United States Patent

Ogilvy et al.

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[54] SYSTEMS FOR TRANSMITTING INFORMATION BETWEEN A RAILWAY TRACK AND MOVING TRAIN

[72] Inventors: **Harry Heggie Ogilvy**, Middlesex; **Clive Valentine Smith**, Kempston, both of England

[73] Assignee: **British Railways Board**

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[30] **Foreign Application Priority Data**

Feb. 21, 1969 Great Britain 9,533/69

[52] **U.S. Cl.** **340/47,** 179/82, 246/2

[51] **Int. Cl.** **B61l 1/00**

[58] **Field of Search** ....246/8, 63 A, 2; 179/82; 340/32, 47

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

1,107,028 3/1968 Great Britain 246/2

Primary Examiner—Arthur L. La Point

Assistant Examiner—George H. Libman

Attorney—Sommers & Young and George Vande Sande, Esq.

[57] **ABSTRACT**

A system for transmitting information between a trackway and a moving vehicle and of the kind in which one or more coils laid on the trackway become inductively coupled with aerial means on the vehicle, the bit of information transmitted by the or each coil being distinguished as "1" or "0" (using conventional binary notation) by utilizing the antiphase relationship of the flux parallel to the plane of the turn(s) of the coil associated with the two opposite sides of the coil. An additional bit of information can be derived from each coil by utilizing the flux perpendicular to the plane of the turn(s) of the coil.

6 Claims, 9 Drawing Figures

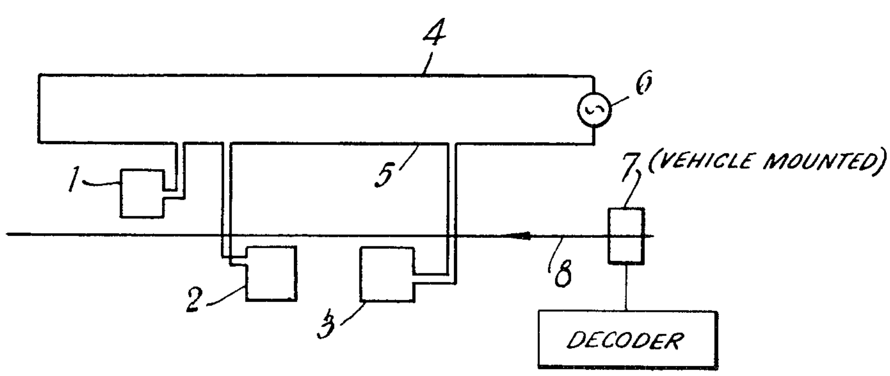


FIG. 1

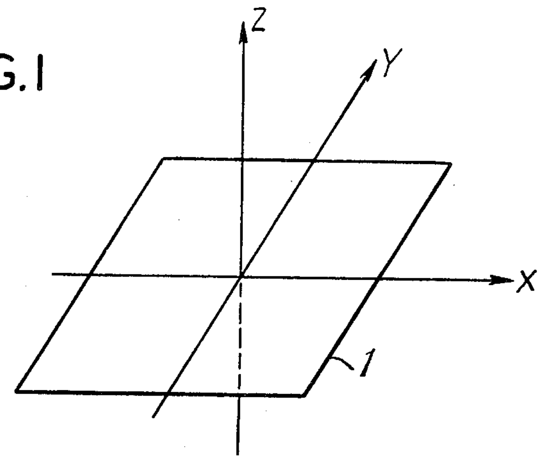
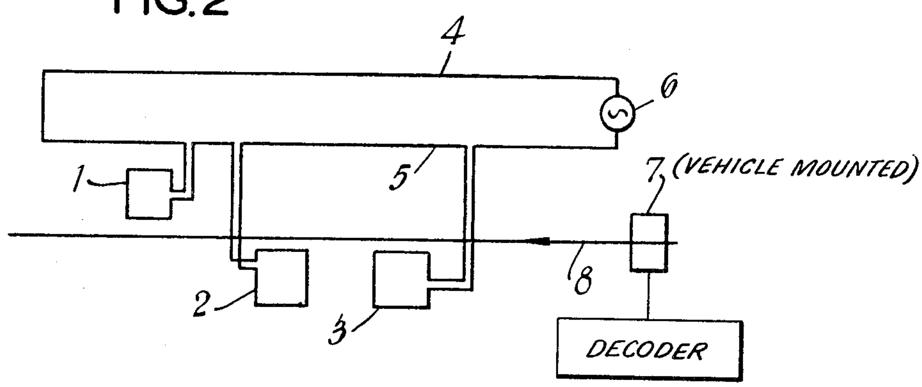


FIG. 2



H.H. OGILVY
C.V. SMITH

by Sommers & Young

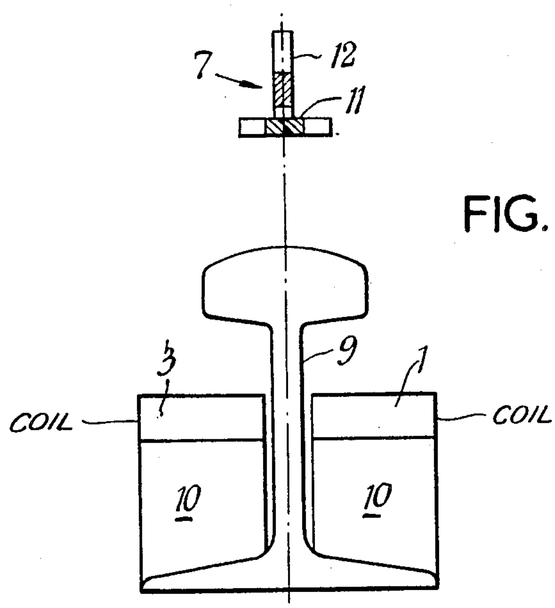


FIG. 3

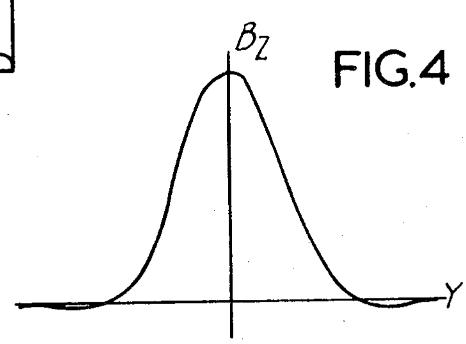


FIG. 4

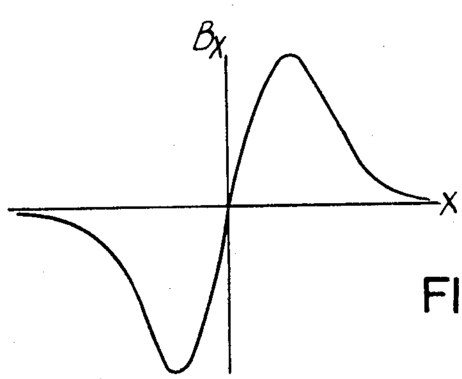


FIG. 5

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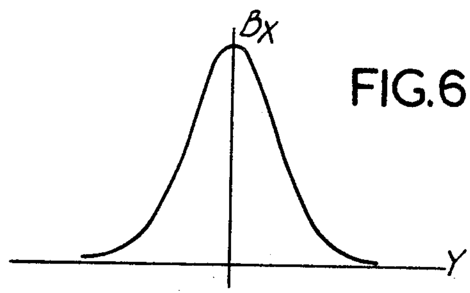

FIG.6

FIG.7

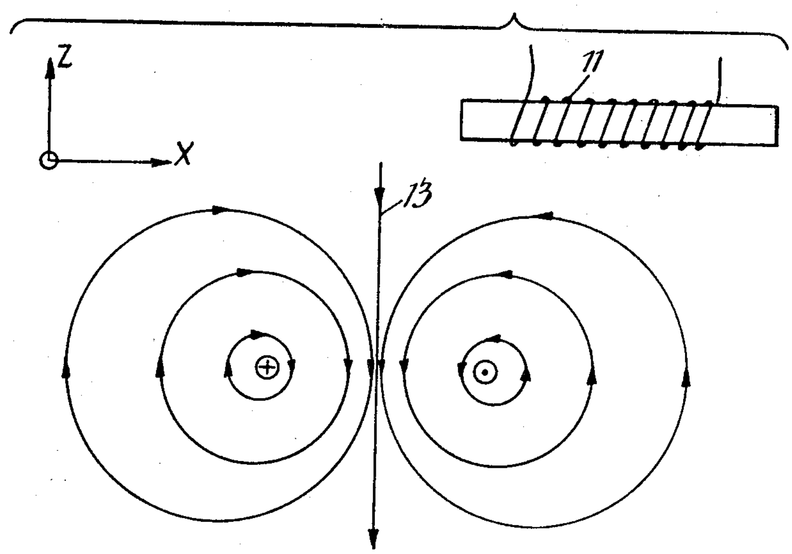

FIG.8

B_Z	B_X (a)	B_X (b)
1	1	0
0	0	1

FIG.9

B_Z	B_X (a)	B_X (b)
1	1	0
0	1	0

H. H. OGILVY
C. V. SMITH
by Sommers & Young

SYSTEMS FOR TRANSMITTING INFORMATION BETWEEN A RAILWAY TRACK AND MOVING TRAIN

This invention relates to systems for transmitting information between a trackway and a moving vehicle, for example between a railway track and a moving train, of the kind in which a coil (hereinafter termed a telegram coil) laid on the trackway and energized by alternating current becomes inductively coupled with aerial means on the vehicle in order to transmit a signal between the trackway and the vehicle.

In British Pat. specifications, Nos. 1,107,028 and 1,147,289 are described systems of this kind for transmitting from a railway track to a moving train local information related to features of the track, e.g., gradient, line speed, station identification etc., the systems having a number of telegram coils arranged one after the other along the track at a local information point, one bit of information being derived from the vertical component of field produced by each telegram coil (i.e., the component of field perpendicular to the plane of the turn(s) of the coil). The bits of information are provided in a binary (i.e., two state) code by virtue of telegram coils laid oppositely to one another producing inductive couplings with the aerial means in antiphase with one another.

The object of this invention is to provide a system enabling two bits of information to be extracted from a single telegram coil.

According to this invention, in a system of the kind described for transmitting information between a trackway and a moving vehicle, said aerial means is sensitive to the flux substantially parallel to the plane of the turn(s) of said telegram coil, and said telegram coil is positioned on the trackway so that one part of the turn(s) of said coil is nearer than the opposite part of the turn(s) of said coil to the line of movement of said aerial means resulting from movement of the vehicle, whereby the aerial means is predominantly influenced by the component of flux associated with the nearer part of the turn(s) of said telegram coil. Since the two components of flux associated respectively with said two opposite parts of the turn(s) of the coil are in antiphase a bit of information can be derived by the aerial means from the telegram coil which in conventional binary notation is either "1" or "0." A second bit of information can be derived from the flux perpendicular to the plane of the turn(s) of the same telegram coil in the manner described in British Pat. specification, Nos. 1,107,028 and 1,147,289.

The invention will now be further explained with reference to the accompanying drawings in which:

FIG. 1 defines the "X," "Y" and "Z" axes referred to in the ensuing description.

FIG. 2 shows one arrangement of telegram coils in plan view for producing a multidigit message.

FIG. 3 is a cross section through one of the rails of the track to show the arrangement of the telegram and aerial coils.

FIGS. 4 to 7 are explanatory diagrams, and

FIGS. 8 and 9 are tables showing two possible forms of coded information obtained from the arrangement of FIG. 7.

Referring now to FIG. 1, a telegram coil 1 is laid on the track with its plane horizontal so that the "Z" axis is in a vertical plane and the "X" and "Y" axes are in a horizontal plane, the "Y" axis extending in the direction along the track and the "X" axis therefore extending transversely of the track. The origin is the center of the coil.

In FIG. 2, three such telegram coils 1, 2 and 3 are shown connected in series with parallel wires 4 and 5 to an alternating current source 6, the parallel wires 4 and 5 extending along the track. Aerial means 7 is mounted on a train and, resulting from the movement of the train, has the line of movement 8.

Referring to FIG. 3, one convenient physical arrangement of the telegram and aerial means is shown, the aerial means 7 having a line of movement over the center of one rail 9 of the track and the coils 1 to 3 being located on the foot of the rail 9 through supports 10. The coil 11 of the aerial means 7 is sensitive to the horizontal component of flux B_x and the coil 12 is sensitive to the vertical component of flux B_z.

FIG. 7 shows the flux distribution around any one of the telegram coils 1 to 3 for a given instantaneous direction of current through the coil. If the vertical component of flux density B_z is plotted against Y, the curve in FIG. 4 is obtained for a given height Z above the coil. If the horizontal transverse flux density B_x is plotted against X the curve of FIG. 5 is obtained. If the horizontal transverse flux density B_x is plotted against Y for the value of $X>0$, that is for a point to the right of the line 13 in FIG. 7, the curve of FIG. 6 is obtained and if B_x is plotted against Y for a value of $X<0$, that is for a point to the left of line 13, the mirror image of the curve of FIG. 6 is obtained so that the values of B_x are negative.

In all the curves of FIGS. 4 to 6, a change in sign of flux density indicates a phase change of 180° in the alternating flux being produced by the telegram coil, thus a value of flux density indicated as positive is in antiphase with a value of flux indicated as negative.

From FIG. 5 it can be seen that proceeding from one side part of the telegram coil to the opposite side part a phase change of 180° occurs in the flux. Hence by positioning of the telegram coils 1 to 3 relative to the line of movement of the aerial 7 as shown in FIG. 2 the aerial means is predominately influenced by one or other of these antiphase components of horizontal flux B_x, while the B_z–Y variation shown in FIG. 4 remains of one phase. If the telegram coil is turned over, i.e., changed from the position shown for coil 1 to that shown for coil 2, then all phases are reversed by 180°.

Assuming the convention that the signal derived in the aerial coil 12 from flux B_z is "1" when B_z is in phase with a comparison signal derived from the parallel wires 4 and 5 and "0" when in antiphase, the bit of information derived by aerial coil 11 from one or other of the antiphase values of B_x depending upon which of the antiphase components of B_x is nearer 11 can be evaluated in two ways. These are

1. comparing the phase of signal derived from B_x with that of a signal derived from parallel wires 4 and 5, or
2. comparing the phase of signal derived from B_x with the phase of signal derived from B_z.

Referring again to FIG. 7 which shows the lines of flux around a telegram coil at a given instant in time, if aerial coil 11 is as shown then, with the assumed convention, if the derived signals from B_z and B_x are all compared with the signal derived from the parallel wires 4 and 5, the table of FIG. 8 holds. If on the other hand the phase of the B_x signals are compared with the phase of the B_z signals, the table of FIG. 9 holds, where the two columns (*a*) and (*b*) under B_x relate to the flux associated with part of the telegram coil to the left and part to the right of the line 13 respectively in FIG. 7.

Assuming that the table of FIG. 8 is the relevant one and the bit of information derived from the B_z flux of telegram coil 1 is a "1," then the multidigit message made up of the bits of information derived from the B_z fields of coils 1 to 3 is "1," "0," "1" and the composite multidigit message derived from the B_x fields of coils 1 to 3, if the direction of winding of coil 11 with respect to the coil 1 is as shown in FIG. 7, would be "0," "0," "1." The decoder 14 responds to the different distinctive voltage signals induced in the coils 11 and 12 of aerial means 7 to produce distinctive output signals representative of these multibit messages.

We claim:

1. A system for transmitting binary coded data from a wayside data transmitting location to a moving vehicle comprising:

A. a plurality of spaced, horizontally disposed, discrete conductor loops at said location and positioned sequentially in the direction of vehicle movement along the wayside and with the vertical axis of at least one conductor loop on the opposite side of a line extending parallel to the direction of movement of the vehicle to at least one other conductor loop,

B. an alternating current source for energizing each said conductor loop producing a magnetic field above each loop which has a vertical component which is either of a first relative phase or a second opposite relative phase dependent upon the direction of current flow in said loop and which has a first horizontal component to one side of said axis of a first relative phase and a second horizontal component to the other side of said axis of a second opposite relative phase,

C. detector means disposed on the vehicle to move along said line and including,

i. first aerial means oriented to be inductively coupled with said vertical component of magnetic field of each conductor loop in sequence,

ii. second aerial means adapted to be inductively coupled with the nearer of said first and second horizontal components of magnetic field of each conductor loop in sequence,

iii. said first aerial means being responsive to an inductive coupling with one said conductor loop which provides a vertical magnetic field of said first phase to provide a first phase manifestation representative of a "one" bit and being responsive to an inductive coupling with one said conductor loop providing a magnetic field of said second opposite phase to provide a second phase manifestation representative of a "zero" bit,

iv. said second aerial means being responsive to an inductive coupling with said first component of horizontal magnetic field of one said conductor loop to provide a third phase manifestation representative of a "one" bit and being responsive to an inductive coupling with said second component of horizontal magnetic field of one said conductor loop to provide a fourth phase manifestation representative of a "zero" bit, and

D. decoder means responsive to the reception of said first, second, third and fourth phase manifestations to provide a composite signal representative of the binary coded data transmitted from the wayside to said vehicle.

2. A system for transmitting binary coded data between a transmitting station and a receiving station as said one station passes the other said station and comprising in combination:

A. at least one transmitting loop at said transmitting station,

B. means for energizing said transmitting loop with an alternating current to thereby produce a first component of flux in a plane normal to the plane of said transmitting loop and with a first relative phase or a second opposite relative phase dependent upon the direction of current flow in said loop and for also producing second components of flux parallel to the plane of said loop one of which lies laterally to one side of the axis of said loop and the other of which lies laterally to the other side of the axis of said loop,

C. and two receiving loops at said receiving station and each passing through an inductive coupling relationship with said transmitting loops as said transmitting and receiving stations pass each other,

D. one of said receiving loops being so oriented and positioned that it has inductively coupled therein a distinctive voltage signal only in response to said first component of flux and with the induced signal having a distinctive waveshape dependent upon the polarity of energization of said transmitting loop,

E. a second receiving loop being so oriented and positioned that there is induced therein a distinctive voltage signal only in response to said second components of flux,

F. each said transmitting loop being selectively positionable in either of two distinctive positions laterally spaced relative to a line defined by the path of relative movement of said second receiving loop as said one station passes said other station so that in one of said two positions said second receiving loop has induced therein a distinctive voltage signal in response to said one horizontal component of flux and in the other of said positions said second receiving loop has induced therein a distinctive voltage signal in response to said other horizontal component of flux,

G. and decoder responsive to the distinctive voltage signals induced in said first and second receiving coils.

3. The system of claim 2 in which said transmitting station is on the track wayside and said other station is on a train.

4. The system of claim 3 in which said transmitting loops are positioned adjacent the track rails.

5. The system of claim 4 in which said transmitting loops and said second receiving loop are all horizontally oriented and said first receiving loop is vertically oriented.

6. The system of claim 5 in which said transmitting loops are all mounted adjacent a track rail and are selectively positionable to either side of said rail dependent on the code to be transmitted to the train.

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