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(54) BELT-TYPE PRINTING MACHINE WITH SERPENTINE BELT SUPPORT

(71) We, MIDLAND-ROSS CORPORATION, a corporation organised and existing under the Laws of Ohio, United States of America, of 55, Public Square, Cleveland, Ohio 44113, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for supporting an endless printing belt.

In the production of books by a belt-type printing machine, such as disclosed in Stroud *et al* United States Patent Specification No. 3 518 940, an essential requirement is that the printing-belt support structure shall be constructed so as to be adjustable to maintain in taut condition any one of a variety of belts whose lengths vary from, e.g. 5 feet to 75 feet in accordance with the number of pages in books to be printed. The above-noted patent discloses support structure defining a generally ovate belt circuit which has served well in the commercial use of single belt machines. However, the machine typified in this patent is being adapted to uses, such as multi-color printing, which require contacting a single printable web with two or more printing belts. To provide belt-supporting structure to the above-noted patent for a multiple belt machine requires individual belt-support systems, each perhaps 30 feet in length, stacked either vertically or horizontally with great consumption of workshop space requiring perhaps special building construction. Furthermore, there is the problem of providing good machine arrangement in the vicinity of the plate roller and the impression roller for each belt for the mounting of ink trains and other equipment, and adequate space for operators to service the equipment.

There also arises the need for machine design in which printing stations may be established progressively along the web path in close consecutive proximity with each other, perhaps no more than about 6 feet apart. Minimum distance between printing stations is desired to avoid such distortion in the length to the web as to affect accuracy of color registration.

Another important point to be considered in the storage of rapidly moving belts during the printing operation is the possibility of lateral vibration or whipping especially when substantial sections of the belt must be oriented in a vertical direction.

In accordance with the invention, there is provided apparatus for supporting an endless printing belt having printing and non-printing sides, the former being divided into a plurality of image areas some of which are separated from others by non-printing lands which are continuous in a direction around the belt parallel to the edges thereof, the apparatus including a plate cylinder and an impression cylinder between which the belt passes, and a belt guide assembly which includes rotatable cylindrical means occupying a first region which is generally box-shaped, the cylindrical means being arranged so that their axes are parallel and staggered and the cylindrical means in the first region define a serpentine path of horizontal portions and consecutively reversed turns the path forming a part of the belt circuit; the rotatable cylindrical means being divided into two groups of which one group contacts the non-printing side of the belt and the other group contacts the printing side of the belt and each member of the latter group comprises cylindrical discs spaced axially along a shaft in positions to contact, in us, the lands of the belt; the apparatus further including a further group of rotatable cylindrical means supported along a plurality of axes and defining another part of the belt circuit, the latter part surrounding a peninsular region projecting from and below said box-shaped

region and terminating distally in a path around the plate cylinder.

According to a particular embodiment of the invention, a belt-type printing machine incorporates apparatus for supporting an endless printing belt in a serpentine path with horizontal runs compacted within a box-shaped region adjacent the path of a web to be printed. Rotatable cylindrical means are located with their axes parallel and staggered to form the serpentine. As the belt has a non-printing side and an opposite printing side divided into a plurality of transversely spaced rows of image areas and separated by longitudinally continuous non-printing lands, at least the rotatable cylindrical means which contact the printing side have cylindrical disc members in tracking contact with the lands of the non-printing side. An entirely unexpected result of this serpentine arrangement is the improved ease with which the belt tracks over the cylindrical devices.

In the invention, some of the cylindrical means defining the belt circuit are arranged and located with respect to the aforementioned box-shaped region to provide a peninsular region contiguous therewith terminating distally in a plate cylinder adjacent the web path. Such an arrangement of the rotatable cylindrical means enables a substantial portion of the periphery of the plate cylinder, e.g. 180° or more, to be contacted by the belt, thereby providing a valuable increase of belt area for inking equipment, impression roller, or any other equipment requiring rolling contact with the portion of belt supported on the plate cylinder.

The invention will be better understood from the following non-limiting description of examples thereof given with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic illustration of a portion of a belt printing machine in accordance with the prior art.

Fig. 2 is a diagrammatic elevation of essential portions of a two-belt printing machine in accordance with the invention.

Fig. 3 is a diagrammatic elevation of a single printing belt unit illustrating the practice of by-passing portions of the belt-supporting structure in the lacing of short-length belts thereon.

Fig. 4 is a fragmentary schematic elevation of elements of a belt-supporting unit employing different types of cylindrical means shown singly in Fig. 5.

Fig. 5 is a fragmentary perspective view illustrating an extension of a printing belt around two types of rotatable cylindrical belt support rollers.

Fig. 6 is a fragmentary elevation with portions in section illustrating the drive relation of a plate roller and a transfer roll with the printing belt and the printable web therebetween.

Fig. 1 illustrates a prior art arrangement of a printing belt machine wherein a printing belt 5 advances around a driven plate roller 6, an idler rollers 7, 8 and 9. The printing occurs on a web 10 at the nip of the roller 6 and an impression roller 11. Rollers 12 comprise an ink train of which two rollers are observed in rolling contact with the plate roller 6. The circuit of the belt 5 may be lengthened or shortened by operation of a screw device 14 operating on bearing blocks of rollers 9 and 8 to appropriately adjust the circuit length of the machine for different length belts. An apparatus typifying the arrangement of Fig. 1 and, in general, the present state of the art is described in much detail in Stroud et al Pat. No. 3,518,940.

The other figures of the drawings illustrate an example of the invention and show a belt supporting structure which achieves a greater utilization of space necessitated in the building of more complex, e.g., multicolor belt-type printing machines, while utilizing the principals of operation disclosed in the simpler machine of Pat. No. 3,518,940. Fig. 2, for example, discloses that a web 20 originating in a supply roll 21 passes through two printing stations established by the nips of impression rollers 11*a* and 11*b* with respective belts 5*a* and 5*b* supported against the transfer rollers by plate rollers 6*a*, 6*b*, respectively. Fig. 2 illustrates two-belt tracking systems 24, 25, which comprise, in addition to respective plate rollers 6*a*, 6*b*, various nondriven idler rollers 26 to 34 inclusive.

Obvious from the drawing is that rollers 6*a*, 28, 30, 32, 33, ,and 34 contact the non-printing or inner side of the belt 5*a*. A similar situation is true with respect to belt 5*b*. The printing side of belt 5*a* or 5*b* is contacted by rollers 26, 27, 29, and 31. The printing side of the belt is plainly portrayed in Fig. 5 wherein its surface is arranged into longitudinal rows of printing areas covered by flexible printing plates 36 typically of synthetic plastics or rubber-like material separated by longitudinally extending lands 37. The lands and the printing areas comprise the printing side 38 of the belt. Also shown in Fig. 5 is the normally smooth non-printing side 39 of the belt. It will be noted that roller 29, typical of one of the rollers which contact the printing side of the belt, comprises shaft means 41 and a plurality of cylindrical discs 42. The discs are spaced lengthwise of the shaft means to track along the longitudinal lands or nonprinting areas 37 of the belt. The discs 42 are of less width than the lands so as not to interfere with printing media on the belt.

As the belt 5*b* is constituted normally of

nonstretchable but flexible synthetic polymeric material, such as the polyester known under the trademark "MYLAR", the outer peripheral surfaces of the discs 42 may be formed of a similar plastics material or any material providing appropriate hardness enabling firm support of the belt but sufficiently soft to minimize belt wear. "MYLAR" is a Regd. Trade Mark.

Roller 28 is shown as having a continuous cylindrical surface for contacting the nonprinting side of the belt. Rollers 6*a* and 6*b* must, in any event, be of uninterrupted cylindrical contour in order to give the belt solid support in effecting printing as the belt and the web 20 pass through the nip of the plate roller and the transfer roller. However, except for the rollers 6*a*, 6*b*, experience has shown that it may be possible to employ the other rollers which contact the non-printing surface 39, and rollers which are similar in construction to the multiple disc roll 29.

In the operation of printing machines, such as described herein and in Pat. No. 3,518,940, it is important to be able to accommodate the belt tracking systems to belts which differ greatly in length, for example, from 5 to 75 feet. In Fig. 3, the belt is shown as by-passing idler roller 30. When the tracking assembly is of the order of 6 feet, in width, to establish such a by-pass means, it has the effect of accommodating the system to a belt of perhaps 10 or 12 feet shorter in length. However, the system also has to provide for adjustability of increments less than the large increment effected by by-passing an idler roller. Roller 28, positioned within a reverse turn, is shown connected with a screw device 46 by which the roller may be adjusted in a horizontal direction toward and away from its position in the reverse turn toward and away from the rollers 27, 29 to effect substantial increments of adjustment for different belt lengths and thus extend or shorten said circuit. Roller 34 is also shown connected with a screw device 47 which enables minor take-up adjustments of the belt by moving the roll 34 in a vertical direction. As the belt tracking system needs tensioning, the apparatus of one of the idler rollers may be resiliently supported against the web 5*a* in the manner for urging the roller 32 into the reverse turn of the belt as shown in Fig. 3 by a spring 48 or other resilient device.

One of the most frequent chores in tending a printing machine is the servicing of the ink train, such as ink train 51 or 52. The arrangement of a printing machine shown in Fig. 2 is of great convenience in the printing of webs to two or more color tones. While a machine in accordance with Fig. 2 has the capability of printing two tones additional tracking units similar to tracking units 24 and 25 to achieve printing of four or more tones may be readily added.

It will be noted that rollers 27 to 33 form the serpentine path portion of the entire circuit of belts 5*a* or 5*b* within a generally box-shaped region. Rollers 33, 44, 6*a* or 6*b*, 26 and 27 form another portion of the belt circuit that is peninsular with respect to the box-shaped region just described. As tracking systems 24 and 25 are formed with respective peninsular regions in the same relationship with the box-shaped regions, i.e., and an extension of the same corresponding side of the box-shaped region, dihedral regions 55, 56 are formed exteriorly of the belt circuits and, as shown, beneath the respective box-shaped regions, within which the ink trains 51, 52 may be located with much space for an operator to perform service thereon and on the idler rollers of the system. The belt tracking systems may be built to maximum heights within seven feet thereby placing all portions within arm reach of operating or servicing personnel.

In the belt tracking configurations herein described, another advantage results. The peninsular arrangement of a portion of the belt circuit extending around the plate rollers 6*a*, 6*b*, the belt is brought into contact with 180° or more, depending on the location of roller 34, with the plate roller. This feature of the tracking system provides a relatively large area of belt in contact with the tracking roller which may be contacted by other rollers, such as the transfer roller 6*a* and rollers 58, 59 of the ink train 51, or 52. In designing ink trains, it is desirable to place as many ink-carrying rollers as practicable in contact with the portion of the belt supported on the plate roller. In most cases, two inking rollers are desired as a minimum but more are sometimes provided.

As Fig. 2 illustrates, a common drive 62 may be used to drive the web forwarding rollers 61 and the belt advancing systems of both tracking units 24, 25, and the transfer rollers 11*a*, 11*b*, for the purpose of having accurate synchronization of the belt and web speeds. As schematically shown in Fig. 6, power transmission from the transfer roller to the adjacent plate roller 6*a* and hence to the belt 5*a*, as shown in Fig. 2, drive is transmitted to transfer rollers 11*a*, 11*b*, through the common drive system 62. Rollers 6*a*, 11*a*, are mounted on shafts 63, 64, suitably bearinged in a frame member 65, gears 66, 67 mounted on shafts 63, 64, respectively, have pitch diameters corresponding to the diameters of rollers 6*a*, 11*a*, respectively, for identical peripheral speeds. The idler rollers of each belt tracking system are supported on high grade anti-

friction bearings to enable the belt to be driven solely through the sprocket gear 68 in mesh with apertures 69 of the belt 5*a* or 5*b*. The sprocket gear 68 is relatively rotatable with respect to the plate roller through a clutch 71 in a manner such as that described in U.S. Pat. No. 3,518,940. A similar sprocket and clutch mechanism is provided at the opposite ends of the rollers 6*a*, 6*b*. It was discovered in the development of the machine of the aforenamed patent, that relative movement, such as permitted under frictional restriction of the two clutches was needed between the sprocket drive for the belt and the portion of the roll between the sprocket drive to maintain the belt in proper registry with the sprockets at high printing speeds.

It will be seen that the invention as particularly disclosed and illustrated herein provides improved apparatus for storing moving printing belts within a belt-type printing machine while multiple printing stations for processing a single web; reduces the lateral oscillation of belts moving at high linear printing speeds; provides belt-supporting structure of improved belt tracking capability; provides a machine configuration which allows adequate room for operators to perform service functions around the printing stations; to provide apparatus capable of handling a great range of lengths of printing belts; and to permit the envelopment of a large portion of the periphery of each plate cylinder by a belt passing around it.

WHAT WE CLAIM IS:—

1. Apparatus for supporting an endless printing belt having printing and non-printing sides, the former being divided into a plurality of image areas some of which are separated from others by non-printing lands which are continuous in a direction around the belt parallel to the edges thereof, the apparatus including a plate cylinder and an impression cylinder between which the belt passes, and a belt guide assembly which includes rotatable cylindrical means occupying a first region which is generally box-shaped, the cylindrical means being arranged so that their axes are parallel and staggered and the cylindrical means in the first region define a serpentine path of horizontal portions and consecutively reversed turns, the path forming a part of the belt circuit; the rotatable cylindrical means being divided into two groups of which one group contacts the non-printing side of the belt and the other group contacts the printing side of the belt and each member of the latter group comprises cylindrical discs spaced axially along a shaft in position to contact, in use, the lands of the belt; the apparatus further including a further group of rotatable cylindrical means supported along a plurality of axes and defining another part of the belt circuit, the latter part surrounding a peninsular region projecting from and below said box-shaped region and terminating distally in a path around the plate cylinder.

2. Apparatus according to Claim 1 which includes inking apparatus comprising at least one roller in rolling opposition to a peripheral portion of the plate cylinder; said rotatable cylindrical means being arranged so that the peninsular region forms an in-line extension of one side of the box-shaped region to establish a region exterior to said circuit and substantially beneath the box-shaped region in which said inking apparatus is received.

3. Apparatus according to claim 1, or 2 in which at least one of the rotatable cylindrical means is an idler roller of one of the first two groups and the idler roller is supported for movement toward and away from the rotatable cylindrical means of other of the first two groups, in order to shorten or lengthen the belt path.

4. Apparatus of claim 3 in which the idler roller is positioned within one of the reverse turns of the path.

5. Apparatus according to any preceding claim in which an idler roller is resiliently mounted so that it is urged resiliently against the belt.

6. Apparatus according to any preceding claim which includes a plurality of endless printing belts of which each has a non-printing side and an opposite printing side divided into a plurality of transversely spaced rows of printing areas separated by longitudinally continuous lands, and a like plurality of impression and plate cylinders; the apparatus further including means for advancing said web and driving the plate cylinders at synchronous surface contacting speeds, the plate cylinders having associated belt driving means for advancing the respective belts in engagement therewith.

7. Apparatus according to claim 2 or any claim dependent thereon in which the further group of rotatable cylindrical means includes an idler roller which is adjustable to tension the belt.

8. Apparatus according to any preceding claim in which the or each belt has a marginal edge with longitudinally spaced perforations, and the or each plate cylinder has a sprocket-toothed member in coaxial drive relation therewith and in tooth-meshing relation with the or each respective belt.

9. Apparatus for supporting an endless printing belt substantially as hereinbefore described with reference to and as illustrated in any one or more of Figures 2—5 of the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG. 1

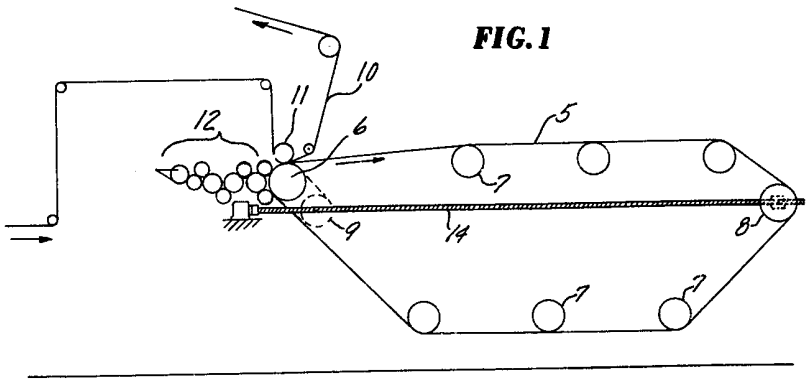

FIG. 2

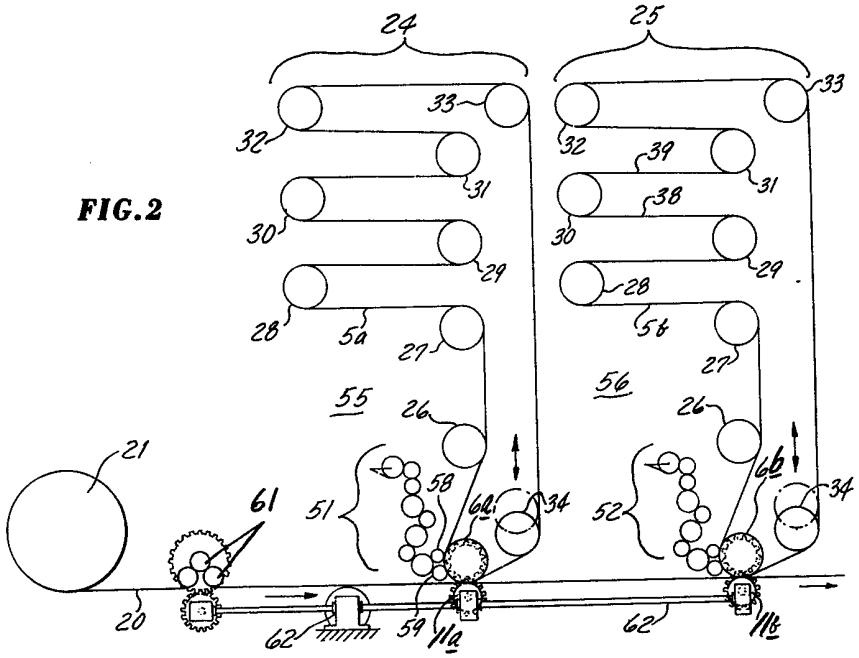

FIG.3

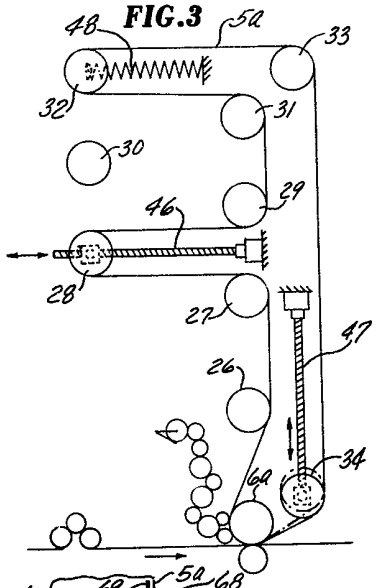

FIG.4

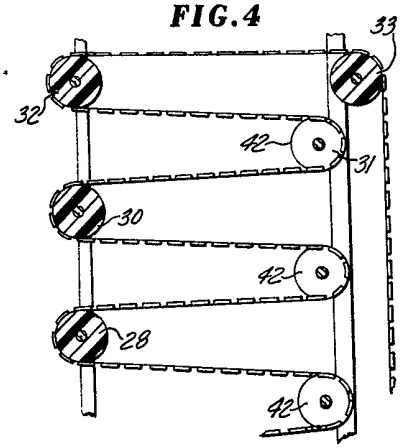

FIG.6

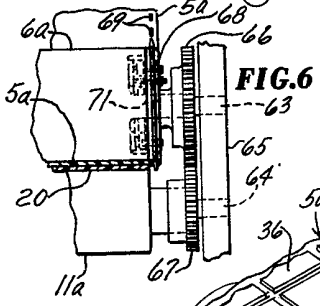

FIG.5