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(54) IMPROVEMENTS RELATING TO TRACKLESS VEHICLE GUIDANCE SYSTEMS

(71) We, ROBERT BOSCH GMBH, a Germany Company, of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, 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:

The invention relates to an arrangement for controlling the velocity of trackless vehicles which are guided along a guide cable, laid in the travel path and, through which an alternating current, preferably of audio-frequency, flows to produce a magnetic field which induces in an antenna system voltages which are dependent upon the lateral deviation of the vehicle from the guide cable, the antenna system being connected to a vehicle steering regulator.

The object of the invention is to make possible throughout the route a continuous desired velocity value signal which is locally restricted and allows both acceleration as well as retardation profiles.

The present invention provides an arrangement for controlling the vehicle velocity in a trackless vehicle guidance system comprising a guide cable, laid along the travel path and serving to conduct an alternating current to produce a magnetic field which induces in an antenna system voltages which are dependent upon the lateral deviation of the vehicle from the guide cable, the antenna system comprising at least two coils and being connected to a steering regulator; a second cable laid at a spacing from the guide cable, which spacing represents the desired velocity value, the second cable serving to conduct an alternating current whose frequency enables the corresponding signal received by the antenna system to be selected with respect to the signal from the current in the guide cable; and a diplexer filter for the antenna voltages induced by the alternating current in the second cable for controlling the vehicle velocity in an evaluating circuit as a function of the cable spacing.

In such an arrangement the vehicle can continuously receive a locally determined control value for the velocity, this control value being determined by the lateral spacing between both above-mentioned cables laid in the direction of travel. This control value can be linked to the desired velocity by a continuous function which however does not necessarily have to be a linear one. This linking contains a basically variable multiplying factor which is communicated to the vehicle by means of a coded message by radio or some other method of communication and can be automatically introduced. In so doing it is possible to communicate the desired multiplying factor to the vehicle and to adjust it automatically by means of a slight deviation in the measuring frequency used for the speed signal with respect to its mean value. In place of such a remote adjustment of the multiplying factor, or combination of such it is possible in a further embodiment of the invention to provide for the multiplying factor to be manually adjustable in the vehicle both during operation as well as for the purposes of calibration. The cable spacing determining zero velocity and the multiplying factor can be selected in such a manner that, for the velocity which occurs most frequently, both cables can lie near or above each other in a common groove.

To increase the safety of information, an additional cable can be laid in a further development of the invention in a manner which, with respect to the guide cable, forms a mirror image of the second cable. Assuming that both multiplying factors and the cable spacings for the zero desired velocity value are of equal magnitude but lie opposite each other with respect to the guide cable, the vehicle can receive two

desired velocity values which in the case undisturbed operation are of equal magnitude.

The invention is hereinafter further described by way of example, with reference to the accompanying drawing which is a diagrammatic sectional view of a guidance system for a trackless vehicle.

The vehicle 1 (seen in rear view) contains an antenna system 2 which is not further shown in detail but however corresponds advantageously to that described in British patent application No. 6294/76 (Serial No. 1530965) in which two coils secured on the vehicle are disposed horizontally and coaxially to each other and each at an equal distance from opposite sides of the vertical longitudinal medial plane of the vehicle and at least in the vicinity of each of these horizontal coils there is disposed symmetrically to the longitudinal medial plane a respective one of two additional coils which subtend an acute angle opening downwardly. In the case of this antenna system with obliquely disposed additional coils there is a linear relationship between the deviation a_q between the longitudinal medial plane 3 and the guide cable K_Q which serves for the lateral guidance of the vehicle and the voltage which can be fed into the steering regulator as a regulating value. An alternating current of audio-frequency of 10 KHz flows through the guide cable K_Q and produces a substantially concentric magnetic field which induces in the antenna system voltages which are dependent on the lateral deviation a_q. The steering regulator (not shown) to which these voltages are applied ensures that the lateral deviation a_q is minimal.

The previously described control of the speed of several vehicles which are being guided along a guide cable K_Q is effected by means of a second cable K_V whose lateral spacing a from the guide cable determines the desired speed value at the relevant place along the route. An alternating current with a frequency f_v = 12KHz flows through the second cable K_V and the voltages induced by its magnetic field in the antenna are filtered out by a diplexer filter set to 12 KHz so that an evaluating circuit which is connected to the filter can detect each distance a_V of the longitudinal medial plane 3 of the vehicle 1 from the second cable K_V.

If v = desired vehicle velocity, k = evaluating factor, a_q = deviation of the vehicle longitudinal medial plane 3 from the guide cable K_Q, a_v = distance between the vehicle longitudinal medial plane 3 and the second cable K_V and a_o = arithmetrical value (which ensures that the value of v within the reception area of the antenna 2 always remains positive) the following relationship is obtained:

$$v = k(a_q - a_v - a_o)$$

If for example the reception range of the antenna 2 with respect to the longitudinal medial plane is ± 50 cm then one can preferably select a = 35 cm. This means that the second cable K_V sets a desired velocity v = O when it lies about −35 cm laterally displaced to the left near to the guide cable K_Q, i.e. the positive direction of measurement being indicated by an arrow. The desired maximum speed or other salient speed can then be coordinated with the position of the cable K_V at the interval of 35 cm to the right of the guide cable K_Q. In the case of all spacings a between the two cables K_Q and K_V which lie between both extreme values of $+a$ and $-a$ intermediately lying speeds can then be provided.

Thereby it is possible without further measures to select desired speed zero and the weighting factor k in such a manner that for the most frequently occurring (average) velocity both cables come to lie near or above one another in a common groove.

The evaluating factor k can be communicated to the vehicle 1 by radio, e.g. as a coded message. The evaluating factor k can thereby be optionally or automatically varied. Alternatively the frequency of the current in the second cable K_V can be varied with respect to a reference value and such variations can be used to set the evaluating factor k. A further possibility is for the evaluating factor k to be manually adjusted on the vehicle.

WHAT WE CLAIM IS:-

1. Arrangement for controlling the vehicle velocity in a trackless vehicle guidance system comprising a guide cable, laid along the travel path and serving to conduct an alternating current to produce a magnetic field which induces in an antenna system voltages which are dependent upon the lateral deviation of the vehicle from the guide cable, the antenna system comprising at least two coils and being connected to a steering regulator; a second cable laid at a spacing from the guide cable, which spacing represents the desired velocity value, the second cable serving to conduct an alternating current whose frequency enables the corresponding signal received by the antenna system to be selected with respect to the signal from the current in the guide cable; and a diplexer filter for the antenna voltages induced by the alternating current in the second cable for controlling the vehicle velocity in an evaluation circuit as a function of the cable spacing.

2. Arrangement as claimed in claim 1, in which the cable spacing, which serves as a velocity control value, is linked to the desired velocity according to a continuous,

preferably, linear function.

3. Arrangement as claimed in claim 2, in which the function contains a variable evaluating factor.

4. Arrangement in accordance with claim 3, in which the evaluating factor is communicated to the vehicle by means of a coded radio message and is thereby automatically adjusted.

5. Arrangement as claimed in claim 3, in which the evaluating factor is communicated to the vehicle as a deviation of the frequency of the current in the second cable from its mean value.

6. Arrangement as claimed in claim 3, in which the evaluating factor can be manually adjusted on the vehicle.

7. Arrangement as claimed in any of claims 3 to 6, in which the function contains an arithmetrical value a_o which is so chosen in conjunction with the evaluating factor k in the relationship $v = k(a_q - a_V - a_o)$ that, for the most frequently occurring velocity, both cables lie near or above each other in a common groove, a_q and a_v being the distances of the longitudinal medial plane of the vehicle from the guide and second cables, respectively.

8. Arrangement as claimed in any of claims 1 to 7, in that an additional cable is laid in a manner which with respect to the guide cable forms a mirror image of the second cable.

9. Arrangement as claimed in any preceding claim in which the alternating current in the guide cable is of audio-frequency.

10. A trackless vehicle guidance system constructed and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*