

Sept. 23, 1947.

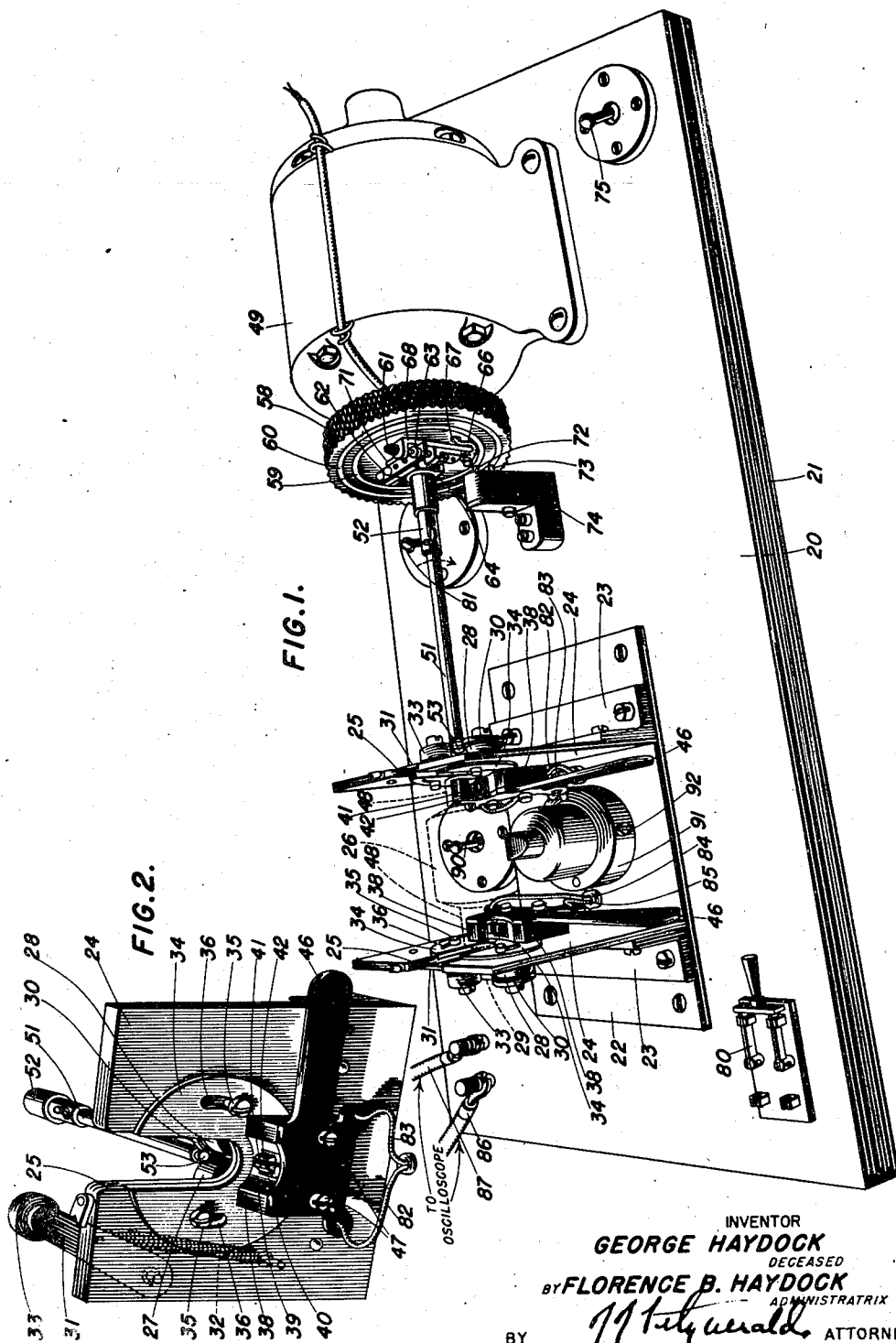
G. HAYDOCK

2,427,672

ARMATURE ANALYZER UTILIZING A CATHODE RAY OSCILLOSCOPE

Filed Oct. 28, 1943

5 Sheets-Sheet 1



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Sept. 23, 1947.

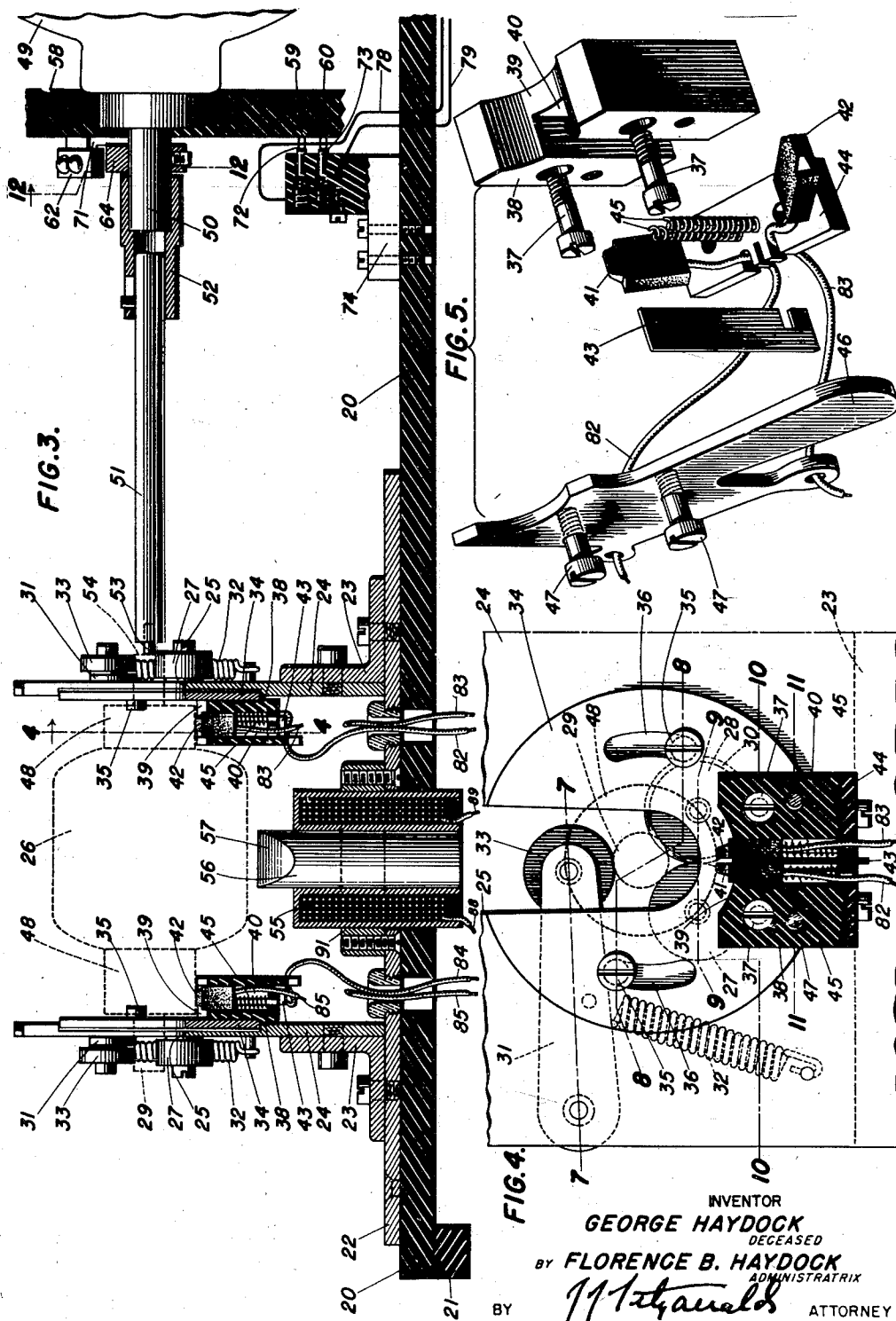
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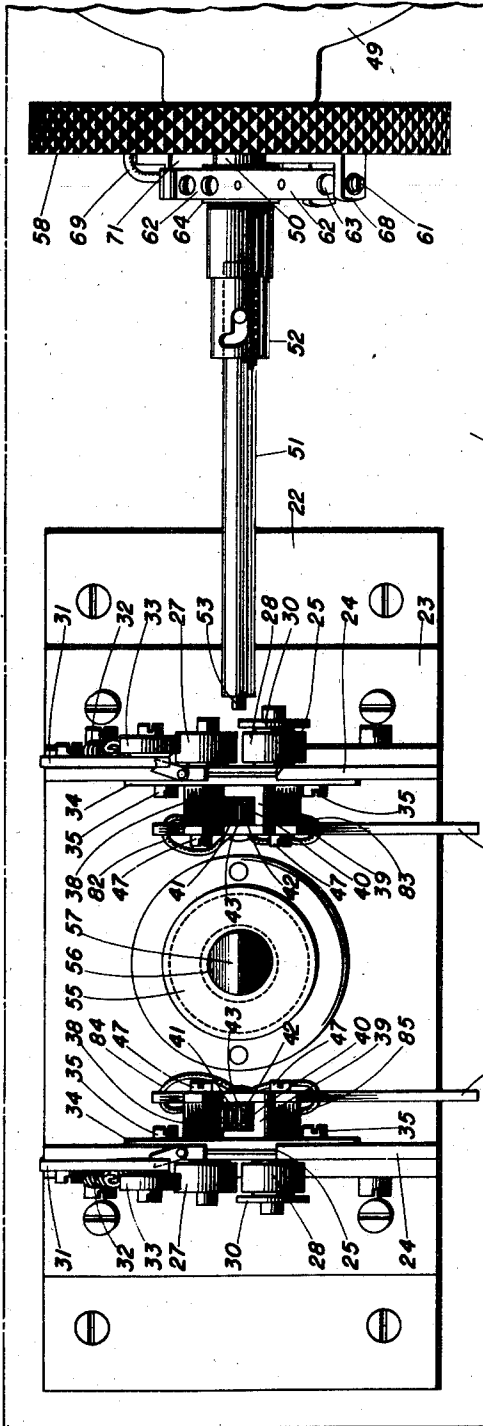


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FIG. 14.

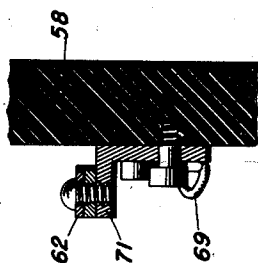


FIG. 13.

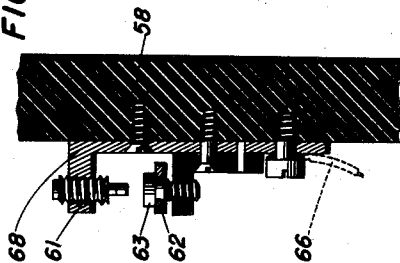


FIG. 16.

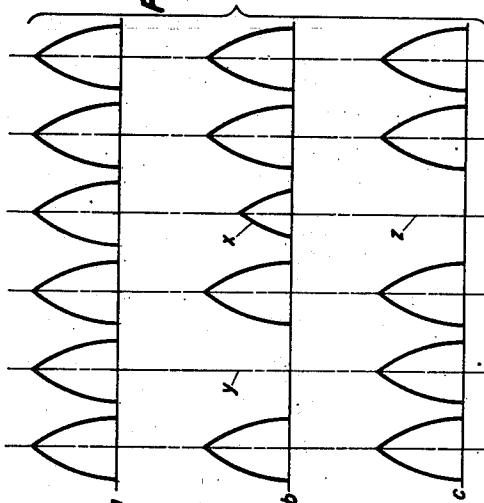


FIG. 12.

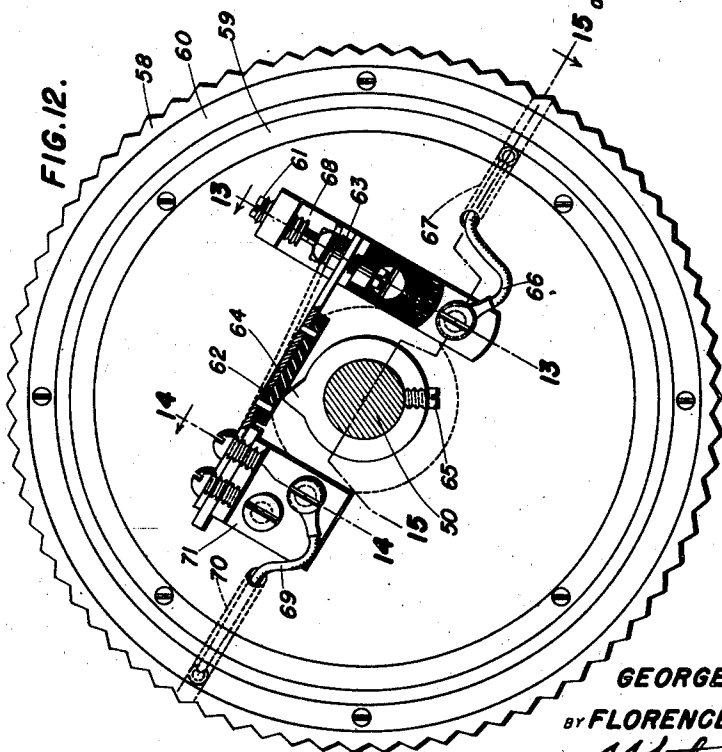
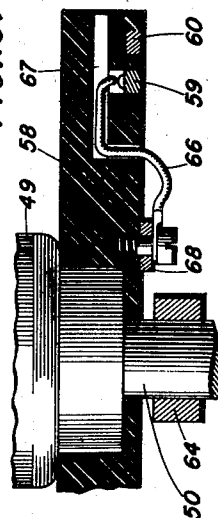


FIG. 15.



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Sept. 23, 1947.

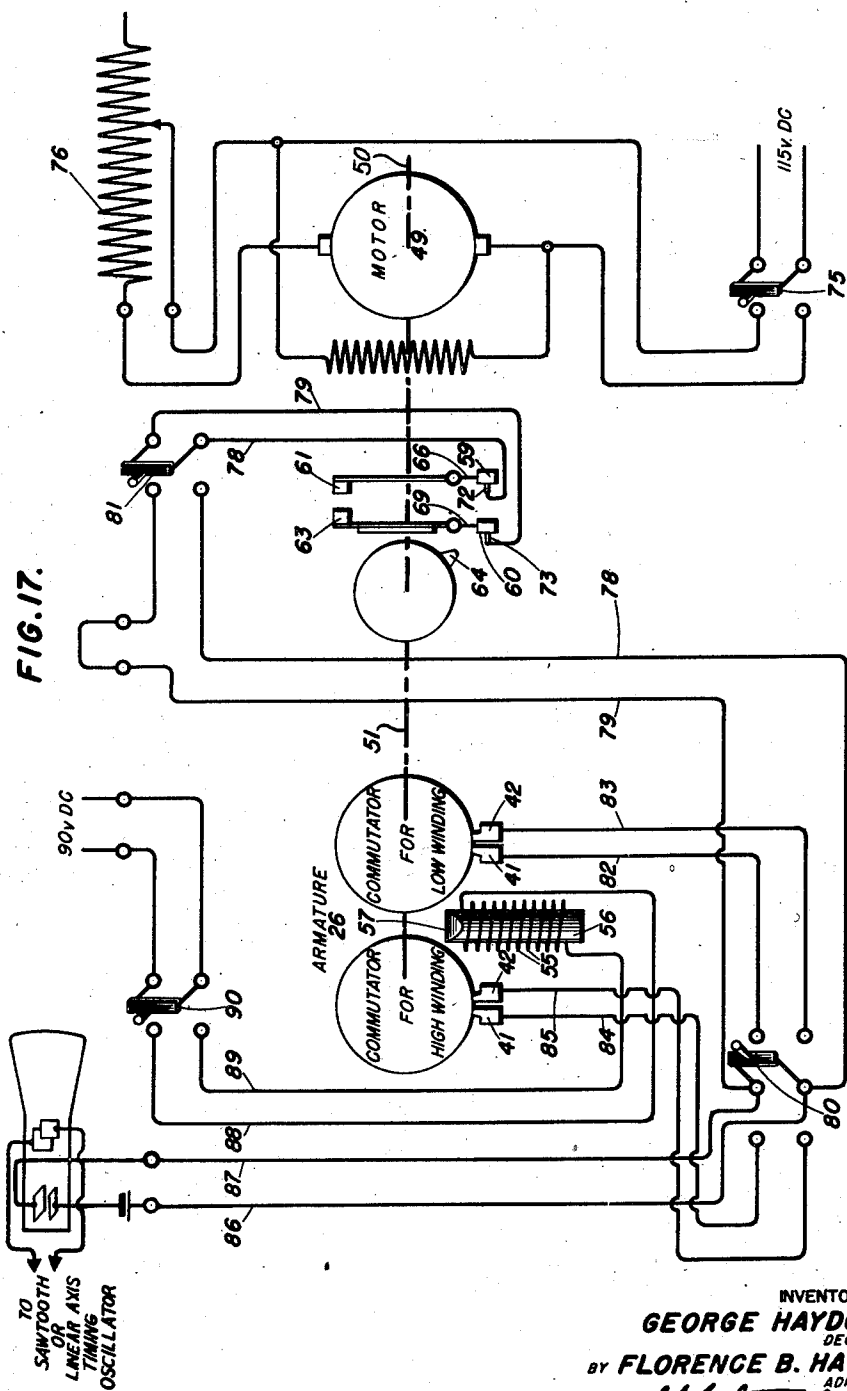
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Filed Oct. 28, 1943

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,427,672

ARMATURE ANALYZER UTILIZING A
CATHODE-RAY OSCILLOSCOPEGeorge Haydock, deceased, late of Newport, R. I.,
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port, R. I.

Application October 28, 1943, Serial No. 507,932

5 Claims. (Cl. 175—183)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

1

This invention relates in general to armature testing devices and in particular to an improved device for dynamically analyzing the electrical characteristics of an armature.

The principal object of the invention is to provide an armature analyzer wherein any armature defects may be observed under dynamic conditions on an oscilloscope and in which any such armature defect may be readily and accurately located.

Some of the defects that can be determined by means of my improved device are high mica, low or high commutator bars, abnormal width of slots between adjacent commutator segments, excess or deficiency in number of turns per armature coil, short circuits in coils or commutators, open circuits, and reversed armature coils.

Other objects and advantages will become apparent from the detailed description to follow when considered with the accompanying drawings, which illustrate a preferred embodiment of the invention as designed for analyzing a lap wound armature having double windings, a commutator being provided on each end of the armature for connecting each such winding to its respective external circuit.

In the drawings, in which like reference characters are used to indicate like parts in the several views presented,

Fig. 1 is a perspective view of the complete armature analyzer;

Fig. 2 is a view in perspective of one of the brush assemblies and the supporting parts therefor;

Fig. 3 is a longitudinal view of a main portion of the analyzer, partially in section and partially in elevation;

Fig. 4 is a vertical view taken on line 4—4 of Fig. 3;

Fig. 5 is an exploded, perspective view of the brush assembly shown in Fig. 2;

Fig. 6 is a plan view of the analyzer;

Fig. 7 is a horizontal sectional view taken on line 7—7 of Fig. 4;

Fig. 8 is a horizontal sectional view taken on line 8—8 of Fig. 4;

Fig. 9 is a horizontal sectional view taken on line 9—9 of Fig. 4;

Fig. 10 is a horizontal sectional view taken on line 10—10 of Fig. 4;

Fig. 11 is a horizontal sectional view taken on line 11—11 of Fig. 4;

Fig. 12 is a vertical sectional view taken on line 12—12 of Fig. 3;

Fig. 13 is a sectional view taken on line 13—13 of Fig. 12;

Fig. 14 is a sectional view taken on line 14—14 of Fig. 12;

Fig. 15 is a sectional view taken on line 15—15 of Fig. 12;

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Fig. 16 is a diagrammatic illustration of a typical set of voltage wave patterns as might be viewed in the oscilloscope utilized in conjunction with the analyzer; and

Fig. 17 is an electrical circuit diagram for the armature analyzer.

A base 20, preferably of Bakelite or other suitable insulating material, is provided for use in mounting the various elements of the analyzer, and includes marginal strips 21 to space the base from its supporting means.

A metallic plate 22 is secured to the base 20. Two angle bars 23 serve to support two spaced vertically extending end plates 24, each of which is slotted vertically at 25, and these end plates serve to cradle an armature 26 under test, the latter being shown in broken lines.

Two roller members 27 and 28 are rotatably mounted on the outside of each of the end plates 24 and function as a bearing for the armature shaft 29. If desired, each of the rollers 28 may be provided with a collar 30 to prevent endwise motion of the armature 26.

In order to keep the armature shaft 29 from rolling off the rollers 27 and 28 when the armature is being rotated, an arm member 31 is secured to each of the end plates 24 and is biased downwardly by a spring 32 (shown in Figs. 2 and 4). Each arm member 31 includes a roller 33 that is adapted to bear upon the top of the armature shaft 29 and hold the latter securely in position against the other rollers 27 and 28.

A plate member 34 is mounted respectively on each end plate 24 by means of bolts 35 that extend through appropriate arcuate slots 36 in the plates 34. The heads of the bolts 35 are slightly larger than the width of the slots 36 in order to hold the plates 34 snugly against the end plates 24 as the bolts 35 are tightened. The bolts should, however, be sufficiently loose to permit rotation of the plates 34 on the end plates 24 within the limits of the slots 36.

Fastened to each plate 34 by means of bolts 37 is a vertical block 38 of Bakelite or other suitable insulating material, which contains an arcuate cut out portion 39 at the top and a vertical guideway 40 extending longitudinally therethrough for housing a pair of brushes 41 and 42. These brushes are electrically insulated from each other by a Bakelite spacer 43, as shown in Fig. 5.

A bottom plate 44 is fastened to the block 38 and serves to support two springs 45 that function as resilient mounting means for the brushes 41 and 42. A handle 46, also of insulating material, is secured by bolts 47 to the brush block 38. The brushes 41 and 42 are adapted to make contact with adjacent segments of the commutator portions 48 of the armature 26 as the latter is placed in a test position, as indicated in Fig. 3.

In order to rotate the armature 26, a motor 49

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is provided. This motor, the speed of which is made variable by suitable rheostat means, is secured to the base 20. In order to extend the motor shaft 50, an auxiliary shaft 51 is connected thereto by a sleeve coupling 52. A rubber plug 53, disposed at the end of the shaft 51, is adapted to abut the end face 54 of the armature shaft 29 and functions to frictionally couple the auxiliary shaft 51 to the armature shaft 29.

For generating a voltage in the coils on the armature 26, a field winding 55 containing a core 56 is provided. Preferably the end of the core 56 nearest the armature 26 terminates in a chisel edge 57, so that the magnetic flux produced by the winding 55 will be confined to a narrow path in this area.

A vertical circular plate 58 of insulating material having a central opening therethrough fits over a cylindrical portion of an end bell of the motor 49 and has imbedded therein a pair of spaced metallic rings 59 and 60. Secured to the face of the plate 58 by means of metallic brackets 68 and 71 is a make-and-break contactor consisting of a fixed contact screw 61 and a movable arm 62 carrying a contact 63. A cam 64 fastened to the motor shaft 50 by a set screw 65 functions to close the contacts 61 and 63 for an instant upon each revolution of the motor shaft 50.

As seen in Figs. 12 and 13, a conductor 66 extends from the ring 59 through an interior duct 67 in the plate 58 to the support bracket 68, thus completing an electrical circuit from the ring 59 to the contact screw 61. In a similar manner, another conductor 69 extends from the ring 60 through an interior duct 70 in the plate 58 to the other metallic bracket 71. This completes the electrical circuit between the ring 60 and the movable contact 63.

A pair of spring biased contacts 72 and 73, as shown in Fig. 3, are suitably supported in a block 74 of insulating material and are adapted to bear against the rings 59 and 60 respectively.

Fig. 17 shows how the various parts of the analyzer are electrically joined. A switch 75 connects the motor 49 to its power source, and a rheostat 76 is included in the armature circuit of the motor to control its speed.

The conductors 78 and 79 connect the contacts 72 and 73 respectively to the middle poles of a double pole, double throw switch 80 through an intermediary switch 81.

As stated hereinbefore, the present embodiment of the invention is adapted for dynamically testing an armature having two separate, lap wound windings, a commutator being provided on each end of the armature for each set of windings. One set of windings occupies the bottom portion of the slots in the armature, and the other set occupies the top portion of such slots. These are commonly referred to as the "high" and "low" windings of the armature respectively, and are so designated in Fig. 17. Two conductors 82 and 83 connect the set of brushes 41-42 for the "low" winding commutator to one set of end terminals on the switch 80, and in a similar manner, two conductors 84 and 85 connect the other set of brushes 41-42 for the "high" winding commutator to the other set of end terminals on the switch 80.

Two conductors 86 and 87 extend from the middle poles of the switch 80 to the vertical deflectors of an oscilloscope. The vertical deflectors are normally biased by a biasing battery or other device, and the horizontal plates of the oscilloscope are connected to a saw tooth or linear tim-

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ing axis oscillator, for the purpose of obtaining a linear periodic sweep of the beam. The field winding 55 is connected by two conductors 88 and 89 through a switch 90 to a power source. In order that the core 56 of the winding 55 may be adjusted vertically to take care of armatures of various diameters, it will be seen from Figs. 1 and 3 that the winding 55 is mounted in a ring 91, the necessary vertical adjustment being obtained by sliding the winding 55 through the ring and locking the former in position by means of a set screw 92.

The magnetic field that is set up by the winding 55 is so narrowed in width by the chisel edge characteristic of the core 56 that each coil cuts the field for only a very short period of time. The position of the brushes 41 and 42 is therefore very critical if adjacent coils should be very close together. Thus, when there is more than one coil per slot in the armature under test, means may be provided for a slight shift of the brushes 41 and 42 relative to the commutator segments so that a complete voltage pattern of each such coil may be viewed on the oscilloscope. As previously described, the brushes 41 and 42 are supported in the brush block 38, and the latter is secured to the rotatable plate 34. The necessary shift in brush position may therefore be obtained by movement of the handle 46 that is fastened to the brush block 38.

Operation

With the test armature 26 in position, the motor 49 is started by closing the switch 75 to thereby obtain rotation of the armature. The switch 90 is also closed. The current through the field winding 55 produces a magnetic flux so that as each coil in the armature 26 passes through the field, a voltage will be generated in each coil of the winding. If the switch 80 is thrown to the right, the wave form of the voltage generated in each coil of the "low" winding will appear on the viewing screen of the oscilloscope. Similarly, if the switch 80 is thrown to the left, the wave form of the voltage generated in each coil of the "high" winding will appear on the oscilloscope.

If the wave form of each coil is alike, such as shown in curve *a* of Fig. 16, this will indicate that there are no defects in any of them or in the connections between the coils and brushes. Should there be any defective coils, however, such as a deficiency of turns in the coil, such defect will appear on the oscilloscope such as at *x* to curve *b* in Fig. 16, and can easily be identified by means of my device.

It will be evident that with the switch 81 closed, one of the coils of the armature 26 will always be shunted out as the contacts 63 and 61 are momentarily closed once in each revolution of the cam 64, thereby leaving one blank space on the oscilloscope viewing screen such as at *y* in curve *b* of Fig. 16. The particular coil that is shunted out is, of course, dependent upon the position of the contacts 63 and 61 relative to the cam 64. Thus by rotating plate 58 (which carries contacts 63 and 61) any one of the coils on the armature may always be shunted out.

To locate the defective coil, it is only necessary to turn the plate 58 by hand until the voltage wave generated by the defective coil such as might be shown at *x* in curve *b* is blanked out of the voltage pattern as shown at *z* of curve *c* in Fig. 16.

The motor 49 is then stopped and the armature

26 rotated slowly by hand until the cam 64 closes the contacts 61 and 63. The operator will then know that the defective coil is the one connected to the adjacent segments of the commutator then in circuit with the brushes 41 and 42.

By means of the switch 80, all of the coils of both the "high" and "low" windings of the armature 26 may thus be tested.

Other types of defects will also manifest themselves in the wave forms appearing in the oscilloscope, and, with a little study, an operator will be able to accurately identify each of them.

In conclusion, it is pointed out that while the present embodiment of the invention was designed specifically for dynamically analyzing a double winding armature, single winding armatures having only one commutator may also be analyzed by the use of one set of the brushes 41, 42.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An analyzer for a commutator type armature comprising means for supporting the armature against longitudinal movement, means for rotating the armature, means for producing a magnetic field adjacent the armature whereby a voltage will be generated in each coil of the armature in sequence as the latter is rotated, a beam oscilloscope provided with means for uniformly sweeping said beam in one direction as the armature is rotated, means for connecting each armature coil when voltage is generated therein to a deflecting element of said oscilloscope effective to deflect said beam in a direction normal to said one direction for obtaining a pattern of the voltage curves produced by said coils, and means for short circuiting said connecting means to eliminate selectively any one of said voltage curves from said pattern.

2. An analyzer for a commutator type armature, comprising means for supporting the armature against axial movement, means for rotating the armature, means for producing a magnetic field adjacent the armature, a beam oscilloscope provided with means for uniformly sweeping its beam in one direction as the armature is rotated, commutator brush means disposed to engage adjacent commutator bars for connecting each of the coils on the armature sequentially in circuit with a deflecting element of said oscilloscope effective to deflect said beam in a direction normal to said one direction whereby a pattern of the voltages generated in said coils respectively as each coil cuts said field will be produced on said oscilloscope, and means for momentarily short-circuiting said brush means at any selected angular position of the armature in its path of rotation whereby the voltage curve on any desired coil may be cut out of said voltage pattern.

3. An analyzer for a commutator type armature comprising means for supporting the armature for rotation, motor means for rotating the armature, means for producing a magnetic field adjacent the armature, a beam oscilloscope provided with means for uniformly sweeping its beam in one direction as the armature is rotated, commutator brush means disposed to engage adjacent commutator bars for connecting each of the coils on the armature sequentially in circuit

with a deflecting element of said oscilloscope effective to deflect said beam in a direction normal to said one direction whereby a pattern of the voltages generated in said coils respectively as each coil cuts said field will be produced on said oscilloscope, and adjustable contact means rotatable with the armature for momentarily short-circuiting said brush means at any selected angular position of the armature in its path of rotation whereby the voltage curve of any desired coil may be cut out of the voltage pattern.

4. An analyzer for a commutator type armature, comprising means for supporting the armature for rotation, motor means for rotating the armature, means for producing a magnetic field adjacent the armature, a beam oscilloscope provided with means for uniformly sweeping said beam in one direction as the armature is rotated, commutator brush means disposed to engage adjacent commutator bars for connecting adjacent coils on the armature sequentially in circuit with a deflecting element of said oscilloscope effective to deflect said beam in a direction normal to said one direction whereby a pattern of the voltage generated in said coils respectively as each coil cuts said field will be produced on said oscilloscope, a support member, means for mounting said support member for rotation coaxially with the armature, contact means carried by said support member, cam means rotatable with the armature, said cam means being operable to actuate said contact means once in each revolution of the armature, and means connecting said contact means to said brush means for short-circuiting said brush means at any selected angular position of the armature in its path of rotation whereby the voltage curve of any desired coil may be cut out of said voltage pattern as said support member is rotated.

5. An analyzer for a commutator type armature, comprising means for producing a magnetic field adjacent the armature, means for producing relative rotation between the magnetic field and the armature to generate voltage in each of the coils of the armature in succession, a beam oscilloscope provided with means for normally sweeping said beam in one direction during the relative rotation between the field and the armature, means for connecting each of the coils of the armature when voltage is generated therein to a deflecting element of said oscilloscope effective to deflect said beam in a direction normal to said one direction to thereby obtain a pattern of the voltages produced by the said coils, and means for rendering said connecting means inoperative at any selected angular position of the armature whereby the voltage pattern produced by a particular coil may be selectively eliminated.

FLORENCE B. HAYDOCK,
Administratrix of the Estate of George Haydock,
Deceased.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

70 Number	Name	Date
1,906,030	Whelchel	Apr. 25, 1933
2,321,424	Rohats	June 8, 1943
1,479,284	Cullin	Jan. 1, 1924