IN THE ANNEXED DRAWINGS

FIG. **1** is a schematic side view, partly in cross section, of a device according to the invention,

FIG. **2** is a top view of part of a support in the device of FIG. **1**,

FIG. **3** is a part view, partly sectioned, of a drum in the device of FIG. **1**,

FIG. **4**A and FIG. **4**B are sectional views corresponding to lines IVa—IVa and IVb—IVb, respectively, of FIG. **3**,

FIG. **5** shows an enlarged part view of the zone marked V in FIG. **4**A,

FIG. **6** is an enlarged side view, partly sectioned, of a ball removal station in the device of FIG. **1** and

FIG. **7** is a top view of an apertured plate in the station of FIG. **6**.

DESCRIPTION

The device according to the invention is generally designated by **10** and is represented in FIG. **1** in about natural size, if somewhat shortened. It comprises a frame **12** with an upper plate **14** and a lower plate **16**. Between these two, braces **18** are provided for propping. A belt band **20** that may include two or more fields of parallel perforations **22** is contiguous on top of the upper plate **14** (FIG. **2**). Belt band **20** is a conveying means of tough and flexible, non-stretching material such as leather, plastics, coated fabric, etc. and is preferably enclosed by a thin foil **70** engaging the belt band at least across the perforation fields. Near either edge, belt band **20** includes engaging holes **24** into which fit sprockets **26** of wheels or tracks **28** that are attached to two drums **30**, **32** or are integral therewith (FIGS. **3** to **5**). As will be seen in FIG. **1**, an electric motor **36**, possibly a step motor, may be provided for enslaving one of these drums, e.g. **30**. If desired, the drum or either drum can also be rotated by means of a hand wheel **58** (FIG. **3**).

The sectional view of FIG. **4**A shows the engaging wheel portion **28** of drum **30** to have radial counterbores **68** for receiving the elements of sprockets **26**. In the embodiment according to FIG. **5**, these are made up by balls, but cylindrical, conical and other projections (**26**) are suited as well. For supporting the drums **30**, **32**, bearings **72** are mounted to either side of frame **12** (FIG. **3**).

With particular reference to FIGS. **2** and **3**, it will be seen that the endless belt band **20** includes, say, two screen fields of bores serving to receive magnetizable balls **38** (FIGS. **5** and **6**), i.e. which consist of magnetically permeable material. A ball feeding station **40** comprising a chute **42** with a bin **44** is provided at the lower side of frame **12**. Underneath this station, sorter compartments **46** (merely indicated schematically) may be arranged for collecting and feeding the balls **38** which are, under the force of a permanent filler magnet **74**, advanced into the perforations **22** of belt band **20** that is passing below in contiguous relation to lower plate **16**.

As an example of dimensions, the perforations **22** or indentations in belt band **20** may have a diameter 1.7 mm which is suitable for receiving steel balls having a diameter $d \leqq 1.6$ mm, and the clear width w of the coil passages **54** may expediently be chosen to be 2.0 mm. If the belt band **20** has a thickness or cheek of 1.0 mm, the ball tips will project therefrom by 0.6 mm. The balls **38** are prevented from falling out by the thin foil **70** that encloses the belt band **20** (FIG. **7**) but permits sensing the balls tactually.

Under the power of the drive system, drum **30** rapidly moves belt band **20** to a ball removal station **50** arranged above the feeding station **40** (FIGS. **1** and **6**). The removal station **50** includes an upper apertured plate **62** below which there are electromagnets **52** with coils **56**. The cores **53** of coils **56** consist of magnetically permeable or ferromagnetic material such as iron and include a thin unmagnetic lining, e.g. of brass, providing axial passages **54** for balls **38**. Belt drive **34** is set going already while a perforated portion of belt band **20** is at the removal station **50**. Balls **38** will arrive there only when the full belt speed of, for example, 500 mm/s will be reached. Thus a time period of merely about 3 ms is available for moving a ball **38** across a hole **54**. In this short time, the gravity fall path amounts to only about 50 μm and is, therefore, negligible.

The invention provides for selectively actuating the electromagnet **52** associated to a particular hole **54**, by energizing the respective coil **56**, at the moment when a ball **38** arrives so that it will be sucked off downwards with an acceleration that is about 500 to 1000 times larger than that of gravity. The ball sucked off will shoot through passages **54** without sticking to any magnetic material and will fall into bin **44** and chute **42** (FIG. **1**). An outer housing **55** (FIG. **6**) connecting the lower ends of coil cores **53** to upper plate **14** prevents a magnetic brake effect on the balls **38** which then return to the feeding station **40**.

The upper apertured plate **62** and a lower apertured plate **64** serve to mount the electromagnets **52** (FIG. **7**). Bores **66** that receive the upper and lower ends of electromagnets **52** are arranged in several parallel rows and are spaced by distances a in the longitudinal direction L. Each of these rows is staggered relative to the adjacent row by an offset dimension v which is chosen to equal the quotient of the ball spacing k in belt band **20** divided by the number of aperture rows.

In order that no counterforce impede the ball movement in the lower half of each electromagnet **52**, these are actuated—preferably by control of a microprocessor (not shown)—only during part of the time period T required for moving belt band **20** in longitudinal direction L across one ball spacing k. It will suffice to energize the individual electromagnets **52** during about T/4 if (as depicted) there are four aperture rows staggered by k/4 each. To begin with, the electromagnets neighboring in direction Q are sequentially actuated. Simultaneously with the advance of belt band **20** by a quarter of a ball spacing, i.e. by k/4, the exciting voltage is applied to the next transverse row of electromagnets, commencing with the first aperture row (topmost in FIG. **7**).

Owing to the short duration of the sucking-off operation, the ball set-up is sped up considerably. It is thus possible to control the electromagnets **52** according to a multiplex program yielding interleaved time gates or windows, so that one and the same electronic control means can be used sequentially for all the electromagnets. Device **10** can be controlled by an uncomplicated interface (not shown) of a low-priced computer including a software driver. Arbitrary graphic information can be displayed, in particular embossed print or braille. There is no restriction to pure texts but pictorial representations, tables, diagrams, schemata or the like may be displayed as well. In addition, clear texts, plots, etc. may be displayed for both tactile and visual perception.