Sept. 9, 1947. C. F. BALL 2,426,980

ARTICULATED SHAFT DRIVE FOR THE FLEXIBLE CONVEYER OF SHUTTLE CARS

Filed May 30, 1945 2 Sheets-Sheet 1

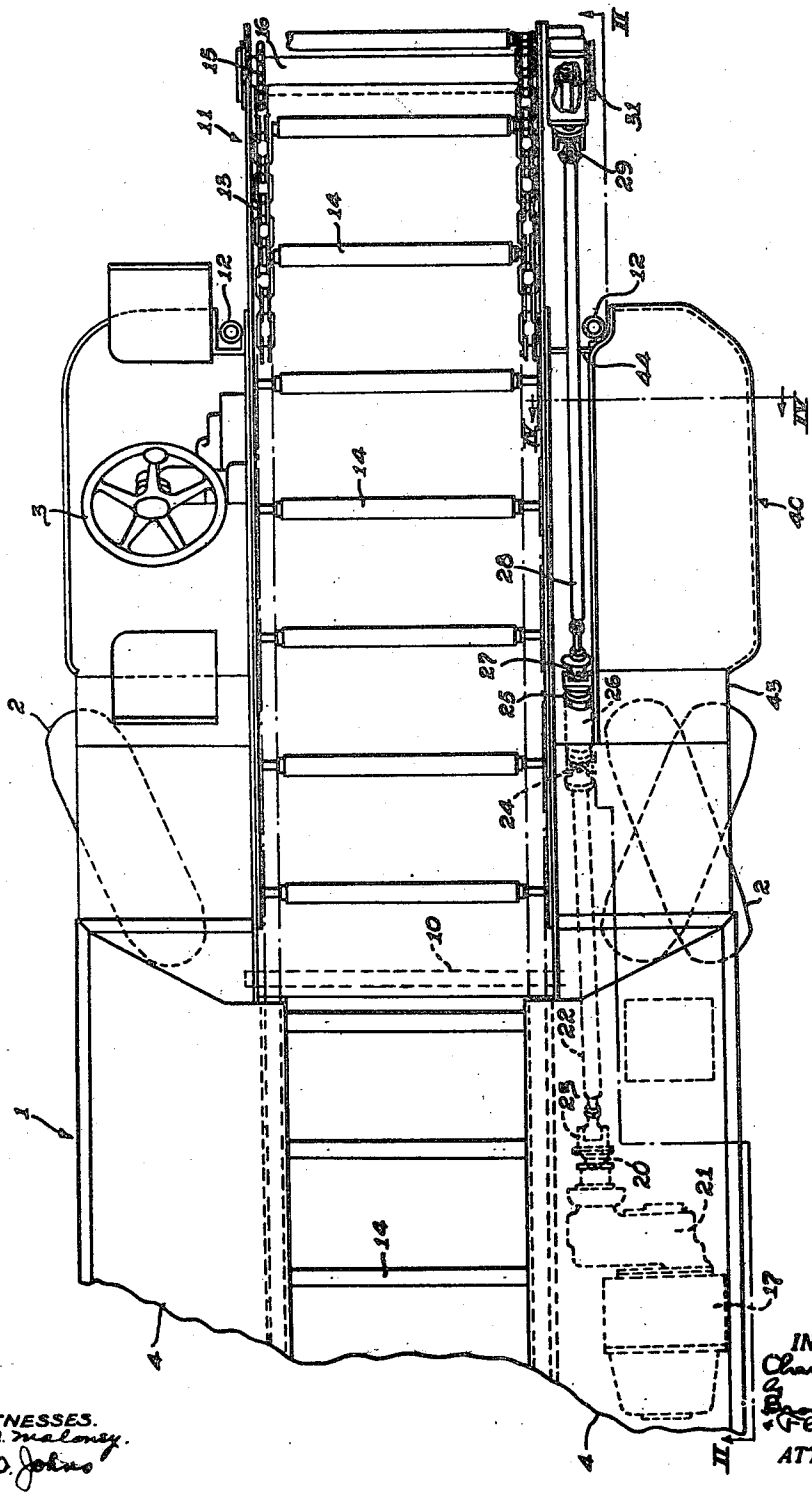



Fig. 1.

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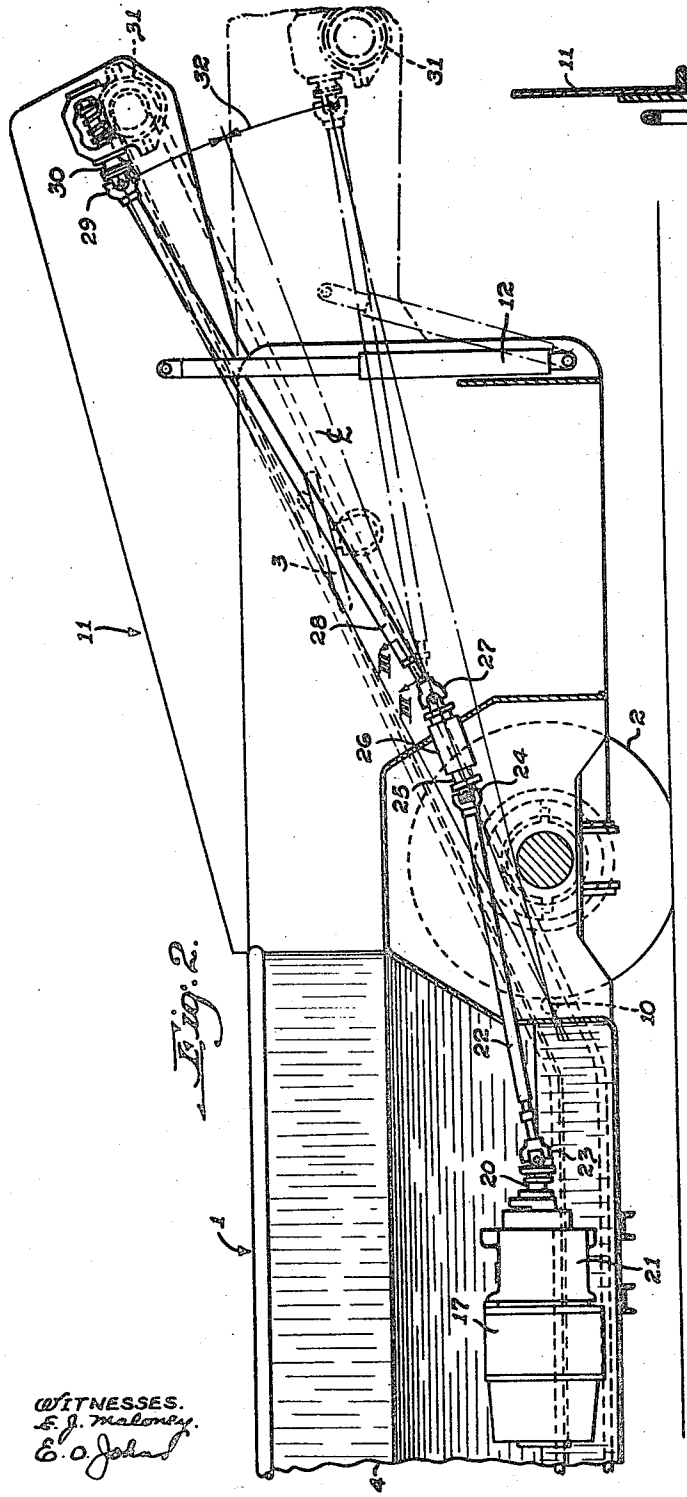



Fig. 2.

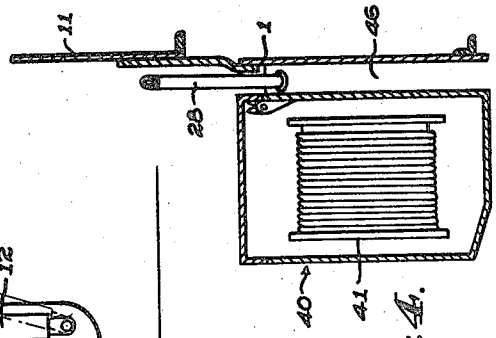



Fig. 4.

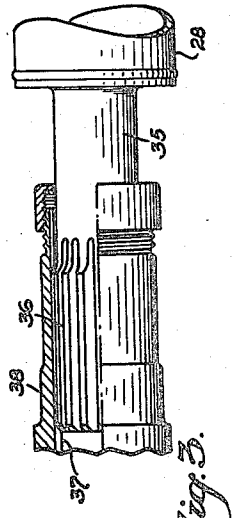



Fig. 5.

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# UNITED STATES PATENT OFFICE

2,426,980

## ARTICULATED SHAFT DRIVE FOR THE FLEXIBLE CONVEYOR OF SHUTTLE CARS

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8 Claims. (Cl. 214—83)

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The invention relates to automotive shuttle cars which are now used extensively in mines to haul mined material, such as coal, from the working area of a mine to the main line haulage, and has particularly to do with shuttle cars of the type that are equipped at their outer ends with discharge sections which are pivoted to the cars for vertical adjustment throughout substantial arcs so that the material transported by the cars may be delivered directly to belt conveyors, mine cars, or any other instrumentality which forms the main line haulage.

For discharging the material that it hauls, a shuttle car of the type here contemplated is provided with a continuous flexible conveyor which has an active strand that extends throughout the bottom of the car and of the discharge section that is pivotally connected to the car, the conveyor being driven at the outer end of a discharge section by a motor that is mounted on the car. Due to the weight of the material in the car that is sustained by the conveyor, particularly at the beginning of an unloading operation, a large amount of power is required to drive the conveyor and heavy strains are accordingly imposed upon the conveyor driving connections, which, because of the vertical adjustability of the discharge section, are necessarily of a flexible character.

The object of the invention is to provide shuttle cars of this type with a conveyor drive of the articulated shaft type that is so constructed and arranged that the conveyor is driven with a minimum loss of power efficiency throughout the range of vertical adjustment of the discharge section of the car, and that the portion of the drive that is attached to the discharge section may move freely in a vertical direction with such section.

The invention is illustrated in the accompanying drawings, of which Fig. 1 is a plan view of the front portion of a shuttle car, including all of its discharge section; Fig. 2 an elevation of the car taken on the broken line II—II, Fig. 1; Fig. 3 a sectional view of a detail of the drive, the view being taken on the line III—III of Fig. 2; and Fig. 4 a vertical sectional view through a cable reel box, the plane of view being indicated by the line IV—IV, Fig. 1.

The shuttle car 1, whose forward end only is illustrated in the drawing, may be of the self-loading type or of the type that is loaded by a loading machine or otherwise. The car is of the automotive type having wheels 2 adapted to be controlled in the usual manner by a steering

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wheel 3, and is provided with a material-receiving hopper having side walls 4 which flare outwardly from the bottom of the car and then extend vertically. To the forward end of the car there is pivotally connected at 10 a discharge section 11 that is vertically adjustable and which is shown in Fig. 2 in full lines in its uppermost and in dotted lines in its lowermost position. The discharge section may be raised and lowered by hydraulic jacks 12 whose lower ends are pivotally connected to the car body and whose upper ends are similarly connected to the discharge section.

A continuous flexible conveyor 13, provided with scraper flights 14, has its active strand extending throughout the bottom of the hopper portion of car 1 and throughout the bottom of discharge section 11 for delivery of material from the car to a main line haulage. Effectively to apply driving power to the conveyor, its side chains are driven by sprockets 15 that are connected to a driven shaft 16 at the outer end of the discharge section, power for the drive being supplied by a motor 17 which is borne by the car body at the rear of pivot 10 in the available space below the outwardly flaring portion of one of the side walls 4 that form the hopper.

The conveyor drive provided according to this invention consists of an articulated shaft that extends from the motor to the outer end of the discharge section, the shaft comprising an inner section that is connected at its inner end by a universal coupling to the motor, an outer section whose outer end is connected by a universal coupling to the conveyor, and an intermediate section which is rotatably borne by the car body in front of the pivotal connection of the discharge section to such body, and which is connected at its ends by universal couplings to the adjacent ends of the inner and outer shaft sections.

Having reference to the embodiment of the invention illustrated in the drawings, motor 17 drives a horizontally disposed driving shaft 20 through a suitable speed reducer 21. An upwardly inclined inner section 22 of an articulated drive shaft is connected at its inner end by a universal coupling 23 to drive shaft 20, and is connected at its outer end by a universal coupling 24 to an end of a short intermediate shaft section whose axis is upwardly inclined with relation to that of inner shaft section 22. Intermediate shaft section 25 is journaled in antifriction bearings within a housing 26 which is rigidly connected to the car body. The outer end of intermediate shaft section 25 is connected by a uni-

versal coupling 27 to the inner end of an outer section 28 of the articulated shaft, and the outer end of this section is connected by a universal coupling 29 to a worm shaft 30 that meshes with a worm 31 attached to the conveyor drive shaft 16 at the outer end of discharge section 11.

In Fig. 2 discharge section 11 is shown in full lines at the highest position to which it can be adjusted for discharging material and is shown in dotted lines in its lowermost adjustable position, and the arc through which the outer end of outer shaft section 28 can swing throughout the range of adjustment of the discharge section is indicated at 32, the arc being struck from the center of universal coupling 27 at the inner end of shaft section 28. So that power can be transmitted to the conveyor with a minimum loss of efficiency throughout this range of adjustment of the discharge section, the axial line of intermediate shaft section 25 preferably bisects arc 32. Similarly to minimize the loss of power efficiency, the angle formed between the axial line of inner shaft section 22 and that of intermediate shaft section 25 is, as shown, preferably the same as the angle formed between the axial line of shaft section 22 and that of horizontally disposed drive shaft 20.

Because intermediate shaft section 25 is in front of the pivot axis of discharge section 11 and because the intermediate shaft section is borne by the car body with relation to which the discharge section moves throughout its range of adjustment, there is a variation in the length of outer shaft section 28 in the variable adjusted positions of the discharge section. To compensate for this variation in length, shaft section 28 is provided with a slip joint such as shown in Fig. 3. As there illustrated, the inner end of shaft section 28, which is shown as being tubular, is provided with an extension 35 whose outer face is equipped with longitudinal splines 36 that lie in correspondingly shaped grooves 37 formed on the interior of a sleeve 38 to which arms of universal coupling 27 are connected. Inner shaft section 22 may, as shown, be provided with a like slip joint to facilitate assembly of the drive connection.

The forward end of main body 1 of the car is provided with a box 40 for housing an electric cable reel 41, the cable being paid out or wound on the reel depending upon the direction of movement of the car. The box is so attached to the car body 1 that a space is formed between it and the outer wall 42 of the car, in which the outer section 28 of the shaft lies. Preferably the rear end of box 40 is attached to the forward end of a fender 43, and the forward end of the box is attached by brackets 44 that extend between car body 1 and the inner wall 45 of the box. This forms a space 46 in which shaft section 28 may move vertically with the vertical adjustment of discharge section 11. As shown in Fig. 4, this space is open at its top and bottom so that particles of coal or other mined material that enter the top of the space will not accumulate in it and interfere with the free vertical movement of the shaft section.

In using the shuttle car, the outer end of discharge section 11 may be raised or lowered to empty material from the car onto main lines of haulage at various elevations throughout the range of adjustment of the outer end of the discharge section. The articulated drive shaft here provided is a direct positive drive that is free from vibrations and is capable of transmitting



power with a minimum loss of efficiency throughout the range of adjustment of the discharge section.

According to the provisions of the patent statutes I have explained the principle and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than specifically illustrated and described.

I claim:

1. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, and a motor borne by said body at the rear of said pivotal connection; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising an inner section connected by a universal coupling to said motor, an outer section connected by a universal coupling to said conveyor at the outer end of said discharge section, and an intermediate section rotatably borne by said car body in front of said pivotal connection and connected at its ends by universal couplings to the adjacent ends of said inner and outer sections.

2. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, and a motor borne by said body at the rear of said pivotal connection; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising an inner section connected by a universal coupling to said motor, an outer section connected by a universal coupling to said conveyor at the outer end of said discharge section, and an intermediate section rotatably borne by said car body in front of said pivotal connection and connected at its ends by universal couplings to the adjacent ends of said inner and outer sections, the axis of said intermediate shaft section lying in a line that extends between the axial lines of said outer shaft section at the limits of the arcuate adjustment of said discharge section of the car.

3. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, and a motor borne by said body at the rear of said pivotal connection; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising an inner section connected by a universal coupling to said motor, an outer section connected by a universal coupling to said conveyor at the outer end of said discharge section, and an in-

termediate section rotatably borne by said car body in front of said pivotal connection and connected at its ends by universal couplings to the adjacent ends of said inner and outer sections, the axis of said intermediate shaft section lying in a line that extends midway between the axial lines of said outer shaft section at the limits of the arcuate adjustment of said discharge section of the car.

4. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, a motor borne by said body at the rear of said pivotal connection, and a horizontally disposed drive shaft adapted to be driven by said motor; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising an upwardly inclined inner section connected by a universal coupling to said drive shaft, an outer section connected by a universal coupling to said conveyor at the outer end of said discharge section, and an upwardly inclined intermediate section rotatably borne by said car body in front of said pivotal connection and connected at its ends by universal couplings to the adjacent ends of said inner and outer sections, the angles formed between the axial line of said inner shaft section and the axial lines of said drive shaft and said intermediate shaft section being substantially equal.

5. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, a motor borne by said body at the rear of said pivotal connection, and a horizontally disposed drive shaft adapted to be driven by said motor; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising an upwardly inclined inner section connected by a universal coupling to said drive shaft, an outer section connected by a universal coupling to said conveyor at the outer end of said discharge section, and an upwardly inclined intermediate section rotatably borne by said car body in front of said pivotal connection and connected at its ends by universal couplings to the adjacent ends of said inner and outer sections, the axis of said intermediate shaft section lying in a line that extends midway between the axial line of said outer shaft section at the limits of the arcuate adjustment of said discharge section of the car, and the angles formed between the axial line of said inner shaft section and the axial lines of said drive shaft and said intermediate shaft section being substantially equal.

6. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end, a continuous flexible conveyor



having its active strand extending throughout the bottoms of said body and of said discharge section, a motor borne by said body at the rear of said pivotal connection, and a cable reel box attached to a side of said body at the front of said pivotal connection; of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft having a section that moves vertically with said discharge section and extends through a vertical space formed between said car body and cable reel box, said space being open at its top and bottom.

7. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, and a motor borne by said body at the rear of said pivotal connection, of an articulated shaft extending from said motor to the outer end of said discharge section for driving said conveyor, said shaft comprising a plurality of sections of which one is connected by a universal coupling with said motor and another is connected by a universal coupling with said conveyor at the outer end of said discharge section, and means carried by the body, at a point substantially spaced both from the universal coupling with the motor and the universal coupling with the conveyor, for supporting a section of said shaft for rotation on a fixed axis.

8. In a mine shuttle car, the combination with a body formed for receiving material to be transported, a discharge section pivotally connected at its inner end to said body for vertical adjustment of its outer end through a substantial arc, a continuous flexible conveyor having its active strand extending throughout the bottoms of said body and of said discharge section, and a motor borne by said body at the rear of said pivotal connection, of an articulated shaft extending from said motor to the outer end of said discharge connection for driving said conveyor, said shaft comprising a plurality of sections of which one is connected by a universal coupling with said motor and another is provided with a slip joint and is connected by a universal coupling with said conveyor at the outer end of said discharge section, means carried by the body, at a point substantially spaced both from the universal coupling with the motor and the universal coupling with the conveyor, for supporting a section of said shaft for rotation on a fixed axis relative to which said shaft section which is connected by a universal coupling with said conveyor is swingable on vertical adjustment of the outer end of said discharge section.

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