Roller-band apparatus wherein rollers are entrapped in the loops of S-shaped portions of flexible bands, each pair of rollers in such an S-shaped portion of band being known as a "cluster," between special parallel opposed surfaces of a guideway comprising relatively fixed rails having opposed surfaces with each surface consisting of two parallel tracks with a depression or slot therebetween to accept end portions of the band on each side of the cluster, the rollers having a similar depression or groove to accept an intermediate portion of the band at the cluster, and the band as well as at least one roller of each cluster having inter-engaging teeth, this feature enabling precision calibration. The rollers of each cluster have inter-engaging annular flanges and all the rollers have contact portions rolling on the opposed surfaces of the guideway.

The foregoing basic features are applied to an X-Y table with carriages having a pair of guideways each with a pair of clusters with certain of the rollers of opposed clusters connected and power driven and the carriages are mounted for movement at right angles to each other and thus adapted for manipulating circuit boards and the like during fabrication.

15 Claims, 5 Drawing Figures
ROLLER BAND APPARATUS

BACKGROUND OF THE INVENTION

The roller-band technological development commonly referred to under the name “Rolamite,” represents extensive research and is reflected in considerable literature, notably the Government Research Report SC-RR-67-566A and a short synopsis of various types SC-M-68-232A, entitled “Introduction to the Rolamite Mechanical Design Concept” including many variations of rollers, bands, and channel guideways.

Several U.S. Pats. have issued disclosing similar concepts and in the later patents specific embodiments of the roller-band principle involving one or more clusters and different types of bands. These U.S. Pats. include those numbered and dated as follows:


Proposals for the adaptation of the roller-band principle to industrial uses has included among others, incorporation in accelerometers and switches, the principal advantage recognized being the extremely low sliding friction, the coefficient of friction is at least scientifically established as being on the order of 1 percent to 10 percent of the published coefficient of friction in ball and roller bearings at low loads. Since the item hereindisclosed employs power-driven clusters it is important that the technical background relating to slippage be mentioned. The slippage of “sliding” between the band and rollers has been established as negligible with a properly tensioned band, the slippage being least in thinner bands, and the rolling friction being also negligible as reported in technical literature, as for example, the above-cited SC-M-68-232A.

The background related to X-Y tables is very extensive and need not be developed here in view of the fact that the hereindisclosed item is proposed as adaptable to various types of tables universally positionable about two or more axes, rather than being limited to a particular X-Y table construction. However, prior art multidirectional tables have frequently employed lead screws or rack and pinion systems with attendant high inertial and non-accuracy problems, or alternative electronic control systems with attendant complications and high cost. There exists a need, therefore, for a reasonably simple, very accurately controllable carriage drive means for multi-directional tables.

SUMMARY OF THE INVENTION

As claimed, this invention satisfactorily meets the immediately abovementioned need by providing a novel roller-band configuration employing clusters of rollers with narrow bands accommodated in annular depressions in both the rollers and aligned slots in the guideway surfaces, the clusters thus divided into co-planar tracks which the rolling contact portions of the rollers engage while annular flanges on the ends of the rollers interengage to impose a second positional relationship or parameter on the rollers, namely the spacing of the axes and more importantly, the spacing of the rolling contact portions of the rollers so that the band is not compressed between the rollers as in most prior roller-band configurations. The hereindisclosed roller-band arrangement is incorporated into an X-Y table with a pair of clusters in each of the channels for each carriage of the table, and a motor is connected to corresponding rollers in opposing channels for each carriage to drive the same. The slots in the rails of the channels may be provided with teeth, as may the annular depressions in certain of the rollers and the flexible band has corresponding teeth for accurate functioning, the band being very slightly extensible for calibration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of principal portions of an X-Y table incorporating the novel roller-band structure, with portions cut away; FIG. 2 is a sectional view taken on line 2—2 of FIG. 1; FIG. 3 is a sectional view taken on line 3—3 of FIG. 2; FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 1; and FIG. 5 is a further enlarged sectional view taken on line 5—5 of FIG. 4.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

The X-Y table structure as illustrated includes a frame or guideway 10 having fixed parallel channelled rails 12—12 which for ease in reference can be thought of as each having a pair of upper co-planar tracks 14 and a parallel pair of lower co-planar tracks 16 as best shown in FIG. 5, with slots 18 and 20 therebetween and extending longitudinally of the rails 12. For purposes of description the co-planar tracks 14 may be considered as constituting an upper rolling surface and the co-planar tracks 16 as constituting a lower rolling surface, and these rolling surfaces co-act with roller band assemblies, hereinafter described in detail, to support a lower carriage 22 having opposing beams 24 and rails 26 generally similar to the rails 12 and carried by the beams 24, this sub-assembly of beams 24 and rails 26 constituting a second guideway similar to the guideway 10 but since it is movable it is referred to herein as the lower carriage. A second or upper carriage 28 is mounted on rails 26 and likewise includes roller-band means hereinafter described supporting upper carriage beams 30 which carry the table 32 as shown in phantom in FIG. 1.

In each of said rails 12 and 26 there are mounted pairs of roller-band clusters 34, each pair having a single band 36. Both ends of each band are adjustably secured to the same rail by means 40 and 42, illustrated best at the left hand side of FIG. 4 as a slide bar 44 connected as indicated at 46 to the band 36 and retained in the channel of the rail by a cross-piece 48 while adjustable longitudinally of the rail and band by a manually adjustable screw 50 threaded through a portion of the rail. A complete band and associated parts can be very slightly shifted longitudinally of the rail, when required, by selective adjustment of the two means 42 at the ends of the rail. Each roller band cluster comprises two rollers 52 and 54 which may, if desired, be identical. A preferred orientation of the rollers is illustrated in the drawing, namely, an arrangement with the clusters oppositely
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3 inclined and spaced apart. The rollers 52 are free and the rollers 54 are mounted on the beams 24 and 30 by spindles 56 and 58, the first mentioned spindles being mounted to and between an opposing pair of rollers 54, preferably fixedly, and at least one of the rollers in each set of roller-band clusters being fixed to a spindle 58 which is driven as by an electric motor 62 mounted on an adjacent beam 24 or 30. The rollers each have rolling contact portions 64 which engage the tracks 14 and 16, and annular rim flanges 66 at each end, these rim flanges being the only inter-contacting portions of the rollers. These rim flanges determine the spacing of the rolling contact portions 64 of the rollers in a cluster and indirectly the inclination of the cluster as a secondary parameter determining the configuration of the elements in a two-pair set of roller-band clusters as illustrated in FIG. 4, the four rollers of course being held in position by a tightened band 36.

The band 36 is very slightly extensible and may be provided with regularly spaced transverse teeth 68 on one side thereof, while one roller of each cluster, as indicated at 70, has similarly dimensioned teeth engaging the belt. In addition, the root portion of one slot 18, as indicated best at 72 in FIG. 4, may be similarly toothed and that part of the band stretched between the clusters 34 may then present some of its teeth 68 for engagement with the toothed rack at 72, and extensibility of the band enables use of one or both means 42 to obtain perfect contrapositioning of the clusters as well as perfect calibration of said part of the band with the rack 72.

To avoid slippage, the effective or pitch diameter of the annular depressions 74 of the rollers must be substantially equal, consideration being given to the elasticity and thickness of the band 36, and this effective or pitch diameter will always be substantially equal to the diameter of the rolling contact portions 64, making the dimension of the slots 18 and 20 somewhat arbitrary although the slots 18 and 20 always aid in preventing lateral aberration in the band.

Provision of the annular rim flanges 66 on the rollers spaces the rolling contact portions 64 of the rollers and provides clearance for the band 36. This feature is further implemented by provision of undercuts or annular depressions 74 in each roller between the rolling contact portions 64, and it should be noted that the above-mentioned transverse teeth 70 in the corresponding rollers are located in this depression 74.

The pitch circumference of the roller is chosen to be an exact multiple of a standard unit of length such as an inch or centimeter. The toothed band and rollers 54 have a matching circular pitch. The slight extensibility of the band enables the achievement of matching exactitude in the circular pitch dimension in the band.

Channels 76 in the rails 12 and 26 receive the rim flanges 66 of the rollers and prevent lateral drifting of the rollers. The confronting faces of the channels 76 and flanges 66 may be chamfered or bevelled as indicated in FIG. 5. When the hereindescribed roller-band configurations are incorporated in an X-Y table or the like as described above, suitable controls such as stepping switches, not shown, are used to operate the motor 62 in each carriage 22-28 so that the table 32 is given a controlled two-directional movement and this movement can be very rapid and accurately controlled.

1 claim:
1. A roller-band apparatus comprising:

4 an inflexible elongated channelled rail having spaced apart, parallel opposed surfaces;
each of said surfaces each comprising a pair of coplanar tracks with a space extending longitudinally therebetween, the tracks being in opposed relation and extending longitudinally of the rails;
a flexible band having an end portion in each of said spaces and an intermediate portion looped into an inclined S-shaped configuration;
a pair of rollers, each having rolling contact portions with an annular depression therebetween, said contact portions engaging said opposed surfaces, the combined diameters of certain portions of the rollers being greater than the distance between said surface, the rollers being entrapped as an inclined cluster in the loops of said band with the band riding in said annular depressions;
means to tension said band; and
said rollers having anti-drift means engaging said tracks.
2. Apparatus according to claim 1 wherein said anti-drift means comprises rim flanges (66) on the ends of said rollers, and channels (76) in said rails at the longitudinal edges of said tracks remote from said space.
3. Apparatus according to claim 1 wherein said rollers have interengaging annular flanges at each end of the rollers, said flanges being the only inter-contacting portions of the rollers.
4. Apparatus according to claim 1 wherein said flexible band has regularly spaced teeth thereon, and said rollers have annular depressions (74) aligned with said space between the tracks, and the depression in one roller has a correspondingly toothed root portion engaging said teeth.
5. Apparatus according to claim 4 wherein said flexible band is slightly extensible and said tensioning means is adjustable to obtain calibration regulation.
6. Apparatus according to claim 1 wherein the diameter of said rolling contact portions is equal to the effective operative pitch diameter of said annular depressions in the rollers.
7. Apparatus according to claim 1 wherein said rollers are duplicated as a second cluster between the same tracks.
8. Apparatus according to claim 7 wherein said second cluster of rollers is entrapped in the same flexible band and inclined in the opposite direction to the first mentioned cluster.
9. Apparatus according to claim 2 wherein the inner edges of said flanges and the adjacent edges of said tracks are all correspondingly bevelled.
10. Apparatus according to claim 7 and including a second rail parallel to and spaced from the first-mentioned rail and having a second similar flexible band with a second set of two clusters of rollers; said clusters of rollers in the two rails being in opposed relationship; said rails being rigidly inter-connected; and a carriage supported on and shiftable with said rollers.
11. Apparatus according to claim 10 and including a spindle directly connecting a roller in the first-mentioned rail with a similar corresponding roller in the second-mentioned rail.
12. Apparatus according to claim 10 and including a motor operatively connected with one of said rollers.
13. Apparatus according to claim 12 and wherein said rails, belts,
clusters and carriage as a first assembly are all substantially duplicated as a second assembly supported on the carriage of said first assembly and at an angle to the first assembly, whereby the carriage of the second assembly is utilizable in an X-Y table and the like.

14. Apparatus comprising:
at least a first and a second assembly, each assembly having parallel rails and roller-band clusters operatively mounted on said rails and a carriage supported by said rollers; said assemblies being angulated with reference to each other and said second assembly being supported by the carriage of the first assembly,

whereby the carriage on the second assembly is utilizable as in an X-Y table and the like.

15. Apparatus according to claim 14 wherein said clusters include bands;
a band tensioner operatively mounted at each end of each band;
said clusters being oppositely mounted on said parallel rails;
whereby said clusters are made positionally adjustable longitudinally of the rails to enable manual adjustment for perfect contrapositioning of the clusters on the parallel rails.

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