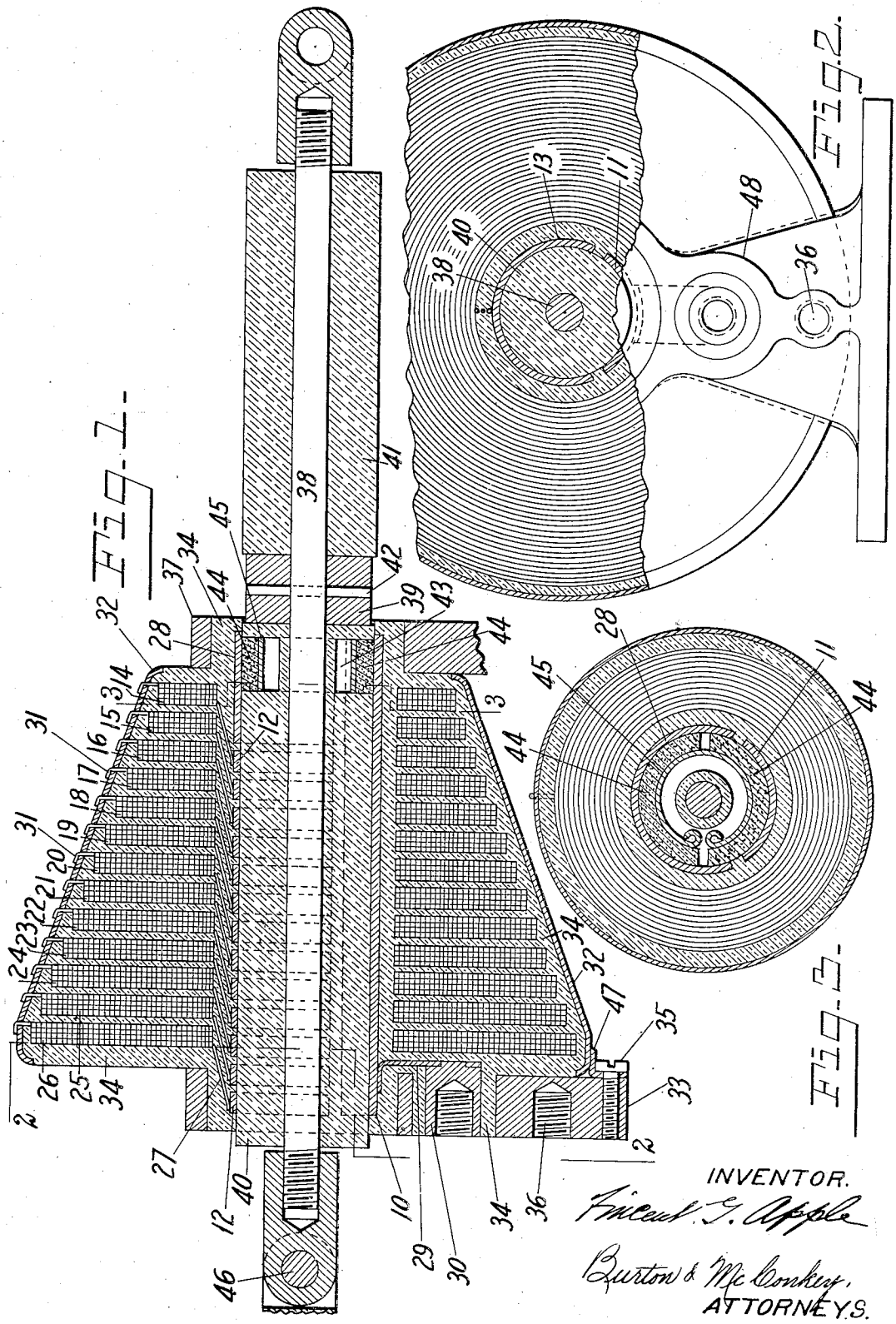
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PROGRESSIVE SOLENOID FOR OPERATING BRAKES

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INVENTOR.
Vincent G. Apple
Burton & McConkey,
ATTORNEYS.

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VINCENT G. APPLE, OF DAYTON, OHIO, ASSIGNOR TO BENDIX BRAKE COMPANY, OF SOUTH BEND, INDIANA, A CORPORATION OF ILLINOIS

PROGRESSIVE SOLENOID FOR OPERATING BRAKES

Application filed July 26, 1928, Serial No. 295,580. Renewed May 5, 1930.

My invention relates to improvements in solenoids.

An object is to provide a solenoid particularly adapted to exert brake applying pressure on the brakes of a motor vehicle either to supplement or to take the place of the manual pressure usually so employed and one specific object is to provide a solenoid wherein the magnetic effort exerted thereby increases with the movement of the core into the winding, and which has a plurality of coils arranged in axially spaced apart relationship and being of progressively increasing ampere turns from one end of the series of the coils to the other.

Another object is the provision of such a solenoid wherein the movement of the brush member over the successive commutator bars is produced by the relative movement of the core into the winding and wherein the brush, as it is advanced into the winding ahead of the iron core, serves to successively throw the winding ahead of the core into the circuit to progressively act upon the core.

My improved solenoid is a simple, rugged, self-contained device wherein all the parts are effectively protected and insulated and it is inexpensive and easily built.

Other objects, advantages and meritorious features of my invention will more fully appear from the following description of the illustrative embodiment shown in the drawings and defined in the claims.

In the drawings,—

Fig. 1 is a longitudinal cross-section through my device.

Fig. 2 is a cross-section taken at 2—2 Fig. 1.

Fig. 3 is a cross-section taken at 3—3 Fig. 1.

Referring to the drawings, a relatively long plate 10 of conductive material is bent to compose a segment of a circle as at 11, and a plurality of narrow strips 12 of similar material are bent to a longer segment of the same circle as at 13. These narrow strips form the commutator sections.

Coils 14 to 26 inclusive are placed around the segments, the diameters of the coils progressively increasing to provide increased ampere turns in successive coils as shown.

The inner ends of coils 14 to 26 inclusive are each connected as at 27 to a strip 12, and a relatively wide strip 28 is placed alongside the narrow strips but is not connected to any coil. It is upon this dead strip that the brush rests when the device is inoperative.

Curved plate 10 is joined by connector 29 to a binding post 30. The outer ends of coils 14 to 26 inclusive are then connected as at 31 to the sheet metal housing 32 which surrounds the coils.

A metal angle piece 47 is welded or otherwise joined to sheet metal housing 32. Bracket 33 is then put in place and fastened by screw 35. Bracket 33 electrically connects to housing 32 alone, leaving a clearance between binding post 30 and the inner diameter of hub 48 of bracket 33 into which insulation may extend.

The structure is next placed in a mold and insulating material 34 is molded through and about the coils and segments, between binding post 30 and bracket 33 to make a solid structure having adequate electrical and mechanical protection.

A hole 36 tapped in bracket 33 provides a common connection to the outer ends of all of the coils. The addition of bracket 37 completes the stationary element of the device.

The movable element is provided by placing on rod 38 a soft iron core 39 and cylinders 40 and 41 of insulating material adjacent the core. Core 39 is shown pinned to rod 38 by pin 42 but may be otherwise secured. Cylinders 40 and 41 are preferably molded about knurled surfaces on the rod. An annular groove 43 in cylinder 40 contains the brush gear.

The brush gear comprises two semi-annular brushes 44 preferably of a material having lubricating properties although lubricating material may be incorporated in the compound from which cylinders 40 and 41 are molded. Annular spring 45 forces the two brushes apart and against plate 10 on the one side and strips 12 or 28 on the

other, whereby plate 10 is electrically connected to one or more of the strips.

The device is illustrated in inoperative position only, but it is readily apparent that if, by manual connection to rod 38 as at 46, brushes 44 are moved from dead strip 28 on to the adjacent strip 12, the coil 14 will be energized and will draw core 39 toward it, whereupon brushes 44 will be moved to the next segment 12, the cycle being thus repeated until core 39 has been drawn into the last and strongest coil 26.

The device hereinbefore shown and described is particularly adapted to translate electrical energy into a servo or booster aid to the manual means employed to apply the brakes of an automotive vehicle, and is therefore preferably employed in connection with an automatic electric brake pedal switch such as I show in my co-pending application, Serial No. 295,581, filed July 26, 1928, whereby the electrical circuit is broken whenever the solenoid operates to apply the brakes independently and to greater extent than that determined by the manual effort being exerted.

In the ordinary manual braking system the manual effort required increases as the brakes are more fully applied, and since the device herein shown progressively increases the strength of the coils operative at any point of manual application, the servo action may be maintained at all times substantially proportional to the manual effort and my improved solenoid here claimed is shown embodied in such a combination in my co-pending application, Serial No. 295,578, filed July 26, 1928.

While the structure shown embodies the principle of my invention and attains the objects set forth, it is my purpose to claim all structural variations within the spirit of the invention. With this object in view

I claim:

1. A solenoid having a winding divided into a plurality of coils arranged in axially spaced apart relationship, a plurality of commutator sections one arranged within each coil and connected to the coil, a core of magnetic material arranged to be drawn through the plurality of coils and adapted to be drawn into each coil when said coil is electrically energized, and a brush movable by said core through said coils to progressively energize the coil immediately ahead of the core.

2. A solenoid comprising, in combination, a winding divided into a plurality of axially arranged spaced apart coils, a tubular commutator within said winding composed of a plurality of sections, one joined to each coil, a core of magnetizable material adapted to be drawn into a coil when said coil is electrically energized, and an annular brush carried along by said core within said tubular commutator to progressively engage the commutator sections within the tubular commutator ahead of the one engaged by the core to progressively energize the coil immediately ahead of the core.

3. A solenoid comprising, in combination, a plurality of wafer like coils arranged in axial spaced apart alignment, a tubular conductor within said coils having a portion divided into independent strips substantially corresponding to the thickness of the coils, each coil being joined to its strip, a core of magnetizable material adapted to be drawn through said conductor, and an annular brush carried along by said core through the conductor to convey current to and electrically energize that coil which is at any time immediately ahead of the core.

4. A solenoid comprising, in combination, a series of wafer like coils arranged in axial spaced apart alignment, the ampere turns of successive coils being progressively increased from one end of the series to the other, a tubular metal lining within said coils divided by axially extending cuts into two segments, the one segment being divided by transverse cuts into detached strips corresponding to the coils in number and in thickness and connected thereto, one to each coil, and a somewhat larger strip at the end not connected to any coil, a binding post connected to the other segment, a core of magnetizable material adapted to be drawn through said tubular lining, and an annular brush divided into halves by axially extending cuts and expanded into said tubular metal lining and carried along by said core to convey current from said binding post segment to that said strip which is connected to that coil which is at any time immediately ahead of the core.

5. A solenoid comprising, in combination, a series of coils arranged in relatively axially spaced apart relationship, said several coils increasing in ampere turns from one end of the series to the other, and a core adapted to be drawn through the series of coils to be acted upon thereby.

6. A solenoid comprising, in combination, a plurality of relatively axially arranged spaced apart coils of successively increasing ampere turns from one end of the series of coils to the other and a core adapted to be drawn through said coils comprising a magnetizable core element having an insulating element arranged adjacent to and at each end thereof and a brush element carried by one insulating element in advance of the magnetizable core element into the coils to establish the circuit through successive coils in advance of said magnetizable core element.

7. A solenoid comprising, in combination, a series of relatively axially arranged spaced apart coils of successively increasing

ampere turns from one end of the series to the other, said coils embedded in a cone-shaped insulating casing having a sheet metal cover connected with each coil, an axially arranged tubular lining extending through the coils and provided with one continuously extending axial segment and a plurality of detached relatively axially arranged spaced apart segments, one for each coil connected with its coil, a core adapted to be drawn through the tubular lining including a magnetizable core element adapted to be acted upon by the various coil windings and a brush element carried along in advance of said magnetizable core element to successively establish in advance of said magnetizable core element the circuit through said core windings.

8. A tension rod operating solenoid comprising, in combination, a tension rod, a series of axially arranged spaced apart coils surrounding said rod, said coils increasing successively in ampere turns from one end of the series to the other, a core carried by said tension rod including a magnetizable core element on the rod adapted to be drawn into said coils, and a brush element carried by the rod in advance of said magnetizable core element to establish the circuit through each coil respectively in advance of the magnetizable core element.

9. A tension element operating solenoid comprising, in combination with a tension element, a series of relatively axially arranged spaced apart coils encircling said tension element, said coils being of successively increasing ampere turns from one end of the series to the other, a tubular metal lining extending axially through said coils having an independent axially extending portion connected with all the coils and a plurality of independent segments, one for each coil connected with its coils, a separate lining segment not connected with any coil and arranged at one end of the series of coils, a core carried by said tension element comprising a magnetizable core member mounted upon the tension element between a pair of insulating cylinders, all adapted to be drawn into said coils through said tubular lining, and a brush gear carried by one of said insulating cylinders and adapted to be drawn through said tubular lining in advance of said magnetizable core member.

10. A solenoid comprising, in combination, a plurality of relatively axially arranged spaced apart coils and a core adapted to be drawn through said coils comprising a magnetizable core element having an insulating element arranged adjacent to and at each end thereof and a brush element carried by one insulating element in advance of the magnetizable core element into the coils to establish the circuit through successive coils in advance of said magnetizable core element.

11. A solenoid comprising, in combination, a series of relatively axially arranged spaced apart coils, said coils embedded in an insulating casing having a sheet metal cover connected with each coil, an axially arranged tubular lining extending through the coils and provided with one continuously extending axial segment and a plurality of detached relatively axially arranged spaced apart segments, one for each coil connected with its coil, a core adapted to be drawn through the tubular lining including a magnetizable core element adapted to be acted upon by the various coil windings and a brush element carried along in advance of said magnetizable core element to successively establish in advance of said magnetizable core element the circuit through said core windings.

12. A tension rod operating solenoid comprising, in combination, a tension rod, a series of axially arranged spaced apart coils surrounding said rod, a core carried by said tension rod including a magnetizable core element on the rod adapted to be drawn into said coils, and a brush element carried by the rod in advance of said magnetizable core element to establish the circuit through each coil respectively in advance of the magnetizable core element.

13. A tension element operating solenoid comprising, in combination with a tension element, a series of relatively axially arranged spaced apart coils encircling said tension element, a tubular metal lining extending axially through said coils having an independent axially extending portion connected with all the coils and a plurality of independent segments, one for each coil connected with its coils, a separate lining segment not connected with any coil and arranged at one end of the series of coils, a core carried by said tension element comprising a magnetizable core member mounted upon the tension element between a pair of insulating cylinders, all adapted to be drawn into said coils through said tubular lining, and a brush gear carried by one of said insulating cylinders and adapted to be drawn through said tubular lining in advance of said magnetizable core member.

14. A solenoid comprising, in combination, a plurality of relatively axially arranged spaced apart coils and a core adapted to be drawn through said coils comprising a magnetizable core element having an insulating element arranged adjacent to and at each end thereof and a brush element carried by one insulating element in advance of the magnetizable core element into the coils to establish the circuit through successive coils in advance of said magnetizable core element, said brush element comprising

a pair of complementary segmental brushes arranged on opposite sides of the core and mounted upon an expansible annular spring element which encircles the core and holds the brush elements outwardly.

15. A solenoid comprising, in combination, a series of relatively axially arranged spaced apart coils, an axially arranged tubular lining extending through the coils and provided with one continuously extending axial segment and a plurality of detached relatively axially arranged spaced apart segments, one for each coil connected with its coil, a core adapted to be drawn through the tubular lining including a magnetizable core element adapted to be acted upon by the various coil windings and a brush element carried along in advance of said magnetizable core element to successively establish in advance of said magnetizable core element the circuit through said core windings.

16. A solenoid comprising, in combination, a plurality of relatively axially arranged spaced apart coils of successively increasing ampere turns from one end of the series of coils to the other and a core adapted to be drawn through said coils comprising a magnetizable core element having an insulating element arranged adjacent to and at each end thereof and a brush element carried by one insulating element in advance of the magnetizable core element into the coils to establish the circuit through successive coils in advance of said magnetizable core element, said brush element comprising a pair of complementary segmental brushes arranged on opposite sides of the core and mounted upon an expansible annular spring element which encircles the core and holds the brush elements outwardly.

17. A tension rod operating solenoid comprising, in combination, a tension rod, a series of axially arranged spaced apart coils surrounding said rod, a core carried by said tension rod including a magnetizable core element on the rod adapted to be drawn into said coils, and a brush element carried by the rod in advance of said magnetizable core element to be drawn into each coil ahead of the magnetizable core element to establish the circuit through each coil respectively in advance of the magnetizable core element.

18. In combination with a tension rod operating solenoid of the character described, a core carried thereby including a magnetizable core element on the rod and a brush element carried thereby in advance of said magnetizable core element and in axial alinement therewith.

19. A tension rod operating solenoid including, in combination, a tension rod, a series of axially arranged spaced apart coils surrounding said rod, a magnetizable core element carried by said rod, and a brush element carried thereby in advance of said magnetizable coil and in axial alinement therewith.

20. A tension rod operating solenoid including, in combination, a tension rod, a plurality of coil sections encircling said rod, a core element carried by the rod, and a brush element carried by the rod in advance of the core element and in axial alinement therewith.

21. A tension rod operating solenoid including, in combination, a tension rod, a plurality of coil sections arranged linearly along said rod, a magnetizable core element carried by the rod, and a brush element carried by the rod spaced from the core element and in axial alinement therewith.

22. A tension rod operating solenoid including, in combination, a tension rod, a core carried by the tension rod, a plurality of coil sections encircling said rod and arranged linearly therealong, and being of progressively increasing ampere-turns from one end of the rod toward the other.

23. A tension rod operating solenoid including, in combination, a tension rod, a core on the rod, coil sections surrounding the rod and arranged end to end therealong, and comprising coils of progressively increasing ampere-turns from one end of the rod toward the other.

24. A tension rod operating solenoid including, in combination, a tension rod, a core on the rod, coil sections surrounding the rod and arranged end to end therealong, and comprising coils of progressively increasing diameter from one end of the rod toward the other.

25. A solenoid structure of the character described comprising a core, a plurality of coil sections axially arranged about the core having a substantially uniform inner diameter and being of progressively increasing external diameter from one end of the plurality of coil sections to the other.

26. In combination with a tension rod operating solenoid comprising a plurality of individual coils arranged end to end, contacts extending forwardly from the inner diameter of each of said coils, and a core carried by said tension rod including a magnetizable portion and a brush portion in advance of said magnetizable portion.

27. A tension rod operating solenoid including, in combination, a plurality of axially spaced apart coils, contact members secured to the inner periphery of each coil and extending forwardly thereof, a tension rod extending axially through said coils, and a core carried by said tension rod, said core including a magnetizable portion and a brush portion in advance thereof.

28. In combination with a tension rod operating solenoid of the character described, a core carried thereby including a magnetiz-

able portion and a brush element in advance thereof, brush contacts secured to each of said coils, said contacts, brush, and magnetizable core portion being so relatively spaced and proportioned that no coil can be energized prior to entrance of the magnetizable core portion within said series of coils.

29. In combination with a tension rod operating solenoid, a plurality of axially spaced apart coils, a core carried by said tension rod, said core including axially alined magnetizable and brush portions.

30. In combination with a tension rod operating solenoid, a plurality of axially spaced apart coils, and an insulation core carried by said tension rod, said core including axially alined magnetizable and brush portions lying substantially flush with the surface of the core.

31. In combination with a tension operating solenoid of the class described, a plurality of axially spaced apart coils of increasing amperage turns, and a contact secured to each of said coils and extending forwardly thereof to overlap a succeeding coil.

In testimony whereof, I, VINCENT G. APPLE, sign this specification.

VINCENT G. APPLE.