Fig.1.

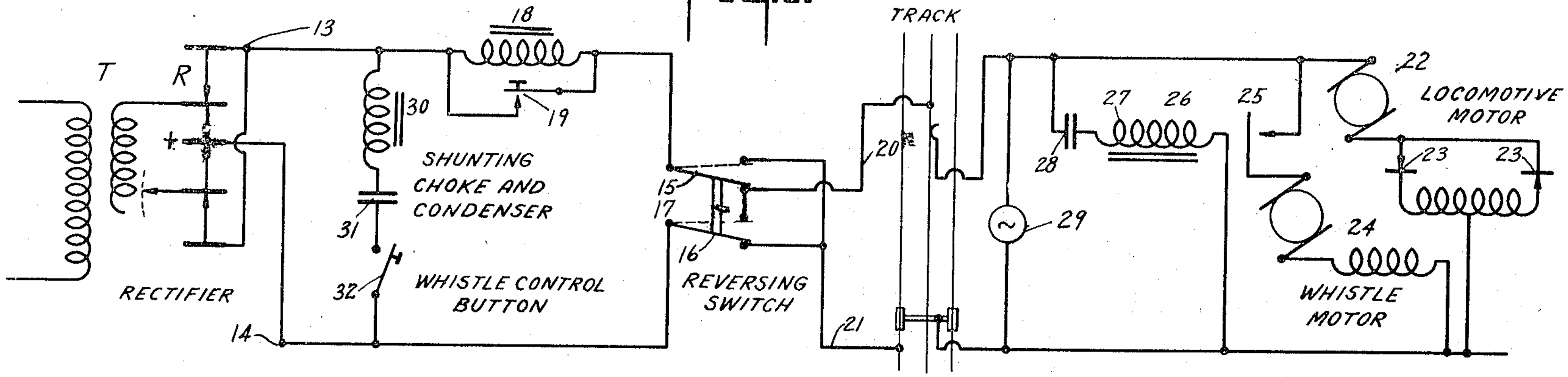


Fig.2.

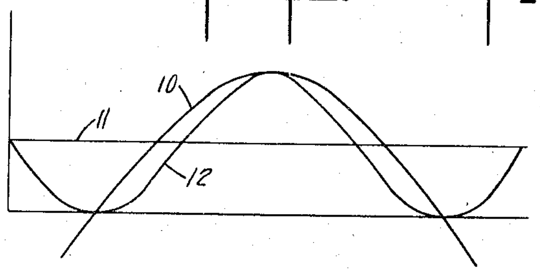


Fig.4.

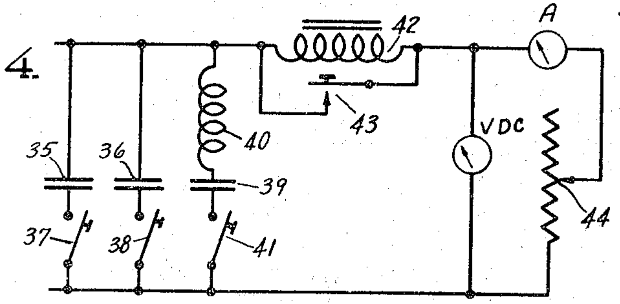


Fig.7.

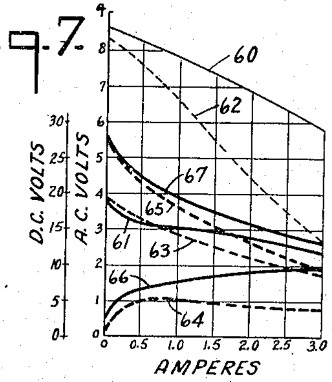


Fig.3.

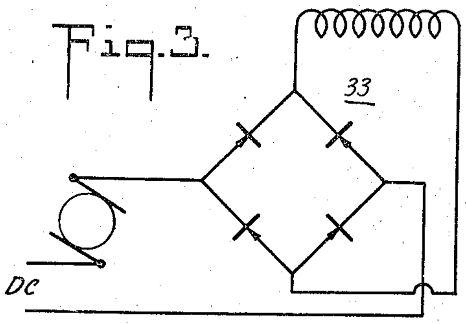


Fig.6.

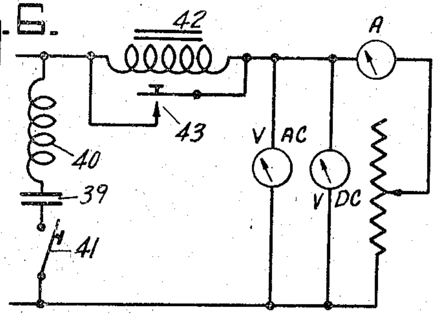
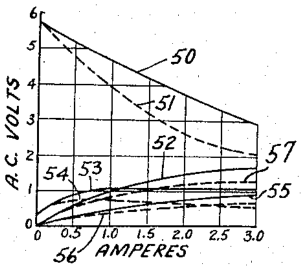


Fig.5



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ELECTRICAL SYSTEM AND METHOD

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Application May 24, 1941, Serial No. 395,098

10 Claims. (Cl. 104—150)

The present invention relates to electrical systems and methods, and is more particularly directed toward electrical systems and methods suitable for use in the operation of toy electric railroad outfits by rectified direct current.

Owing to the more general availability of alternating current in house lighting, toy electric trains and accessories have been developed for operation on alternating current circuits. To obtain directional control of the trains it has been customary to employ a reversing switch operated by a relay on the locomotive responsive to successive impulses of current so that obtaining true directional control of the train required the use of moving parts as well as the operation of the impulse sending switch. This switch had to be manipulated the desired number of times to secure operation in the desired direction.

In toy train operation the whistle has usually been operated by an alternating current motor under the control of a relay responsive only to superposed direct current. A similar circuit is used for control of electromagnetically operated couplers.

The present invention contemplates an electrical system and method according to which the alternating current is passed through a full wave rectifier and the output of this rectifier consisting of direct current with admixed or superposed alternating current of double frequency (usually 120 cycles) is supplied to the toy track circuit and train through a reversing switch, and the locomotive employs a propulsion motor with field, armature, and associated rectifiers permanently connected so that the direction of rotation of the propulsion motor is definitely related to the polarity of the current supply or permanent magnet.

According to the present invention the second current consuming device (such as the whistle motor or coil of the coupler) is direct current operable, non-polarized and under the control of a relay normally held open by alternating current normally flowing from the rectifier, and suitable means are provided whereby the alternating current output of the rectifier may be filtered out of the track circuit, or reduced to a sufficient amount, to permit the relay to release its contacts so that the second current consuming device may be operated.

The operation of the second motor, or whistle, at the same time that the main or propulsion motor is operating causes a sustained increased load on the circuit which in usual practice has limited output and relatively poor regulation, and according to the present invention the whistle controller is preferably of such design as to substantially increase the available direct current voltage for operating this motor so that substantially the same voltage is applied to the locomotive motor, irrespective of whether the whistle is, or is not, operated.

The accompanying drawing shows, for purposes of illustrating the present invention, one of the many embodiments in which the invention may take form, together with modifications of certain parts, it being understood that the drawing is illustrative of the invention rather than limiting the same.

In the drawing:

Figure 1 is a complete wiring diagram for an alternating current to direct current power supply for the track circuit of a toy railroad outfit having a polarized motor;

Figure 2 is a diagrammatic view illustrating the action of the full wave rectifier in providing direct current potential and superposed alternating current potential of double the supply frequency;

Figure 3 is a fragmentary view illustrating a modified form of reversible motor;

Figure 4 is a diagrammatic view illustrating various filtering circuits which may be employed;

Figure 5 is a diagram illustrating the alternating current performances of the circuits of Figure 4;

Figure 6 is a wiring diagram of the preferred form of filtering circuit as set up for a test of alternating current and direct current performance; and

Figure 7 is a diagram illustrating the direct current and alternating current performance of the circuit of Figure 6.

In Figure 1 a variable voltage output transformer, indicated at T, is connected with a full wave-rectifier R, preferably of the copper oxide type. This rectifier, as shown in Figure 2, is adapted to convert a supply voltage, indicated by the sine curve 10, into a direct current potential, indicated by the horizontal line 11, and an alternating current "ripple" voltage, indicated by the curve 12, of twice the frequency of the supply current 10. In the more ordinary uses of rectifiers for providing direct current this alternating current frequency is completely filtered out and eliminated, but according to the present invention this double frequency alternating current is employed for control purposes.

The output terminals 13 and 14 of the full wave rectifier R are connected to the movable contacts 15 and 16 of a reversing switch 17. This connection is preferably made through a choke coil 18 adapted to be shunted by a switch 19. The reversing switch is connected to a toy railroad track circuit by wires, indicated at 20 and 21, so that current of desired polarity may be applied to the track circuit.

The track load has a locomotive propulsion motor 22, which is here shown as of the split field type with two half-wave rectifiers 23, 23 connected to the respective halves of the field. Such a motor has a definitely controlled direction of operation. A lamp or other load is indicated at 29.

A whistle motor 24 is connected into the track circuit through the contacts 25 of a relay 26 which is normally open so that the whistle motor does not operate. Different forms of auxiliary equipment, such as magnetically operated couplers, may be substituted for the whistle motor. The coil 27 of the whistle relay is connected through a condenser 28 with the track circuit so that alternating current may flow through the whistle relay coil, the condenser and coil being preferably tuned to proper frequency. This tuning increases the sensitivity by lowering the impedance to the current to 120 cycle frequency and also keeps spurious frequencies generated by commutator sparking from interfering with the operation of the relay. In other words the relay is selectively tuned. The condenser 28 prevents any direct current from flowing through the relay coil. The output terminals 13 and 14 of the rectifier are shunted by a choke coil 30, condenser 31 and normally open switch 32, the choke and condenser being tuned to the proper frequency.

The parts 26 to 28 are here shown as permanently connected in parallel with the propulsion motor, but they, or their equivalent, may be temporarily or permanently connected elsewhere in the network so long as they are in parallel with the filtering circuit when control is desired.

When the propulsion motor alone is to be operated it can be started, stopped and reversed by means of the reversing switch 17 and may be supplied with the output of the rectifier with the choke 18 in circuit or without, as desired. For loads such as the whistle motor, the direct current voltage regulation is better with the choke 18 permanently in circuit. The lamps 29 will be lighted only when the motor is energized.

When the whistle is to be operated the whistle control button 32 is moved to the circuit closing position so that the dominant portion of the alternating current output of the rectifier R is by-passed through this shunt and does not reach the whistle relay, thereby reducing the current in the whistle relay to such an amount that it drops its contact to close the circuit for the whistle motor.

Instead of using a propulsion motor with a split field one could use a propulsion motor of the usual type shown in Figure 3 with full wave rectifier 33. The principal advantage of this arrangement lies in the fact that the field winding has a higher space factor due to the use of the entire space available for the field winding at all times. This improvement over the split field is obtained however at an increased rectifier cost, four sets of elements being required instead of two. A permanent field motor may also be used.

Figures 4 and 5 illustrate the operation of an output circuit from a full wave rectifier of the copper oxide type wherein alternative forms of filtering means are provided, the alternating current input to the rectifier being 14 volts. In this set up two 2,000 mfd. condensers 35 and 36 are provided to be connected across the circuit by switches 37 and 38. A condenser 39 of 300 mfd. tuned with a choke 40 is under the control of a switch 41. A series choke 42 of .8 ohms direct current resistance is adapted to be shunted by a switch 43, a variable resistance load 44 is employed and the current and voltage measured by instruments as indicated.

The results of a series of tests are shown in Figure 5, the curve 50 indicating the results when there is no shunt and no series choke, the curve 51 the results when the series choke is unshunted, the curve 52 the results with one condenser 35 only in circuit, the curve 53 the results with the tuned condenser and choke 39, 40 only in circuit, the curve 54 the results with the choke and condenser 39, 40 and the choke 42 in circuit, the curve 55 the results where two condensers 35 and 36 are in circuit, the curve 56 the results where two condensers 35 and 36 and the choke 42 are in circuit, and the curve 57 the results where one condenser 35 and the choke 42 are in circuit.

From Figure 5 it will be apparent that under the particular conditions of the tests several methods are available for reducing or substantially eliminating the alternating current component. The simplest, but not the best, is to use a large condenser such as illustrated by the curve 55. This is less effective at heavy load, but the cost of the high capacity condenser (necessary on 60 cycles) makes this method objectionable. The tuned circuit 39, 40 producing curve 53 on Figure 5, while not so effective at low current values, is practically as effective at large current values, as the 4,000 mfd. condenser arrangement resulting in curve 55. This filter arrangement is therefore the one which is shown in Figures 1 and 6.

Figures 6 and 7 illustrate the results obtained by placing a 300 mfd. condenser 39 and tuning choke 40 across the rectifier output terminals, and employing a series choke 42 with a direct current resistance of 0.89 ohm. These tests were made with a full wave rectifier of the copper oxide type provided with a 21 volt alternating current input. The direct current volts are indicated in Figure 7 in heavy lines, the alternating current volts are indicated in light lines. These curves are tabulated as follows:

Curve—	
60	A. C. volts—no series choke—no shunt filter
61	D. C. volts—no series choke—no shunt filter
62	A. C. volts—with series choke—no shunt filter
63	D. C. volts—with series choke—no shunt filter
64	A. C. volts—with series choke—with shunt filter
65	D. C. volts—with series choke—with shunt filter
66	A. C. volts—no series choke—with shunt filter
67	D. C. volts—no series choke—with shunt filter

Form curves 61 and 60 of Figure 7 it will be apparent that a rectifier with an input of 21 volts alternating current and delivering between 13 and 14 volts direct current with a load of from zero to 3 amperes will have present across the load from 3.6 to 5.8 volts, 120 cycle A. C. Any means that will enable the alternating current component to find a ready path will improve the action of the rectifier and increase the direct current voltage output.

The various filtering means above discussed are available for this purpose. For example, the effect of introducing the tuned condenser shunt 39, 40 across the line is apparent by comparison of the curves 61 and 67. At a load of 1.25 amperes the direct current voltage rises from 15 volts to 17 volts when the tuned condenser choke shunt is completed. This rise in voltage serves to compensate for the drop in voltage through the rectifier and transformer when the whistle motor is introduced as a further load.

As stated above neither the large condenser nor the shunt alone will entirely eliminate the alternating current voltage on heavy loads. For example, as shown by curve 66 there is still 1.9 volts alternating current present across the load with the choke and condenser shunt 39, 40. The curve 60 shows that at the same time there is a normal alternating current voltage of 5.8 volts without the shunt so that there is available a ration of 3 to 1 in alternating current voltage available for operation of the relay. This ratio can further be improved by placing a series choke in the line to the load which increases the effectiveness of the tuned shunt with increasing current and thereby flattens out the minimum alternating current voltage curve which is plotted at 64 in Figure 7. Even though the normal alternating current voltage drops rapidly when a series choke is used the ratio between the two alternating current voltages is improved. By the use of a choke of slightly less direct current resistance the curve 64 may be made flatter.

When the whistle is not being blown there would be a minimum of 5.8 volts alternating current to open the contacts of the blower motor circuit. Closing the filtering circuits, as above described, reduces this voltage to a voltage in the neighborhood of one volt, so that a relay adjusted to drop out on 1½ to 2 volts alternating current will give satisfactory operation with reasonable margin for manufacturing tolerances when alternating current voltages of one volt or less remain in the relay coil circuit.

When the above discussed system is to be employed for toy electric railroads it makes it possible to obtain true directional control of the motor and train without moving parts, except for the manually operable switches. The relay whistle control is simpler than where the relay is one sensitive to superposed direct current and insensitive to alternating current.

It is obvious that the invention may be embodied in many forms and constructions within the scope of the claims and I wish it to be understood that the particular form shown is but one of the many forms. Various modifications and changes being possible, I do not otherwise limit myself in any way with respect thereto.

What is claimed is:

1. In combination, a source of alternating current, a full wave rectifier connected to the source and adapted to supply rectified direct current voltage with superposed alternating current voltage, a principal load normally continuously connected with the rectifier to be operated by rectified direct current therefrom, a relay having its coil normally continuously connected with the rectifier and sensitive only to alternating current, a second load disconnected from the rectifier by the relay when the relay is energized, and a normally open circuit filtering means connectible across the rectifier and adapted to reduce the alternating current voltage supplied the relay below that necessary to hold the relay open whereby the relay is released and current supplied the second load.

2. The combination claimed in claim 1, wherein the principal load includes a motor and rectifiers whereby the motor may be reversed by changing the polarity of the direct current applied.

3. The combination claimed in claim 1, wherein the filtering means includes a choke coil and condenser shunted across the rectifier output terminals and tuned to twice the frequency of the source.

4. The combination claimed in claim 1, wherein the filtering means includes a choke coil and condenser shunted across the rectifier output terminals and tuned to twice the frequency of the source, and a series choke coil.

5. The combination claimed in claim 1, wherein the filtering means includes a condenser connected across the rectifier terminals.

6. The combination claimed in claim 1, wherein the filtering means is of such value as to increase the direct current voltage output of the rectifier so that additional voltage is available for operation of the combined loads.

7. A power supply for toy railroads comprising a source of alternating current, a full wave rectifier connected to the source and adapted to supply rectified direct current voltage with superposed alternating current voltage, a locomotive having a propulsion motor normally continuously connected with the rectifier to be operated by rectified direct current therefrom, a relay having its coil normally continuously connected with the rectifier and sensitive only to alternating current, a whistle motor disconnected from the rectifier by the relay when the relay is energized, and a normally open circuit filtering means connectible across the rectifier and adapted to reduce the alternating current voltage supplied the relay below that necessary to hold the relay open whereby the relay is released and current supplied the whistle motor.

8. In combination, an electric motor having its field and armature interconnected with one another and the supply line through rectifiers so that the motor is reversible by change of polarity of current supplied, a full wave rectifier adapted to supply rectified direct current voltage and superposed alternating current voltage, a reversing switch between the rectifier and motor to control the polarity of the current supplied the motor, a relay sensitive only to the alternating current voltage and when energized holding its contacts open, a relay controlled current consuming device, and means for concurrently reducing the alternating current voltage supplied the relay to cause it to release its contacts and increasing the direct current voltage supplied so that relay controlled current consuming device and the motor may be simultaneously operated at a higher voltage than when the motor alone was operated.

9. The combination claimed in claim 8, wherein the relay and relay controlled device are in parallel with the motor and are unaffected by the change of polarity effected by the reversing switch.

10. The method of controlling the operation of two direct current operable current consuming devices connected in parallel one of which is reversible by change of polarity, which comprises operating a full wave rectifier to supply direct current of selected polarity with superposed alternating current voltage, passing the alternating current only through a relay to keep the circuit for the non-reversible current consuming device open, and intermittently filtering out the alternating current voltage to increase the direct current voltage and deenergize the relay.

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