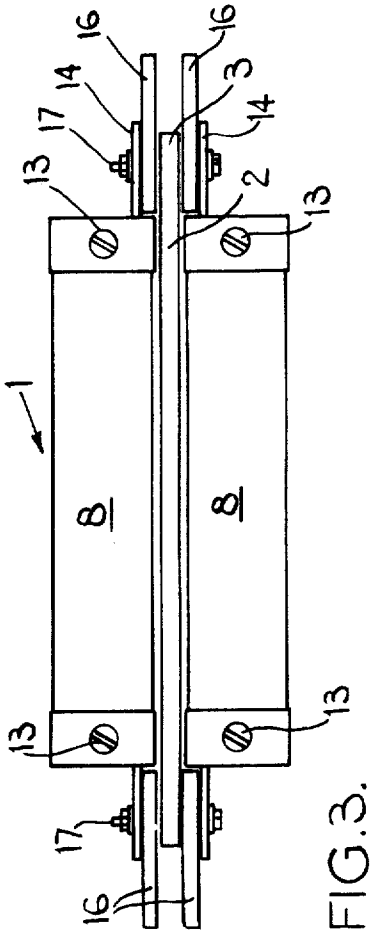


FIG.3.

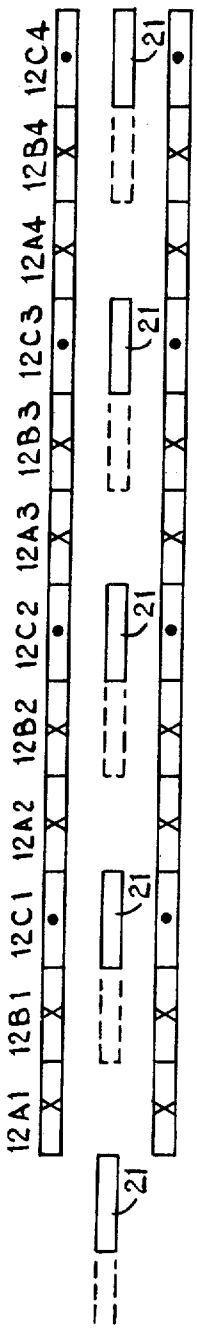


FIG.5A.

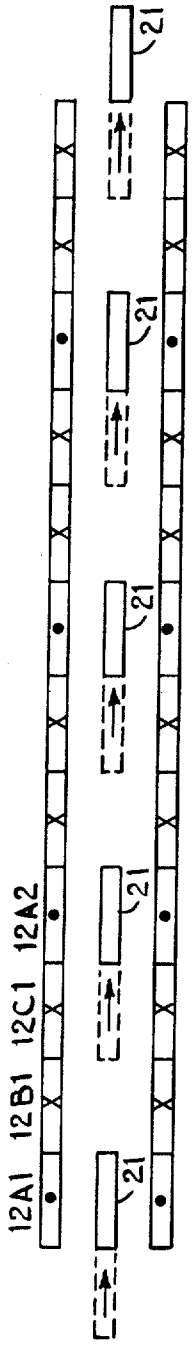


FIG.5B.

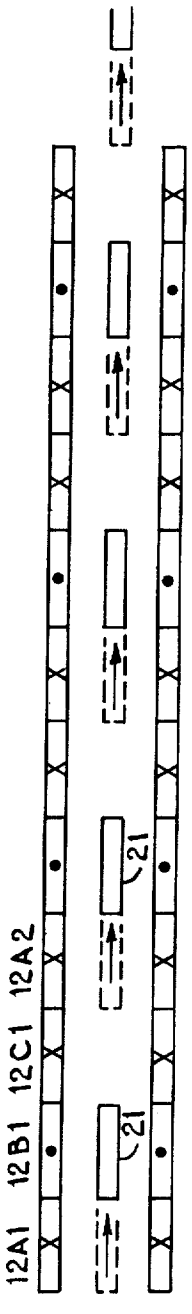


FIG.5C.

SHEET MATERIAL TRANSPORT

BACKGROUND OF THE INVENTION

This invention relates to sheet material transport devices and in particular to tractors for feeding web material.

In the operation of data processing machines the data output is printed line by line upon a web of paper and between printing each line the web needs to be fed by one line space. In order to achieve a high printing speed the web must be accelerated from rest and then brought to rest in as short a time as possible and in addition the web must be precisely positioned in order that the lines of printing are equally spaced.

It is known to feed the web of paper line by line by means of tractors consisting of endless belts carrying outwardly projecting pins which engage in perforations in the web. In the known constructions of tractor the belt is carried by two spaced wheels, of which one is driven from a power source, and the pins engage the perforations of the web during their travel in a linear path from one wheel to the other wheel. To prevent skewing of the web, separate tractors are provided to engage with rows of perforations extending along each edge of the web and then tractors are driven through suitable drive transmissions from a common electric motor. In order to ensure that the tractors are driven in synchronism and with a minimum of backlash the construction needs to be relatively massive and consequently the tractor drive arrangement has a high inertia and it becomes difficult to achieve a high stepping speed for the paper web.

SUMMARY OF THE INVENTION

According to the present invention web feeding apparatus includes guide means to guide an endless belt around a path having a linear portion; means on the belt arranged to engage the web at least during travel along the linear portion of the path; a plurality of spaced magnetic elements carried on the belt; and means operable to generate a pattern of magnetic fields which moves along at least a portion of the path in a sequence of steps, the magnetic fields being effective to co-operate with the magnetic elements on the belt to cause the magnetic elements and the belt to move along the path in steps corresponding to the stepping movement of the pattern of magnetic fields.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a side view of a tractor constructed in accordance with the invention,

FIG. 2 is a section on the line II—II of FIG. 1,

FIG. 3 is a plan view of the stator assembly of the tractor shown in FIGS. 1 and 2,

FIG. 4 is a perspective view of a part of the movable element of the tractor and

FIGS. 5A, 5B, 5C schematically illustrate stages in the stepping motion of the tractor.

DESCRIPTION OF THE PREFERRED EMBODIMENT.

Referring first to FIGS. 1, 2 and 3, a stator assembly 1 of the tractor includes a rectangular centre spacer plate having at each end thereof an upper lug 3 and a lower lug 4. End plates 5 are secured to each end of the plate 2 and are located thereon by means of the lugs 3 and 4 engaging in slots 6 in the end plates 5. Each end

plate 5 provides two pairs of mounting surfaces 7 which extend outwardly from opposite faces of the spacer plate 2 and perpendicular to the plate 2. Yoke assemblies 8 are secured to the mounting surfaces 7 on the end plates 5, each yoke assembly 8 extends from one surface 7 on one of the end plates 5 to a corresponding surface 7 on the other end plate 5 so that one pair of yoke assemblies 8 extend in parallel spaced relation on opposite sides of the plate 2 adjacent one edge 9 thereof and the other pair of yoke assemblies 8 extend similarly adjacent the opposite edge 10 of the plate 2. Each yoke assembly 8 consists of a laminated magnetic core 11 carrying a plurality of stator coils 12 electromagnetically coupled to the core and positioned end to end along the length of the core 11. The yoke assemblies 8 are secured to the end plates 5 by means of screws 13 through the ends of the cores 11. Strips 14 extend along each side of the stator assembly 1 and are secured by screws 15 to the end plates 5. Pairs of semi circular guide cheeks 16 are secured to the ends of the strips 14, the lugs 3 and 4 extend between the cheeks 16 of a pair to maintain the cheeks 16 in spaced relationship. The cheeks 16 are secured to the strips 14 by means of screws 17 in slots 18 in the strips 14 to permit adjustment of the cheeks longitudinally of the assembly.

The semi circular surfaces of the cheeks 16 define guide paths for two endless belts 19, 20. The belts 19, 20 carry a plurality of separate magnetic elements 21 each of which consists of a magnet supported by a magnet carrier 22 which is in turn connected to the endless belts 19, 20.

A construction of magnet carrier 22 is illustrated in FIG. 4 in which the carrier is formed from sheet material. The carrier has two side walls 23 depending from a box part 24 and a flap 25 on one edge of each side wall 23 is turned inwards toward the other side wall to form a box like structure to receive the magnet. The magnets are secured in the carriers 22 by means of an adjesive. The base part 24 is formed with two pairs of lugs 26. One pair of lugs 26 is secured to the belt 19 and the other pair of lugs is secured to the belt 20. Pins 27 for engaging in perforations in a web 28 of paper sheet are secured to the carriers 22. In the illustrated example one pin 27 is secured to each carrier 22 and hence the carriers 22 are secured to the belts 19, 20 such that the pins 27 have a pitch equal to the pitch of the perforations in the web.

The coils 12 on each yoke assembly 8 are connected in three interlaced groups. The first group consists of the 1st, 4th, 7th etc. coils 12, the second group consists of the 2nd, 5th, 8th etc. coils 12 and the third group consists of the 3rd, 6th, 9th etc. coils 12. The grouping of the coils of the two yoke assemblies adjacent on edge of the spacer 2 is arranged to be identical so that upon energisation of the coils of the two adjacent yoke assemblies a pattern of pairs of similar magnetic poles is generated. The groups of coils 12 are energised with current polarities as shown in FIG. 5A in which one group of coils 12A1, 12A2, 12A3 and 12A4 are energised with first polarity, the second group 12B1, 12B2, 12B3 and 12B4 are energised with first polarity and the third group 12C1, 12C2, 12C3 and 12C4 are energised with opposite polarity so that it will be seen that pairs of coils are energised with current of the same polarity whereas the coil lying between each pair is energised with current of the opposite polarity. This energisation

of the coils 12 results in the genreation of a pattern of magnetic fields such that opposing magnetic poles are produced at the interfaces between the ends of the pairs of coils and the single coils lying between the pairs. Hence the magnetic elements 21 are acted upon by these magnetic fields to move the magnetic elements 21 until the poles of the magnetic elements 21 are aligned with unlike poles of the magnetic field generated by the coils 12 as shown by full lines in FIG. 5A.

In order to cause the tractor to move on by one step, the polarity of energisation of the 12A group of coils is reversed as shown in FIG. 5B. It will be seen that, in comparison with FIG. 5A, the magnetic field pattern has not changed in form but has moved on by one step along the coils 12 so that the magnetic elements 21 are subjected to forces which cause them to move into the stable positions shown in full lines in FIG. 5B.

Similarly in the next step of the operation of the tractor, the polarity of energisation of coil groups 12B and 12A is reversed so that the field pattern moves to the position shown in FIG. 5C and the magnetic elements 21 move by a further step. The next step of the operation results in energisation of the coils 12 as shown in FIG. 5A and the magnetic elements 21 will have moved by a distance equal to the pitch of the elements 21.

It will be understood that the movement imparted to the magnetic elements 21 and hence the pins 27 carried thereby is equal to the pitch of the coils 12. Hence if it is desired to print on the web at 6 lines per inch, the coils are positioned in the yoke assemblies with a pitch of one sixth of an inch.

The edges 9, 10 of the spacer plate 2 may provide bearing surfaces for the magnetic elements 21 and during travel of the belts 19, 20 round the guide cheeks 16, the elements 21 move in the space between the cheeks 16 and hence are guided in a lateral direction by the inner faces of the cheeks. The length of the path of travel defined by the cheeks may be adjusted to suit the belts 19, 20 by movement of the cheeks relative to the strips 14.

While a construction using two belts 19, 20 has been described, a single belt could be used to carry the magnetic elements provided a suitable guiding arrangement is provided.

The magnets 21 may be magnetised transversely and the coils 12 on opposite sides of the path energised oppositely to generate flux transverse to the path. The magnets 21 then align between magnetically opposed poles on opposite sides of the stator.

I claim:

1. Web feeding apparatus including guide means to guide an endless belt around a path having a linear portion; means on the belt arranged to engage the web at least during travel along the linear portion of the path; a plurality of spaced magnetic elements carried on the belt; and means operable to generate a pattern of magnetic fields which moves along at least a portion of the path in a sequence of steps, the magnetic fields being effective to co-operate with the magnetic elements on the belt to cause the magnetic elements and the belt to move along the path in steps corresponding to the stepping movement of the pattern of magnetic fields.

2. Apparatus as claimed in claim 1 including a row of coils located along the portion of the path and electrically connected in three interlaced groups such that each coil of a group lies between two coils from the other two groups; the coils of two of the groups being energised with one polarity of current and the coils of the other group being energised with the opposite polarity of current to generate the pattern of magnetic fields, movement of the pattern by a step being affected by reversing the polarity of energisation of the coils of said other group and of the coils of one of said two groups.

3. Apparatus as claimed in claim 2 including a pair of elongate magnetic cores extending in spaced parallel relationship adjacent and parallel to the portion of the path, in which each core carries a row of coils electromagnetically coupled thereto, the magnetic elements moving between the magnetic cores in their movement along the portion of the path; and energisation of the coils being effective to generate the pattern of magnetic fields in the space between the magnetic cores.

4. Apparatus as claimed in claim 1 in which the path consists of first and second linear portions spaced apart and parallel to one another connected by substantially semicircular sections defined by semicircular guide surfaces and inclusing first and second means operable to generate patterns of magnetic fields along the first and second linear portions respectively, the first and second means being operated in synchronism to drive the belt in steps along the first and second linear portions.

5. Apparatus as claimed in claim 4 in which the magnetic elements project inwardly from the belt and each semicircular guide surfaces are provided by two guides spaced apart to permit the passage of the magnetic elements therebetween.

6. Apparatus as claimed in claim 1 in which the magnetic elements each include a carrier secured to the belt and a magnet secured to the carrier.

7. Apparatus as claimed in claim 6 in which each magnetic element carries a pin operative to engage in a perforation of the web.

8. Apparatus as claimed in claim 1 including pins carried by the belt and projecting outwardly from the belt to engage in perforations in the web.

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