

July 20, 1954

W. D. STAPLES ET AL
MEANS FOR TESTING INDUCTORS

2,684,466

Filed Feb. 20, 1951

3 Sheets-Sheet 1

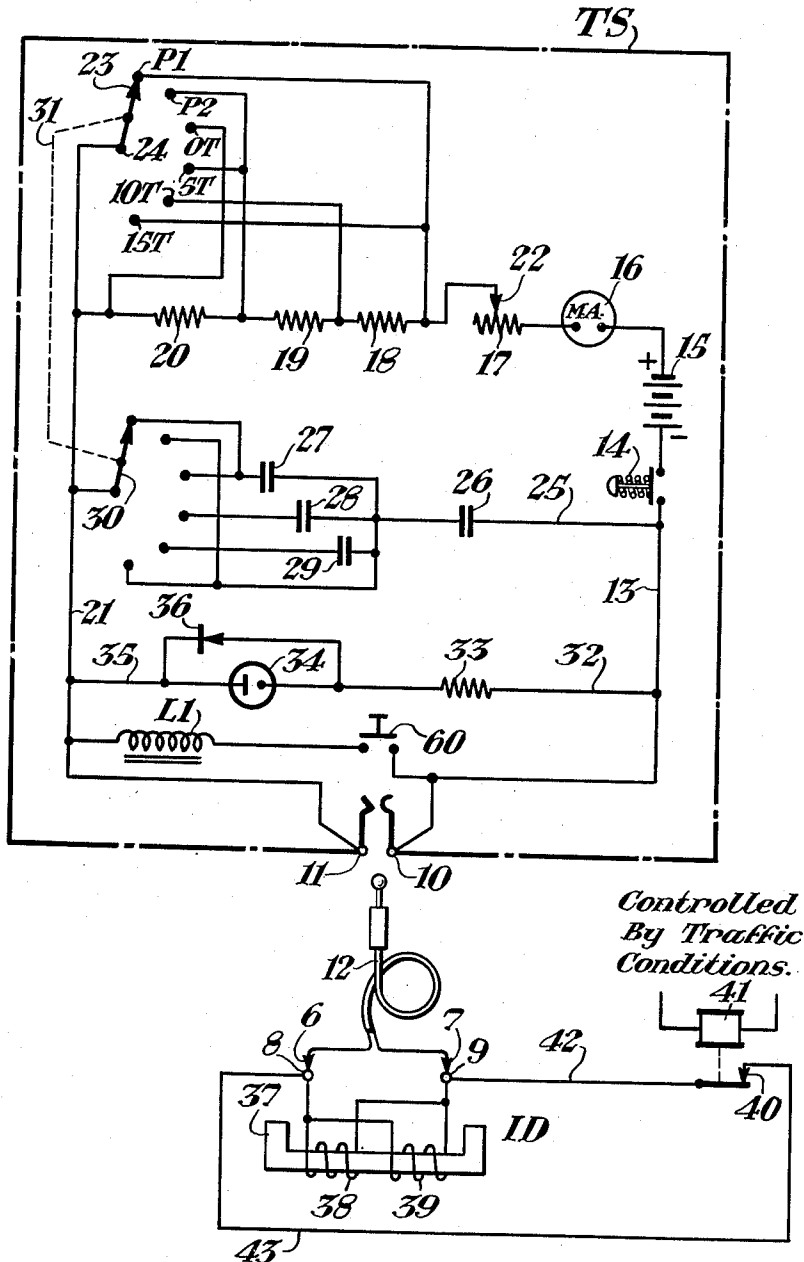


Fig. 1.

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3 Sheets-Sheet 2

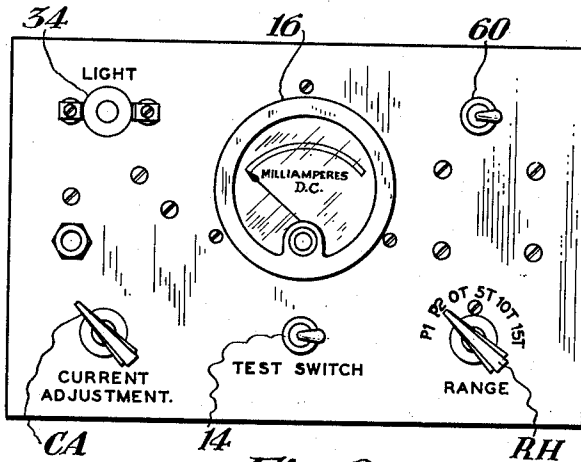


Fig. 2.

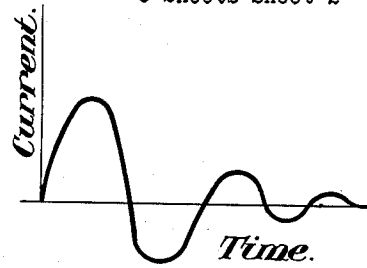


Fig. 3.

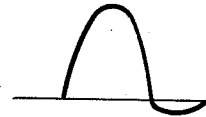


Fig. 4.

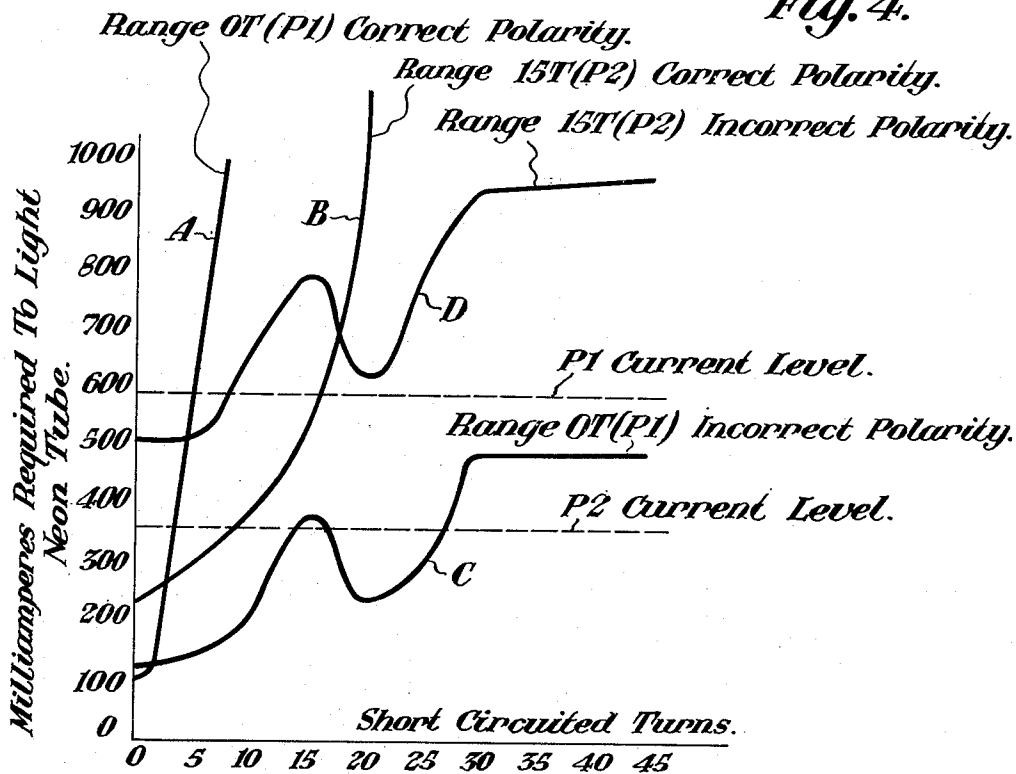


Fig. 5.

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3 Sheets-Sheet 3

Correct Polarity.

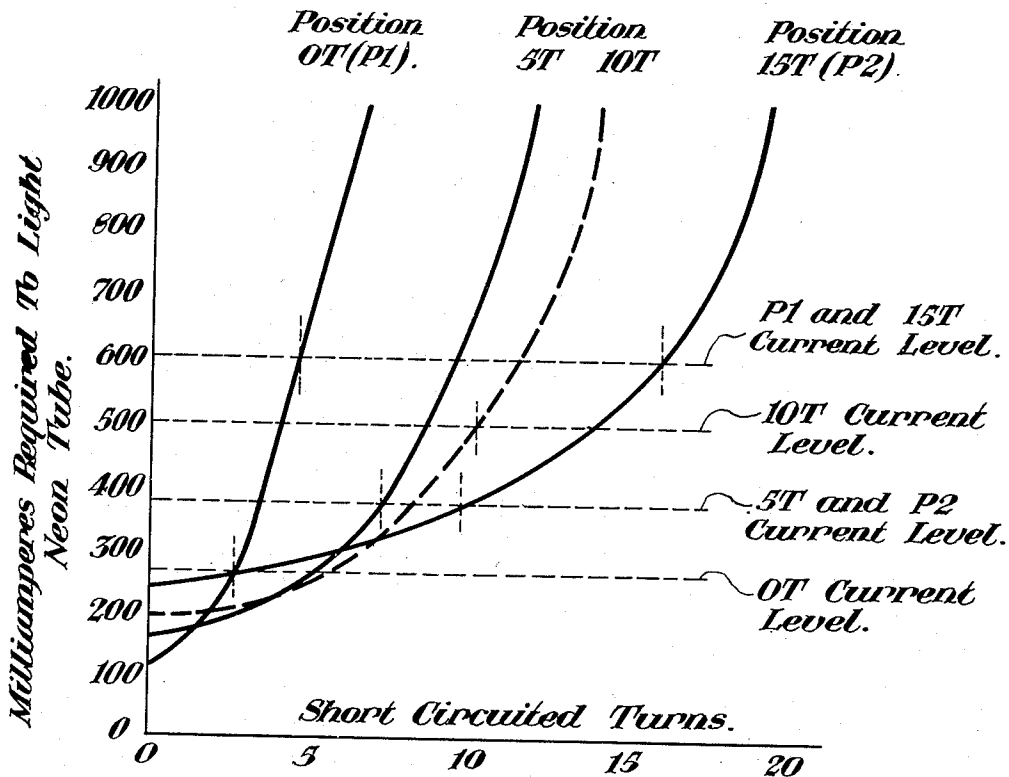


Fig. 6.

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2,684,466

MEANS FOR TESTING INDUCTORS

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Application February 20, 1951, Serial No. 211,944

7 Claims. (Cl. 324—51)

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Our invention relates to method and means for testing inductors, and more particularly to method and means for testing an inductor which is used for transferring impulses to an associated receiver.

Intermittent inductive train control is a well-known form of automatic control for railway trains. In intermittent inductive train control an inductor at a fixed point along the track is relied upon for transferring control impulses to a receiver on a locomotive or vehicle as the train passes the inductor. Both the trackway inductor and the train carried receiver comprise a magnetic core having one or more windings thereon. The two are disposed for the receiver to pass in inductive relation to the inductor and the inductor is arranged to vary the reluctance of the magnetic circuit of the receiver when the train passes and thereby transmit a control influence from the track to the train. There are a number of different arrangements for such intermittent train control apparatus and it may be similar to that disclosed in Letters Patent of the United States No. 1,698,470, granted January 8, 1929, to Paul N. Bossart, for Railway Traffic Controlling Apparatus.

Generally speaking, the inductors of such train control systems are conditioned to transmit a first or a second control influence or impulse to the receiver according as the inductor winding is short circuited or is open circuited, the closing and opening of the winding circuit being effected through a control relay which is responsive to traffic conditions of the railway. It is obvious that a short circuited condition of a portion of the inductor winding due to defective insulation or a ground on the winding leads may so assimilate the short circuited condition relied upon for the conveyance of a control impulse as to cause the inductor to transmit a false impulse to the receiver. For example, a clear traffic indication is usually reflected by short circuiting the inductor winding at a front contact of the control relay and a stop traffic indication is reflected when the relay is released to open its front contact. It is to be seen, therefore, that the short circuiting of a portion of the inductor winding or a low resistance ground on the winding leads tends to reflect a clear traffic indication even though the control relay is released in response to a stop traffic condition.

In view of these circumstances, it is important to provide tests on the inductors of these train control systems.

Accordingly, a feature of our invention is the

provision of an improved method and means for testing an inductor.

Another feature of our invention is the provision of novel and improved means for checking short circuited turns and low ground resistance of the winding of an inductor used to transmit inductive influences.

Again, a feature of our invention is the provision of an improved means for checking the polarity connections of two or more coils used to form the winding of an inductor.

A more specific feature of our invention is the provision of an improved portable test set for checking an intermittent train control wayside inductor for short circuited turns, terminal leakage and coil connections.

A further feature of our invention is the provision of a portable test set for inductors and wherein there is incorporated novel means for checking the operation of the test set.

Other features, objects and advantages of our invention will appear as the specification progresses.

It is to be understood that our invention is not limited in its use to train control systems and this example is cited to illustrate one of the many places the invention may be used to an advantage.

The foregoing features, objects and advantages of our invention are attained by using the principle that the successive half cycles of a wave created by shock excitation of an oscillatory circuit are of opposite polarity and the magnitude of the successive half cycles decreases at a rate determined by the condition of the oscillatory circuit which sets up the wave. Also, that the peak voltage of the second half cycle of the wave varies to a greater degree than does the peak voltage of the first half cycle of the wave for a given load condition of the oscillatory circuit. To apply these principles we provide a portable instrument having two terminals across which three parallel circuit paths of the instrument are connected. A first one of the paths comprises a power source such as a battery, a variable resistor, a snap switch and an ammeter in series. A second circuit path includes a variable capacitance and a third path includes a resistor in series with an electric discharge lamp, such as a neon lamp, and a half wave rectifier in multiple. In addition to these three circuit paths, the instrument is preferably provided with an inductance or reactance which is connected at times across the terminals of the instrument through a suitable switching means.

The two outside terminals of the instrument are adapted to be connected across the terminals of the winding of an inductor that is being tested by means of a suitable cord circuit. Consequently, when the instrument terminals are connected across an inductor winding and the snap switch of the first circuit path of the instrument is closed, the direct current power source of the instrument energizes the inductor winding and a corresponding magnetic field is stored in the core of the inductor. For a given voltage of the direct current source and a given inductor winding the magnitude of this field is determined by the amount of resistance interposed in the first circuit path of the instrument. When the switch of the first circuit path is opened, the stored magnetic energy of the inductor dies away and induces a voltage in the inductor winding, the value of this voltage depending upon the magnitude of the stored magnetic field. The inductor winding in connection with the capacitance of the second path of the instrument forms an oscillator circuit and thus the induced voltage in the inductor winding sets up a wave having a frequency and an amplitude that is determined by the proportioning of the parts of this oscillatory circuit. This wave is a damped wave and the damping is determined according to the condition of the circuit. This oscillatory wave is impressed on the third circuit path of the instrument. The resistance interposed in the third circuit path is made relatively high and it has little effect on the damping action of the oscillatory wave. The rectifier of the third circuit path is poled to pass in its forward direction the voltage of the first half cycle of the wave and thus during the first half cycle of this wave there is little or no voltage impressed across the neon lamp. The second half cycle of the wave is of the opposite or negative polarity and it is blocked by the rectifier so that its voltage is impressed on the neon lamp. The parts are proportioned so that for a given setting of the test set, the voltage impressed across the neon lamp during the second half cycle of the wave has a value sufficient to ionize the lamp and cause the lamp to be illuminated in the event the inductor winding across which the instrument is connected is in its normal and proper condition. A short circuited condition of a few of the turns of the inductor winding will act as a load and the oscillatory wave set up due to the operation of the instrument is damped to a degree that the amplitude of the second half cycle of the wave is decreased and its voltage is insufficient to illuminate the neon lamp. By determining the level of the direct current that must be supplied to the inductor winding and interrupted to produce a voltage that causes a flash on the neon lamp, the number of short circuited turns that causes the lamp to remain dark can be determined within five turns of the actual number. This result is obtained because the instrument uses the second and negative half cycle of the wave for checking the inductor winding and the amplitude of which half cycle of the wave is varied greatly by changes in the circuit conditions of the oscillatory circuit.

Also, a relatively low resistance between the two terminals of the inductor winding due to ground conditions of the winding act to damp the wave and thereby cause the second half cycle of the wave to have an amplitude insufficient to illuminate the neon lamp. That is to say, a ground on the inductor winding reduces the resistance

between the terminals of the inductor and the reduction in the terminal resistance below its normal value will be detected by the neon lamp of the instrument remaining dark.

When the inductor winding is made up of two or more coils connected in multiple, a wrong connection of one of the coils will cause a change in the magnetic field set up when the test set is connected thereto and the test set includes means to check such wrong connection of the coils.

Furthermore, we provide a circuit arrangement which includes an inductance or reactance as part of the test set and wherewith the test set is capable of checking its own continuity and proper functioning.

We shall describe one form of test apparatus effective to carry out the method of testing inductors embodying our invention and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of apparatus embodying the invention when used as a portable test set to check the inductors of an intermittent train control system. Fig. 2 is a plan view showing the top panel of a housing in which the apparatus of Fig. 1 may be mounted to provide a portable test set. Figs. 3, 4, 5 and 6 are graphs illustrating operating characteristics of the apparatus of Figs. 1 and 2.

Referring to Fig. 1, a portable test set is indicated as a whole by a dot and dash rectangle TS. This test set is mounted in a housing of suitable size and material and it is provided with carrying means, not shown. The top of the housing forms a top panel for the test set, the top panel being shown in Fig. 2 and on which panel a portion of the apparatus is mounted, this apparatus being referred to from time to time as the specification progresses.

The housing is provided with two terminals 10 and 11 which are adaptable of making contact with corresponding parts of the plug of a cord circuit 12. This cord circuit includes two clips 6 and 7 by which the cord circuit can be clipped to the terminals of an inductor ID to be referred to hereinafter.

The apparatus of the test set TS comprises three circuit paths connected in parallel to the terminals 10 and 11. A first one of these circuit paths is a charging circuit and includes a lead wire 13 connected to terminal 10, a snap switch or push button 14, a power source such as a battery 15, an ammeter 16, a variable resistance comprising resistors 17, 18, 19 and 20, a multiple position switch member 23, and lead wire 21 connected to the other terminal 11. The switch 14 is mounted in the top panel of the case where the switch is accessible to the operator making the test. The battery 15 would preferably be of the dry cell type of a suitable voltage, its polarity being as indicated by the plus and minus signs of the drawings. The ammeter 16 is of a suitable range and is preferably mounted in the top panel where it can be read by the operator. The resistor 17 is made adjustable by an adjustable contact 22 which is mechanically connected by means not shown to a handle CA mounted on the top panel and thereby enables the operator to readily adjust the value of this resistance. The junction terminals of the resistors 17, 18, 19 and 20 are connected by individual lead wires to individual contact buttons identified by the reference characters P1, P2, 5T, 10T and 15T. A movable contact member 23 is mounted and

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made adaptable to successively engage these contact buttons by movement of the member 23 in step by step fashion about the pivot 24 and to which pivot the lead wire 21 is connected. The function of the variable resistors will appear when the operation of the test set is described.

A second parallel path between terminals 10 and 11 is a discharge circuit and includes lead wires 13 and 25 extending from terminal 10, a capacitor 26, variable capacitance including capacitors 27, 28 and 29, a multiple position switch member 30 and lead wire 21 to terminal 11. The capacitors 26, 27, 28 and 29 are connected to a series of six contact buttons which correspond to the six contact buttons provided for the variable resistance of the first circuit path. A contact member 30 is made to successively engage the different contact buttons of the variable capacitance when moved in a step by step fashion about a pivot point as will be apparent by an inspection of the drawing. The two contact members 23 and 30 are mechanically connected together as indicated by a dotted line 21 and this mechanical connection is brought out to a handle RH on the top panel of the test set and which handle is provided with six different positions P1, P2, 0T, 5T, 10T and 15T which corresponds with the contact buttons P1, P2, 0T, 5T, 10T and 15T, respectively of Fig. 1. It follows that the first and second circuit paths of the instrument can be set for different ranges through the medium of the handle RH.

The third circuit path of the test set comprises the lead wires 13 and 32 extending from terminal 10, resistor 33, an electric discharge lamp, such as a neon tube 34, and lead wires 35 and 21 to the terminal 11. A half wave rectifier 36 preferably of the dry surface contact type is connected in shunt with the lamp 34. Thus the third circuit path of the instrument comprises the resistor 33 connected in series with the lamp 34 and rectifier 36 in multiple. The lamp or tube 34 is mounted in a suitable socket in the top panel of the instrument where it can be observed by the operator. The resistor 33 is of a relatively high value for reasons to appear shortly.

The inductor ID of Fig. 1 is of the construction generally provided for the trackway inductor of an intermittent inductive train control system. As here shown, the inductor ID includes a magnetic core 37 having upstanding pole pieces and a winding. The winding comprises two coils 38 and 39 disposed side by side on the core and connected in parallel to terminals 8 and 9 of the inductor. The coils 38 and 39 are preferably alike and are poled to add their inductive effects. As explained in the aforementioned Bossart patent, an associated receiver is mounted on a vehicle for its pole pieces to pass over the pole pieces of the trackway inductor with a given clearance. It is apparent that when the receiver registers with the inductor ID the magnetic cores of the two cooperate to form a magnetic circuit the reluctance of which can be controlled by the winding 38—39. The reluctance will have one value when the winding 38—39 is short circuited and another value when the winding 38—39 is open circuited. As previously explained, a clear traffic condition is reflected in systems of the type here involved by short circuiting the inductor winding and a stop traffic condition is reflected by open circuiting the inductor winding. This control is illustrated in Fig. 1 by the terminals 8 and 9 being short circuited through a connection including a front contact 40 of a

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traffic controlled relay 41 and lead wires 42 and 43. This circuit connection is open circuited when the relay 41 is deenergized and released opening its front contact 40.

Thus in testing an inductor there are two electrical conditions for which tests should be made, one of which is to check the polarity of the coil 38 with respect to coil 39, and the other of which is to check whether there are any short circuited turns or high resistance short circuits on the coils 38 and 39. As will appear shortly, the two positions P1 and P2 of the selector handle RH of the test set are used to make the polarity check and the positions 0T, 5T, 10T and 15T are used to test for short circuited turns.

In using the test set TS to check the inductor ID the terminals 10 and 11 of the test set are clipped to the inductor terminals 8 and 9 and the cord circuit 12 is then plugged into the jack. Also, the control relay 41 is released during the testing of the associated inductor.

With the test set thus connected to the inductor ID and the push button or switch 14 closed, the battery 15 is connected across the inductor winding 38—39 through the first circuit path comprising the meter 16, resistor 17, and the resistors 18, 19 and 20 according to the position of the contact member 23. With this connection to the winding 38—39 completed, the flow of current will be indicated on the ammeter 16, the value of the current being according to the setting of the resistors 17 to 20. It is to be observed that with the polarity of the battery 15 as indicated by the plus and minus signs, the direct current is blocked from flowing in the third circuit path of the test set by the rectifier 36, it being understood that the voltage of the battery 15 is insufficient to ionize the tube 34.

With the test set thus connected to the inductor, a magnetic field is built up in the core of the inductor due to the direct current flowing in the coils 38 and 39. The push button 14 is next released to interrupt the circuit. This permits the magnetic flux in the inductor core to die away and induce a voltage in the winding 38—39. This voltage sets up an oscillatory wave in the circuit made up of the inductor winding and the second or discharge circuit path including capacitor 26 and capacitors 27, 28 and 29 according to the setting of the contact member 30. This oscillatory wave will be a damped wave and it will have the general form of that illustrated in Fig. 3. The first half cycle of this wave will cause the terminal 10 to be positive with respect to the terminal 11 and will be a positive half cycle of the wave. This polarity of the first half cycle of the wave will be passed by the rectifier 36 in its forward direction and thus by-passed around the tube 34 with the result the tube 34 remains dark. The resistor 33 of the third circuit path of the test set is a relatively large resistance having little effect on the damping of the wave.

The second half cycle of the wave will be of the opposite or negative polarity and it will be blocked by the rectifier 36 and the voltage will be impressed across the tube 34 and the tube will be illuminated when the voltage of this negative cycle of the wave is of an amplitude sufficient to ionize the tube.

Thus, the electrical condition of the winding of an inductor for which the test set TS is designed can be determined by selecting the charging circuit and the oscillatory circuit so that for a given condition of the winding the tube 34 is or is not flashed when the switch 14 is released.

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When a number of turns of the winding 38—39 are short circuited, there will be some decrease in the voltage induced in the inductor winding and there will be additional damping of the oscillations of the wave and if the damping is sufficient the wave will have the general shape illustrated in Fig. 4. The first or positive half cycle will be relatively large and it will be by-passed around the tube 34 by the rectifier 35 the same as before. This time the second or negative half cycle of the wave will be so damped that it is of insufficient voltage to ionize the tube 34 and it remains dark.

It can be demonstrated mathematically that for a given change in the load condition of any oscillatory circuit the resulting change in the second half cycle of the oscillatory wave is greater than the resulting change in the first half cycle of the oscillatory wave. Hence, with the test set TS constructed to utilize this principle of an oscillatory circuit by including means responsive to the magnitude of the second half cycle of the wave, it is enabled to check a short circuited condition of but a few turns of an inductor winding having a relatively large number of turns. For example, a short circuited condition of as few as 5 turns in an inductor winding having as many as 1000 turns can readily be checked. The number of short circuited turns which causes the lamp of the test set to remain dark is far less than the number of short circuited turns that will cause the inductor to transmit a false clear traffic condition impulse to the associated train receiver. For example, we have found that in a given train control system, approximately forty turns of the winding of the inductors must be short circuited before the inductor will transmit an improper clear impulse when the control relay is released, whereas the test set TS constructed for that system will detect a short circuited condition of as few as 5 turns or less.

As set forth hereinbefore, a partial ground on the inductor winding or the leads of the winding may set up such a low resistance between the inductor terminals that the inductor will transmit an improper clear traffic impulse. Such low resistance paths will be detected by the test set TS in much the same manner as short circuited turns are detected, because the low resistance ground paths affect the amplitude of the oscillatory wave. For example, at the position 15T of handle RH of the test set, we have found that a ground resistance of the order of 3000 ohms between the terminals 8 and 9 of an inductor will be detected by causing the lamp 34 to remain dark. Also, at the position 0T of handle RH a ground resistance of the order of 50,000 ohms will be detected by the test set. Furthermore, we have found that in these inductors a ground resistance of a much lower value than stated above can be tolerated before an inductor will transmit an improper clear traffic impulse.

Consequently, along with using the test set TS to check the relative polarity connection of the coils of the inductor winding, and short circuited turns, it can also be used to check the relative ground resistance of the winding and its leads.

In testing an inductor, the normal procedure is to determine first the polarity check and then to test for short circuited turns and grounds.

Obviously, the flashing of the lamp 34 or the lamp remaining dark under correctly and incorrectly connected inductor coils for a given charging current and a given discharge or oscil-

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latory circuit will depend also upon whether or not there are short circuited turns or grounds on the coils. In Fig. 5 there are shown curves for the test set of Figs. 1 and 2 when used with a given standard inductor, the curves being plotted between the value of charging current required to flash the lamp 34 and short circuited turns of the inductor winding under correctly and incorrectly connected coils of the inductor winding. Curve A, for example, indicates that what the coils are correctly poled and the oscillatory circuit includes the capacitors 26 and 27 (range position 0T or P1), a charging current of about 600 milliamperes must be applied to the inductor winding in order to light the lamp 34 by interrupting the charging circuit when there are only 5 short circuited turns. Similarly, the curve B indicates the relationship between charging current required to light the lamp 34 and short circuited turns of the winding when the oscillatory circuit includes capacitor 26 only (range position 15T or P2) and the coils are of correct polarity. We have found that this relationship between charging current which causes the lamp 34 to light and short circuited turns is according to the irregular shaped curve C when the oscillatory circuit includes capacitors 26 and 27 (range position P1 or 0T) and the coils are of incorrect polarity. Also, that this relationship is accordingly to the irregular shaped curve D when the oscillatory circuit includes capacitor 26 only (range positions 15T and P2) when the coils are of incorrect polarity.

Consequently, by placing the selector handle RH of the test set at position P1 so as to include capacitors 26 and 27 in the oscillatory circuit and adjusting the resistor 17 so that a charging current of 600 milliamperes flows in the inductor winding when the switch 14 is closed, the flashing of the lamp 34 when the switch 14 is released indicates one of two conditions, namely, either that the coils 38 and 39 are connected at correct polarity and there are less than 5 short circuited turns (curve A) or that the coils are connected at incorrect polarity and there may be some short circuited turns (curve C). If the lamp does not flash, we know that the polarity of the coils is correct and also that there are more than 5 short circuited turns. Again, with the handle RH set at position P2 so that capacitor 26 only is in the oscillatory circuit and the resistor 17 adjusted to provide a charging current of the order of 370 milliamperes when the switch 14 is closed, the lamp 34 is flashed when the switch 14 is released if the coils 38 and 39 are connected at correct polarity and there are not more than 10 short circuited turns (curve B) and it is not flashed if the coils are connected at incorrect polarity (curve D).

That is to say, at position P1, if the lamp 34 does not flash we know that the polarity of the coils 38 and 39 is correct and incidentally that there are more than 5 short circuited turns. If the lamp 34 flashes we know that one of two things may exist, namely, that the polarity of the coils 38 and 39 is incorrect or that the polarity is correct with less than 5 short circuited turns. To determine which of these two conditions exists the position P2 is used, and at position P2 if the lamp 34 is flashed then we know that the polarity of the coils is correct and incidentally that there are not more than 10 short circuited turns. If the lamp 34 does not flash we know that the polarity is incorrect.

In Fig. 6 there are shown curves plotted be-

tween short circuited turns of the inductor coils 38 and 39 and the charging current required to flash the lamp 34 of the test set TS. Taking the curve for position 0T (P1), for example, the arm RH is set at position 0T so that all of the resistors 17 to 20 are in the first or charging circuit path and the capacitors 26 and 27 are in the second or discharging circuit path. With the discharge circuit maintained with capacitors 26 and 27, let us assume that the resistors 17 to 20 are varied to provide different values of charging current. Now for different numbers of short circuited turns on the inductor winding the charging current as read on the meter 16 is varied until the charging circuit is just sufficient to cause the lamp to flash when the switch 14 is released. This curve for position 0T (P1) shows that for different numbers of short circuited turns different values of current are required to cause the lamp to flash. The greater the number of short circuited turns, the larger is the current required to cause the lamp to flash. Similarly, the curves of Fig. 6 for the positions 5T, 10T and 15T are obtained. For these curves of Fig. 6, the correct polarity of the coils 38 and 39 exists.

Now in testing the inductor ID for short circuited turns, if we set the handle RH at range position 15T and adjust resistor 17 so that there is a charging current of approximately 600 milliamperes and the tube 34 flashes when the switch 14 is released we know there are not more than 16 short circuited turns (see curve 15T (P2)). Again, if we set the handle RH at range position 10T and adjust resistor 17 to cause a charging current of 500 milliamperes and the tube 34 flashes when the switch 14 is released, we know from curve 10T of Fig. 6 that there are not more than 10 short circuited turns. Similarly, when the handle RH is set at range position 5T and the resistor 17 adjusted for a charging current of 370 milliamperes and the tube 34 flashes when the switch 14 is released, we know that there are not more than 7 short circuited turns (see curve for position 5T). With the handle RH set at position 0T and the resistor 17 adjusted to provide a charging current of 280 milliamperes and the tube 14 flashes we know that there are not more than 3 short circuited turns.

It follows that by testing the inductor ID in the manner explained above, as few as three short circuited turns of the winding can be detected.

The matter of testing for partial grounds on the inductor winding or its lead wires is carried out in much the same manner as the checking for short circuited turns. For example, we have found that with the correct polarity and less than three short circuited turns, the position 15T (P2) of the test set and the charging current set at 600 milliamperes will detect a ground resistance of the order of 3000 ohms by the lamp remaining dark. Also, the position 0T (P1) will detect a ground resistance of the order of 50,000 ohms by the lamp remaining dark. With the inductors here involved a ground resistance of a much lower order than 3000 ohms can be tolerated before the inductor will transmit an improper impulse. Consequently, an unsafe low ground resistance can be checked by the lamp 34 remaining dark at the different range positions.

As stated hereinbefore, the test set TS is arranged to check its own operation. In checking the operation of the test set the operator would remove the cord circuit 12 from the instrument thereby disconnecting the inductor ID.

Following this, the operator would close the switch 60 and thereby connect the inductance L1 across the terminals 10 and 11. The inductance of the element L1 is of such a value as to develop a sufficient negative voltage of the oscillatory wave created when the switch 14 is opened to cause the lamp to be flashed when the range switch is set at the position P1 and at each of the other positions of the apparatus except P2. Thus the operator would repeat the operation of closing and then opening the push button 14 for each of the different positions of the handle RH except for the position P2. At position P2 the negative half cycle of the wave is insufficient to illuminate the neon lamp. This operation will therefore check the continuity and proper functioning of the component parts of the test set. If the rectifier 36 is open circuited then the lamp 34 will be illuminated by both positive and negative half cycles of the oscillatory wave and the fact that the lamp is illuminated in position P2 is an indication of a defective rectifier. The ammeter 16 indicates the flow of current each time the switch 14 is closed and if no current flow is registered on the ammeter it is obvious that there is an open circuit. Also, when the test set is connected to the trackway inductor and there is no current flow registered by the ammeter, it is apparent that there is an open circuit condition in the inductor. If the current reading on the ammeter is only about one-half of the normal reading for the particular position at which the handle RH is set, then it is obvious that one of the coils must be open circuited.

Although we have herein shown and described only certain forms of means for testing inductors embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In combination with a testing means comprising, a pair of terminals, a first circuit path including a direct current power source, a switch and a resistance in series connected across said pair of terminals, and a second circuit path including capacitance connected across said pair of terminals; a third circuit path including an electric discharge lamp and a half wave rectifier in multiple connected across said pair of terminals.

2. In a testing means including a pair of terminals to which a circuit to be tested can be connected, a first circuit path including a direct current source, a two position switch and a resistance in series connected across said terminals; said first circuit path being effective to energize and deenergize a circuit to be tested when it is connected to said terminals, and a second circuit path including capacitance connected across said terminals, said second circuit path cooperating with a tested circuit connected to the terminals to form an oscillatory circuit; a third circuit path including an electric discharge lamp and a half wave rectifier in multiple connected across said terminals, said rectifier being poled to pass in its forward direction the positive half cycles of an oscillatory wave created in said oscillatory circuit and said lamp being illuminated only by the peak voltage of the negative half cycles of the oscillatory wave.

3. In combination with means for testing an inductor having a winding mounted on a mag-

netic core, said means including a pair of terminals adapted for the winding of an inductor to be tested to be connected thereto, a first circuit including a battery, a switch and a resistance in series connected to said terminals to energize an inductor connected to said terminals when said switch is closed; and a second circuit including capacitance connected to said terminals, said capacitance and the inductor winding connected to the terminals forming an oscillatory circuit in which an oscillatory wave is set up when said switch is opened subsequent to its being closed; a third circuit including a resistance in series with an electric discharge lamp and a half wave rectifier in multiple connected across said terminals, said lamp being adaptable of being illuminated by the peak voltages of said oscillatory wave and said rectifier being poled to shunt the positive half cycles of the wave around said lamp.

4. In means for checking short circuited turns of an inductor having a winding mounted on a magnetizable core, said means including a pair of terminals across which an inductor winding can be connected; a first circuit having a battery, a switch and an adjustable resistance in series connected across said terminals; said first circuit being effective to energize an inductor connected to the terminals storing a direct magnetic flux therein by the closing of said switch, the strength of said flux being determined by the adjustment of said resistance; and a second circuit including an adjustable capacitance connected across said terminals, said second circuit forming with the winding of an inductor connected to the terminals an oscillatory circuit in which a damped wave is set up when said switch is opened; a third circuit including a resistance in series with a neon lamp and a half wave rectifier in multiple connected across said terminals, said lamp being adapted to be illuminated by the peak voltages of the first and second half cycles of said wave when the inductor is free from short circuit turns, and said rectifier poled to pass in its forward direction the first half cycle of the wave, thereby restricting the illumination of said lamp to the second half cycle of said wave.

5. In combination with means for checking the connections of an inductor winding having two coils connected in multiple, said means including a pair of terminals to which an inductor winding can be connected; a first circuit including a battery, a switch and a variable resistance in series connected across said terminals; said first circuit effective to energize an inductor connected to said terminals at a first or a second value of direct current when said switch is closed according as said variable resistance is set at first or a second value; and a second circuit including a vari-

able capacitance connected across said terminals, said second circuit forming with the winding of an inductor connected to the terminals an oscillatory circuit in which a damped wave is set up when said switch is opened, said oscillatory circuit having a first or a second operating characteristic according as said variable capacitance is set at a first or a second value; a third circuit including a resistance in series with a neon lamp and a half wave rectifier in multiple connected across said terminals, said lamp being adaptable of being illuminated by the peak voltages of said wave, and said rectifier being poled to shunt the positive half cycles of the wave around said lamp.

6. Means for indicating the relative peak voltage of selected half cycles of an oscillatory wave, said selected half cycles having a chosen polarity, the alternate half cycles of said wave having the opposite polarity; said means comprising a pair of terminals to which the source of said oscillatory wave is connected, and a neon lamp and half-wave rectifier in multiple connected across said terminals, said rectifier being poled to block said selected half cycles and to pass those of opposite polarity, thereby impressing on said lamp only the voltage of said selected half cycles, said lamp becoming illuminated only if the peak voltage exceeds the ionization voltage of said lamp.

7. In combination with an electric circuit testing device, including a pair of terminals to which the circuit to be tested is connected; means for indicating that the peak voltage of a second half cycle of a damped oscillatory wave exceeds a critical value, said means being connected across said pair of terminals and comprising a resistance in series with an electric discharge lamp, having a critical ionization potential characteristic, and a half-wave rectifier connected in multiple; said half-wave rectifier being poled to pass in its forward direction the first half cycle of said damped wave and to block said second half cycle, thereby causing the peak voltage of said second half cycle to be impressed on said electric discharge lamp, said lamp becoming illuminated if said peak voltage exceeds said critical ionization potential of said lamp.

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