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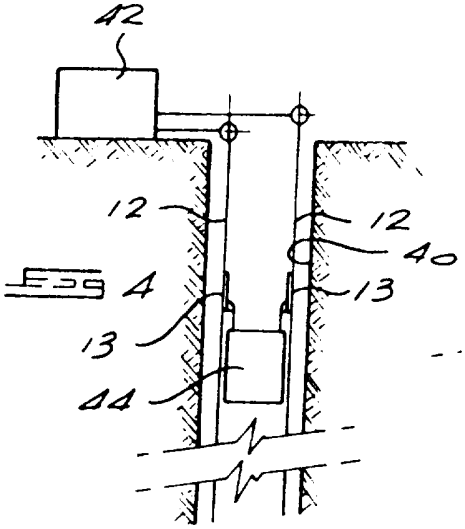
(54) **Title:** MINE SHAFT CONVEYANCE SYSTEM

(57) **Abstract:** The mine shaft conveyance system makes use of a synchronous linear motor to drive mine conveyances up and down a shaft. The system includes spaced parallel winding support members which carry stator windings and between which a reaction member is located so as to be driven in the required direction by electromagnetic forces when current is supplied to the windings. The reaction member is flexible about at least one axis transverse to the length of the winding support members.



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(56) **Documents cited:** US 3 896 736 JP 01-203 182

"SHAFT CONVEYANCE SYSTEM"

THIS invention relates to a shaft conveyance system.

Existing underground mines use vertical shafts and a system of personnel and material cages and ore skips for transporting men and materials underground. The cages and skips are carried by steel ropes which are wound in and out on drums. In the underground mine itself, trains, rock conveyors and so forth are used to transport men and materials from one point to another. There are practical limitations on the depth of shafts imposed by the capacities of the winding equipment used to raise and lower the shaft conveyances. In deep mines, this means that sub-shafts may have to be sunk underground. This in turn means that to get to the bottom of the mine, men and materials may have to transfer from one shaft to another. Clearly, the required transfer from one shaft to another is time-consuming and counter-productive. Even when the men and materials have arrived at the required level in the mine, time is lost in travelling by one means or another to the work site.

It would be advantageous to have an integrated conveyance system in which men and materials could be conveyed from a starting point on the surface to the worksite or at least to the lower levels of the mine without having to change shafts.

It is an object of the present invention to provide such a shaft conveyance system.

The invention provides a shaft conveyance system comprising a linear motor having spaced, parallel, elongate winding support members carrying stator windings, the winding support members being mountable in a shaft so as to extend in the longitudinal direction of the shaft, and a reaction member located between the winding support members so as to be driven up and down the shaft by electromagnetic forces, the reaction member being flexible about

at least one axis transverse to the length of the winding support members and having means for the attachment thereto of a shaft conveyance which is to be driven up and down the shaft.

In a preferred embodiment, the linear motor is a synchronous motor, in which case the reaction member may comprise one or more permanent magnets. Typically, the reaction member includes a plurality of permanent magnets in articulated relationship. The magnets may, for instance, be articulated to one another for relative pivotal movement about axes which are transverse to the length of the winding support members and which lie in a plane parallel to the faces of the winding support members.

The invention extends to a shaft in which:

a) spaced, parallel elongate winding support members carrying stator windings are mounted, the winding support members extending in the longitudinal direction of the shaft;

b) a reaction member is located between the winding support members so as to be driven up and down the shaft by electromagnetic forces, the reaction member being flexible about at least one axis transverse to the length of the winding support members and having means for the attachment thereto of a shaft conveyance which is to be driven up and down the shaft; and

c) guide means extend in the longitudinal direction of the shaft for guiding the movement of the conveyance or the reaction member up and down the shaft.

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1	shows a perspective view of a shaft linear motor conveyance system of the invention;
Figure 2	shows a schematic cross-sectional view at the line 2-2 in Figure 1;
Figure 3	shows a detail of the lower end of the reaction member; and
Figure 4	shows a schematic view of a shaft fitted with a linear motor conveyance system of the invention.

Figure 1 shows a linear motor conveyance system of the invention. The system includes two pairs of winding support members 10 of a suitable conducting material, such as soft iron construction and they carry stator windings 12 which are seen in Figure 2 but which are omitted from the other Figures in the interest of clarity of illustration. The winding support members form the stator of a three\-phase synchronous motor.

The reaction members or "rotors" 13 of the motor each comprise a series of permanent magnets 14 of which the poles are at the major surfaces 16. Each permanent magnet 14 may itself be in the form of an assembly of smaller permanent magnet blocks abutting together. The magnets 14 are articulated to one another in the manner illustrated in Figure 3, such that they are capable of pivoting relative to one another about axes 18. The articulation is achieved by means of lugs 20 formed with aligned holes receiving studs 22 in pivotable fashion. The reaction members 13 are located centrally between the winding support members 10 with small airgaps on either side.

A plate 24 is connected in articulated fashion to the lowest magnet 14 of each reaction member 13. Shackles 26 connects cables 28 to the plates, the cables carrying the conveyance, in the illustrated case represented diagrammatically by a platform 30.

The two pairs of winding support members 10 extend vertically in a shaft (not illustrated) and are connected to the shaft buntons or other shaft steelwork. The intention is to drive the platform 30 upwardly and downwardly in the shaft. Those skilled in the art will readily recognise the manner in which the reaction members 13 are driven by electromagnetic forces in the desired direction when current is supplied to the windings 12.

Figure 4 shows a schematic view of a shaft 40 which may have a considerable depth, possibly a few thousand metres or even more. Electrical current is supplied to the winding support members 12, which are fixed in the shaft 40, by means of a surface-located power source 42. The conveyance, typically a cage or skip, which is to be driven up and down the shaft is indicated with the reference numeral 44 and the reaction members with the numeral 13.

It will be observed that the axes 18 are at right angles to the direction of designed movement, i.e. they are horizontal, and that they are in a plane parallel to the opposing faces of the winding support members 10. Thus the reaction members 13 are flexible in a vertical plane about the axes 18. The reaction members can flex readily to take account of local variations in the straightness of the winding support members or guiding steelwork, due for instance, to manufacturing or installation inaccuracies, shaft sinking inaccuracies and rock movements in the shaft. This in turn enables the reaction members to maintain their central positions between the winding support member. Furthermore, the flexible nature of the reaction members enables them to turn through the required angle on moving from a vertical path in the shaft to a horizontal path at the surface or underground. Because

the magnets 14 are relatively small in size, the reaction members will be able to negotiate curves in the vertical plane of fairly small radius of curvature.

The platform 30 is shown by way of example only. It will be appreciated that the conveyance which is to be driven up and down the shaft could take any one of a variety of different forms, such as personnel cages, ore skips and so forth. Referring to Figure 1 it will be seen that the platform is fitted with wheels 32 which ride on the edges of the winding support members 10 or guiding steelwork to guide the platform as it moves. Also, the magnets 24 carry small wheels 34 which will ride on the winding support members in the event of any temporary undesired movement of the reaction members away from their central positions between the winding support members. Further guide wheels 36 are also provided on the plates 24 to ride on rails of guiding steelwork situated alongside the winding support members.

The embodiment described above allows the reaction members to flex in one vertical plane only. However, the invention envisages a modification in which flexure could take place in other planes as well. The magnets 14 could, for instance, be articulated to one another by means of universal hinges. Alternatively, the assembly of magnets could be replaced by one or more magnets which are themselves made of flexible material.

CLAIMS:

1.

A vertical shaft conveyance system comprising a linear motor having spaced, parallel, elongate winding support members carrying stator windings, the winding support members being mountable in a shaft so as to extend in the longitudinal direction of the shaft, and a reaction member located between the winding support members so as to be driven up and down the shaft by electromagnetic forces, the reaction member being flexible about at least one axis transverse to the length of the winding support members and having means for the attachment thereto of a shaft conveyance which is to be driven up and down the shaft.

2.

A shaft conveyance system according to Claim 1, wherein the linear motor is a synchronous linear motor and the reaction member comprises one or more permanent magnets.

3.

A shaft conveyance system according to Claim 2, wherein the reaction members comprises a plurality of permanent magnets in articulated relationship.

4.

A shaft conveyance system according to Claim 3, wherein the magnets are articulated to one another for relative pivotal movement about axes which are transverse to the length of the winding support members and which lie in a plane parallel to the faces of the winding support members.

5.

A shaft conveyance system according to any one of the preceding claims and comprising a member articulated to the reaction member and having means thereon from which the conveyance can be suspended.

6.

A shaft

in which:

a) spaced, parallel elongate winding support members carrying stator windings are mounted, the winding support members extending in the longitudinal direction of the shaft;

b) a reaction member is located between the winding support members so as to be driven up and down the shaft by electromagnetic forces, the reaction member being flexible about at least one axis transverse to the length of the winding support members and having means for the attachment thereto of a shaft conveyance which is to be driven up and down the shaft; and

c) guide means extending in the longitudinal direction of the shaft for guiding the movement of the conveyance or the reaction member up and down the shaft.

7.

A shaft according to Claim 6 wherein the winding support members and the reaction member constitute a synchronous linear motor, the reaction member comprising one or more permanent magnets.

8.

A shaft according to Claim 7 wherein the reaction member comprises a plurality of permanent magnets in articulated relationship.

9.

A shaft according to Claim 8 wherein the magnets are articulated to one another for relative pivotal movement about axes which are transverse to the length of the winding support members and which lie in a plane parallel to the faces of the winding support members.

10.

A shaft conveyance system substantially as herein described with reference to the accompanying drawings.

DATED THIS 8th DAY OF March 1990

FISHER CORMACK & BOTHA
Patent Agents for the Applicants

ABSTRACT

The shaft conveyance system makes use of a synchronous linear motor to drive conveyances up and down a shaft. The system includes spaced parallel winding support members which carry stator windings and between which a reaction member is located so as to be driven in the required direction by electromagnetic forces when current is supplied to the windings. The reaction member is flexible about at least one axis transverse to the length of the winding support members.

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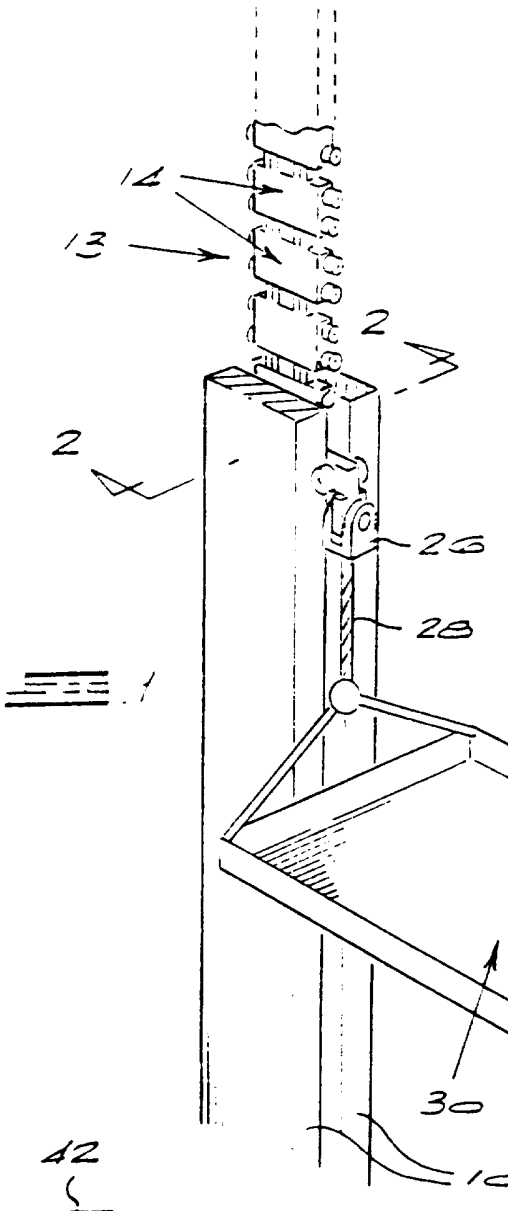

FIG. 1

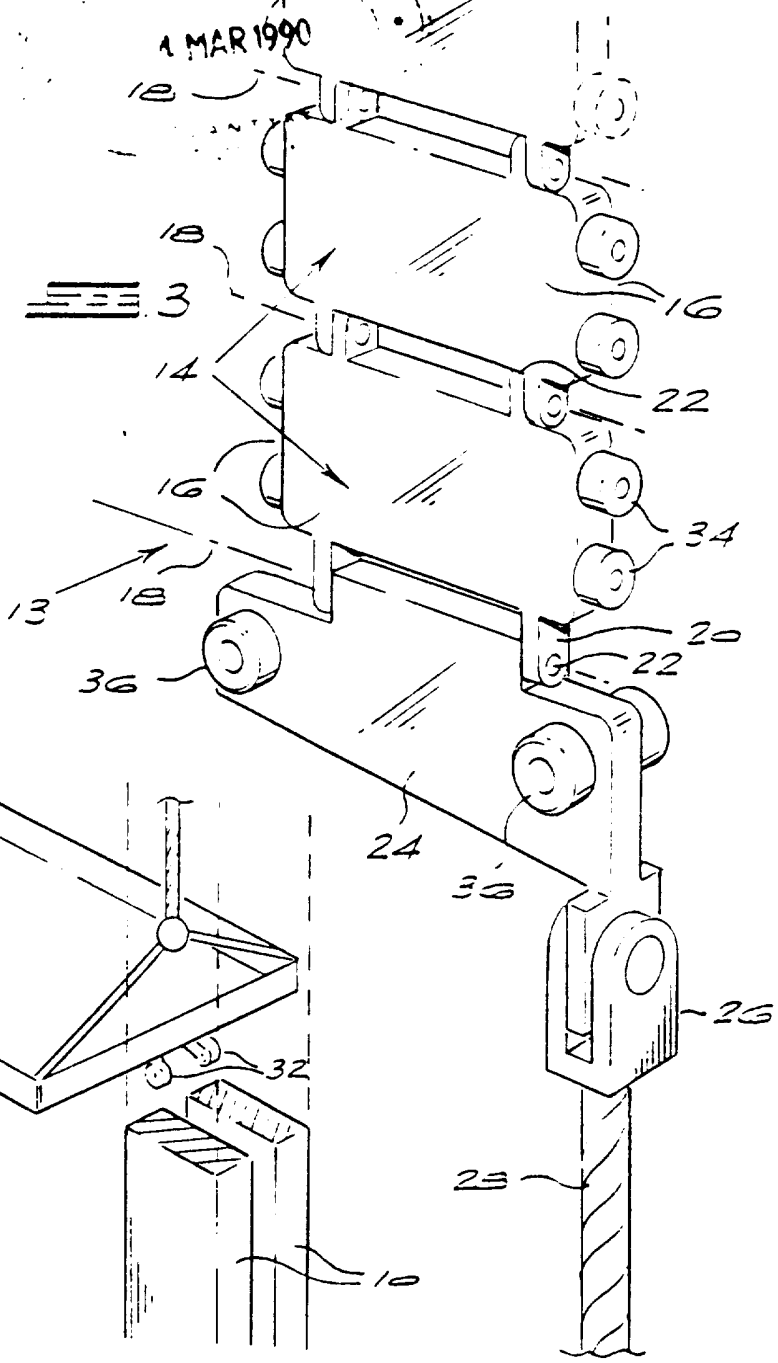

FIG. 3

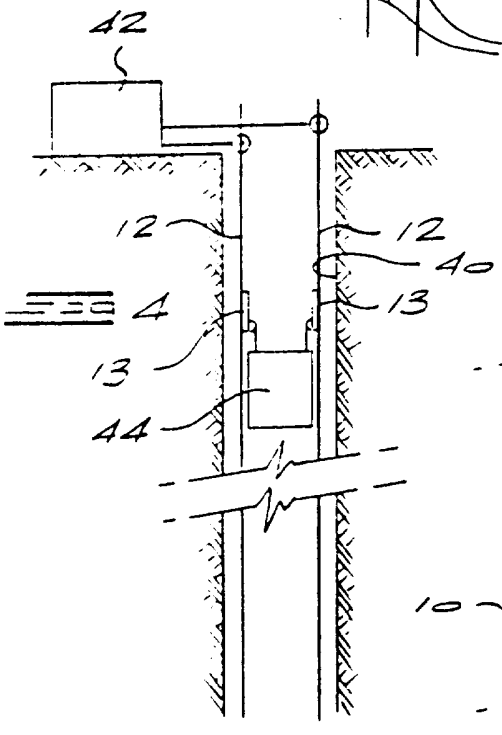

FIG. 4

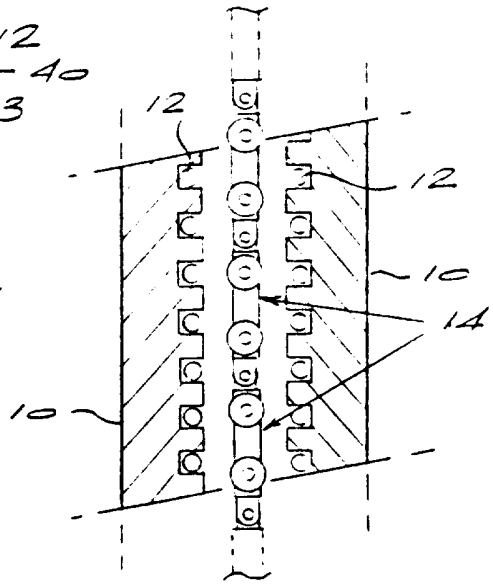

FIG. 2