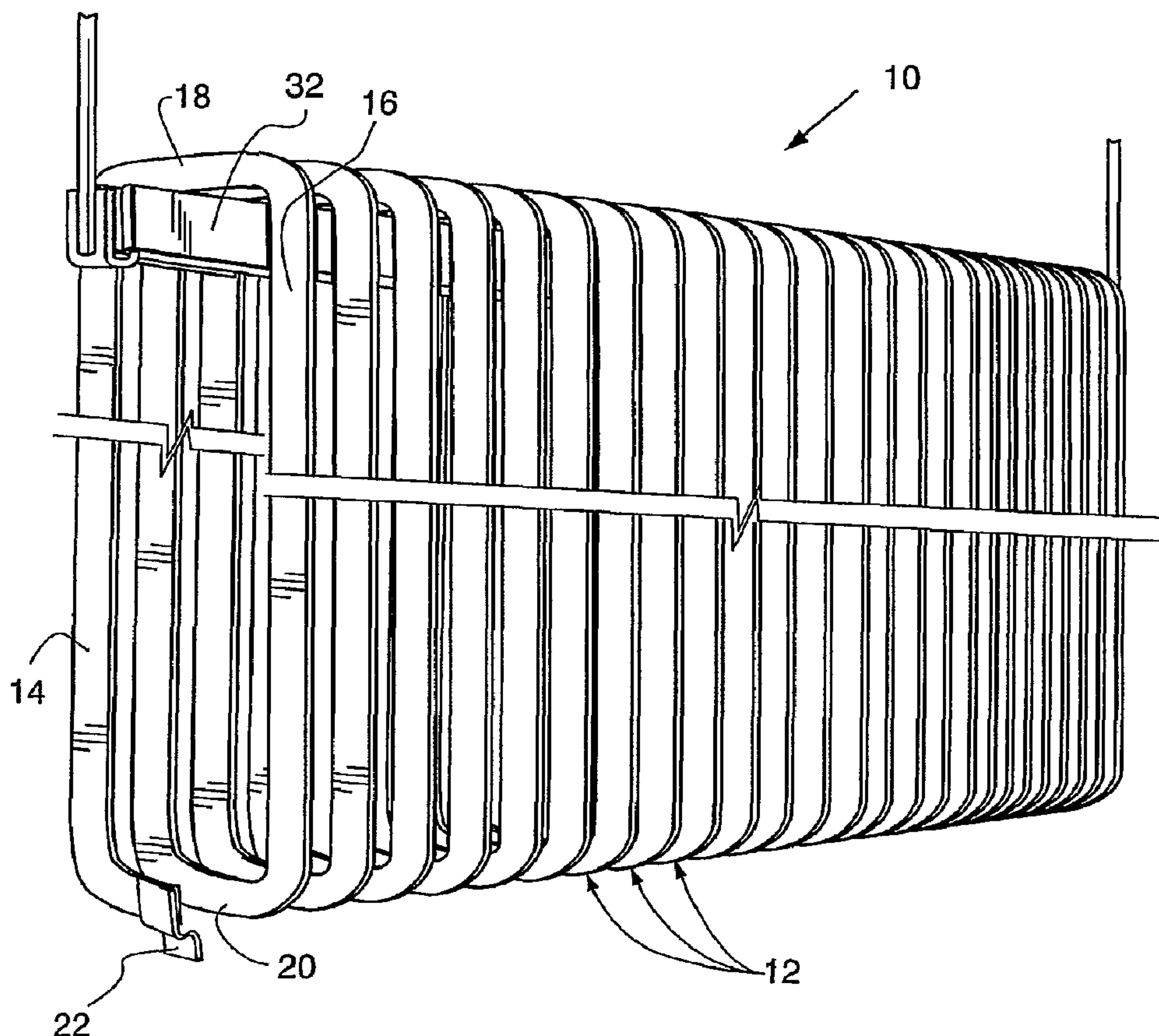




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(54) Title: POWDER COATED GENERATOR FIELD COILS AND RELATED METHOD



(57) Abrégé/Abstract:

A field coil (10) for an electromagnetic rotor comprising multiple windings (12), each substantially entirely coated with a powder resin having a dielectric strength of at least in the range of 1000-1500 v/mil. A method of manufacturing a field coil (10) for an



(57) **Abrégé(suite)/Abstract(continued):**

electromagnetic rotor includes the steps of a) providing a field coil comprising multiple layers (12) of copper bars; b) coating the multiple layers (12) of the field coil (10) with a powder resin having a dielectric strength of at least about 1000-1500 v/mil.; and c) curing the powder resin.

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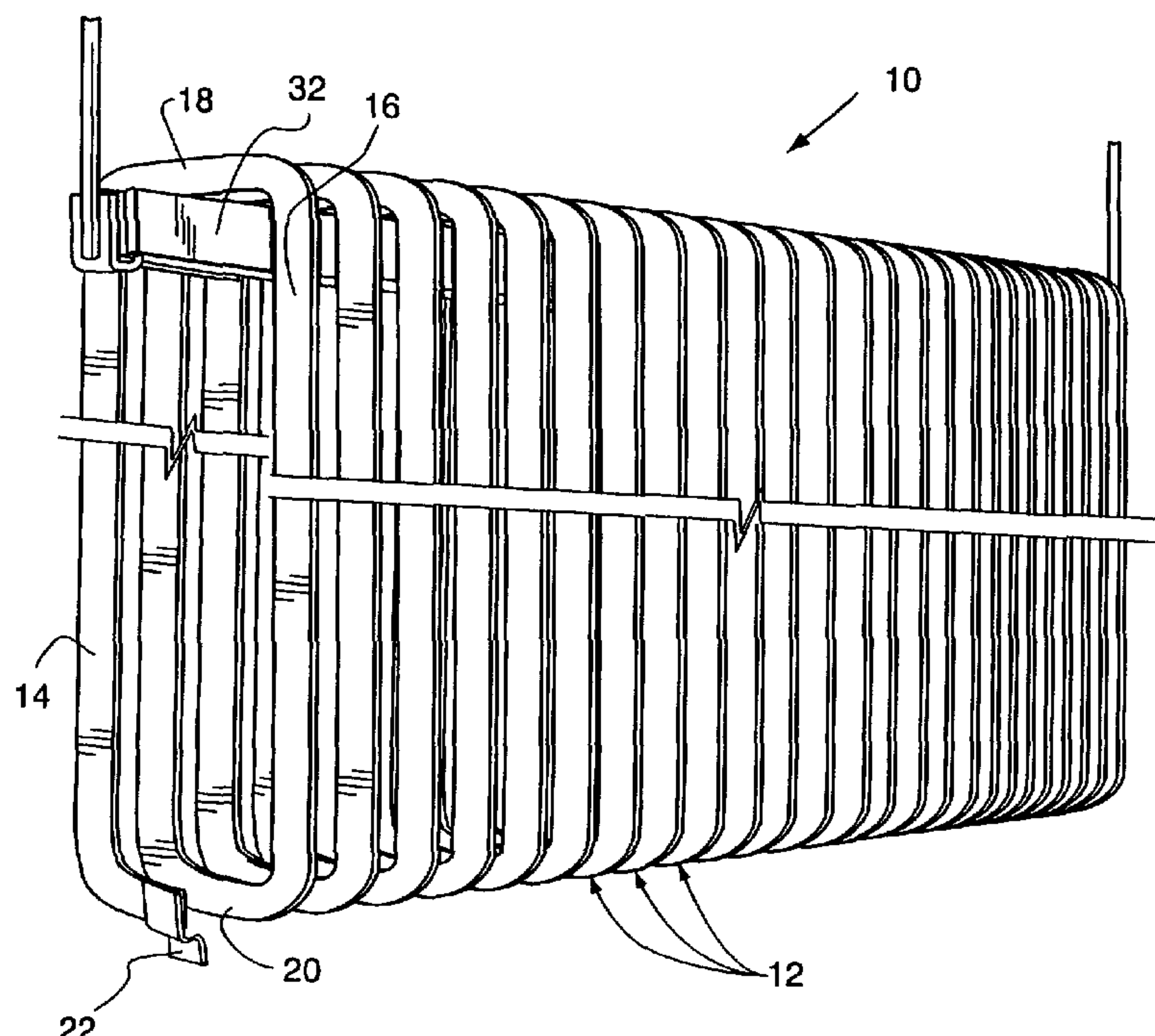
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: POWDER COATED GENERATOR FIELD COILS AND RELATED METHOD



(57) Abstract: A field coil (10) for an electromagnetic rotor comprising multiple windings (12), each substantially entirely coated with a powder resin having a dielectric strength of at least in the range of 1000-1500 v/mil. A method of manufacturing a field coil (10) for an electromagnetic rotor includes the steps of a) providing a field coil comprising multiple layers (12) of copper bars; b) coating the multiple layers (12) of the field coil (10) with a powder resin having a dielectric strength of at least about 1000-1500 v/mil.; and c) curing the powder resin.



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POWDER COATED GENERATOR FIELD COILS AND RELATED METHOD

BACKGROUND OF THE INVENTION

This invention relates to the manufacture of generator electromagnetic rotors, primarily for use in power generating equipment.

5 In conventional processes for manufacturing generator electromagnetic rotors, the current-carrying copper coils (called "field coils") are laboriously hand insulated. Each coil must be insulated from other coils, and the entire coil package must be insulated from the steel of the rotor. Significant cost savings and productivity improvements could be realized with a simpler and
10 faster insulation system.

SUMMARY OF THE INVENTION

It is now proposed to coat the copper field coils with a suitable powder resin. The coating can be applied by electrostatic spraying or other suitable process. In one technique, the field coils remain stationary while electrostatic
15 spray guns revolve around the coils. In an alternative technique, the coils are carried along a conveyor through a power spray booth. With either technique, the resin powder can be cured onto the field coils using resistance heating, induction heating, convection heating or infrared heating. Two coats of the resin powder are required to ensure complete coverage. In addition, and
20 depending on the coil configuration, the ends of the copper bars may be masked to prevent powder coverage where not desired (for example, at the site of the electrical connections).

Three classes of powder resins have the greatest potential for success in this particular application. They are epoxy powder coating resins, silicone
25 powder coatings and hybrid systems of silicones/epoxies and silicones/acrylics. These materials have been shown to have high dielectric

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strength, impact strength, thermal stability, flexibility, chemical resistance and adhesion.

Thus, in accordance with its broader aspects, the present invention relates to a field coil for an electromagnetic rotor comprising multiple windings, each substantially entirely coated with a resin having a dielectric strength of at least in the range of 1000-1500 v/mil.

In another aspect, the winding relates to a field coil for an electromagnetic rotor comprising a field coil substantially entirely coated with a resin selected from a group consisting essentially of epoxy powder resins and silicone powder resins.

In another aspect, the invention provides a method of insulating a field coil for an electromagnetic generator comprising:

- a. providing field coils comprising multiple layers of copper bars;
- b. coating the multiple layers of the field coil with a powder resin having a dielectric strength of at least about 1000-1500 v/mil.; and
- c. curing the powder resin.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a partial perspective view of a known field coil configuration; and

FIGURE 2 is a flow diagram of a field coil coating process in accordance with this invention.

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figure 1, a copper field coil 10 is shown that is of the helical wound type, with multiple layers or windings 12 formed from a single copper bar. The longitudinal sides 14, 16 of the windings are received within radial slots in the rotor body, while the ends 18, 20 of the windings project beyond the slots. In an alternative coil construction, each layer is comprised of a single winding or bar, the windings ultimately secured together in a stacked arrangement within the rotor slots. The present invention is equally applicable to either field coil construction.

The invention here relates to the elimination of known wrap-type insulation in favor of a powder resin coating. In an exemplary embodiment, two coats of a suitable resin powder coating are applied to the field coil 10. Prior to coating, the coil ends where the electrical connectors are located, are masked off, one such connector shown at 22. The masking can be done with Teflon® sleeves or other suitable means.

Three classes of powder resins are preferred as coating compositions for the field coils. They include epoxy powder resins, silicone powder, and silicone hybrid resin systems (silicone/epoxies and silicones/acrylics). Examples are provided in Table I below.

TABLE I

	<i>Material</i>	<i>Dielectric Strength, v/mil</i>	<i>Impact Strength, inlb</i>	<i>Thermal Stability, use temp.</i>	<i>Flexibility, mandrel bend test</i>	<i>Chemical Resistance</i>	<i>Adhesion</i>
1.)	134 Epoxy	1000	>200 direct	155C	Passes 1/4" mandrel	H ₂ S, salt water	Good
2.)	5555 Epoxy	1100	>200 direct	180C	Passes 1/4" mandrel	Oils and hydro- carbons	Good
3.)	5230 Epoxy	1100	>160 direct	155C	Passes 1/4" mandrel	Oils and hydro- carbons	Good
4.)	5388 Epoxy	1200	>160 direct	180C	Passes 1/4" mandrel	Oils and hydro- carbons	Good
5.)	Silicone	>1000	>160 direct	300C	Passes 1/4" mandrel	Unknown	Fair
6.)	Silicone hybrid	1500	>220 direct	220C	Passes 1/4" mandrel	Oils	Good

The epoxy powder compositions (items 1-4) are commercially available from 3M Corporation. The silicone powder coating composition (item 5) is a generic name and is currently less preferred. The Silicone hybrid (item 6) is commercially available from Crosslink Powder Coatings, Inc.

The compositions, particularly compositions 1-4 have high dielectric strength, impact strength, thermal stability, flexibility, chemical resistance and adhesion. The dielectric strength and thermal stability are critical factors, but chemical resistance and adhesion are important as well. The invention also contemplates modification of the base compositions through the addition of inorganic fillers that can enhance the properties of the final product, e.g., increased thermal conductivity of the coated copper bar and corona resistance of the coating.

Turning to Figure 2, a layout is schematically illustrated by which the coating process can be implemented.

This arrangement includes, generally, loading/unloading station 24; a powder coating station or booth 26; a curing oven 28; and an inverting station 30.

Coils to be coated may be moved by a suitable conveyor (not shown) to the loading/unloading station 24 where they are mounted, in succession, on suitable racks (one shown in Figure 1 at 32). Each rack 32 is carried along a first circuit or track 34 to a main track or circuit 36 at switch point 38, and the coil is moved by conveyor, overhead tram or other suitable means, to the powder coating station or booth 26. After coating, the coil is moved along the track 36 to the curing oven 28 where the coating is cured by resistance heating, induction heating, convection heating or by infrared heating. Once cured, the coil is moved along track 36 to a switch point 40 where the rack 32 and coil 10 are moved to an extension track 42. At the inverting station 30, the coil 10 is removed from the rack 32, inverted, and placed back on the rack. This inversion of the coil insures that the part of the coil not contacted by the coating composition, i.e., that part of the end 16 of the coil that rests on the rack 32, will be coated. Subsequently, the rack with the inverted coil rejoins the main track or circuit 36 for travel through the powder coating station 24 where a second coat is applied. The rack and coil continue to the curing oven 26 before switching back to the track 34 at switch point 40 for removal of the coil from the rack 32 and transfer to a conveyor (not shown). The construction of the powder spray booth 26, curing oven 28, and inverting station 30 transfer or switch mechanisms at switch points 38, 40 are all within the skill of the art.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

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WHAT IS CLAIMED IS:

1. A field coil for a generator electromagnetic rotor, the field coil comprising multiple conductive layers, each layer having a pair of ends connected by a pair of longitudinal sides that are adapted to be received within respective slots formed in the electromagnetic rotor, prior to assembly of the rotor each layer being substantially entirely coated with a resin having a dielectric strength of at least 1000 v/mil, and a thermal stability above 155° C.
2. The field coil of claim 1, wherein electrical connector portions of the field coil are not coated with the resin.
3. The field coil of claim 1, wherein said field coil comprises a single helically wound member.
4. The field coil of claim 1, wherein each layer comprises a discrete winding.
5. The field coil of claim 1, wherein said resin comprises an epoxy resin.
6. The field coil of claim 1, wherein said resin comprises a silicon hybrid resin.
7. The field coil of claim 1, wherein said field coil has two coats of said resin coating applied thereto.
8. A field coil for a generator electromagnetic rotor, the field coil comprising multiple copper layers, each layer having a pair of ends connected by a pair of longitudinal sides that are adapted to be received within respective slots formed in the electromagnetic rotor, prior to the assembly of the rotor each layer being substantially entirely coated with a resin comprising at least one of an epoxy resin and a silicone resin, wherein said resin has a dielectric strength of at least 1000 v/mil and a thermal stability above 155° C.

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9. A field coil for a generator electromagnetic rotor, the field coil comprising helically wound copper layers, each layer having a pair of ends connected by a pair of longitudinal sides that are adapted to be received within respective slots formed in the electromagnetic rotor, each layer being substantially entirely coated with insulation comprising a resin having a dielectric strength of at least 1000 v/mil, and a thermal stability above 155° C.

10. A method of insulating a field coil for a generator electromagnetic rotor prior to the assembly of the rotor, the method comprising the steps of:

a) providing a field coil comprising multiple layers made from at least one copper bar;

b) applying a first insulating coating over substantially the entire surface of each of the multiple layers of the field coil, said first insulating coating comprising a powder resin having a dielectric strength in the range of 1000-1500 v/mil.; and

c) curing the powder resin.

11. The method of claim 10, further comprising masking an electrical connector of said field coil prior to step b).

12. The method of claim 10, wherein step b) further comprises applying a second insulating coating of said powder resin over said first insulating coating.

13. The method of claim 10, wherein said powder resin comprises an epoxy powder resin.

14. The method of claim 10, wherein said powder resin comprises a silicone hybrid powder resin.

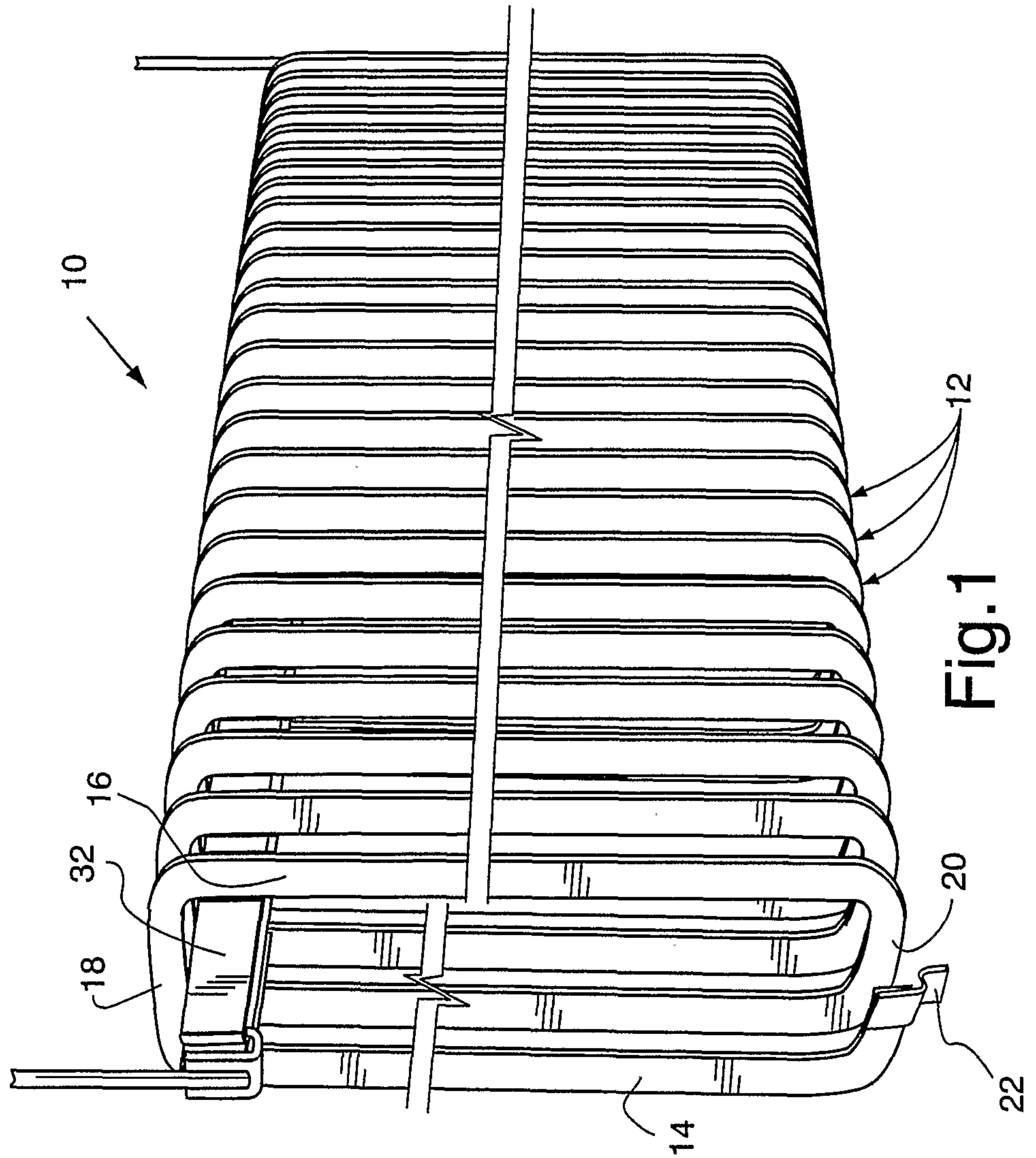
15. The method of claim 10, wherein step c) is carried out by resistance heating, induction heating, convection heating or infrared heating.

16. The method of claim 12, wherein said field coil is inverted prior to application of said second insulating coating.

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17. The method of claim 10, wherein said field coil is supported on a rack during steps b) and c) and wherein after step c), the field coil is removed from the rack, inverted, and re-placed on the rack; and subsequently, a second insulating coating is applied to said field coil, over said first insulating coating.

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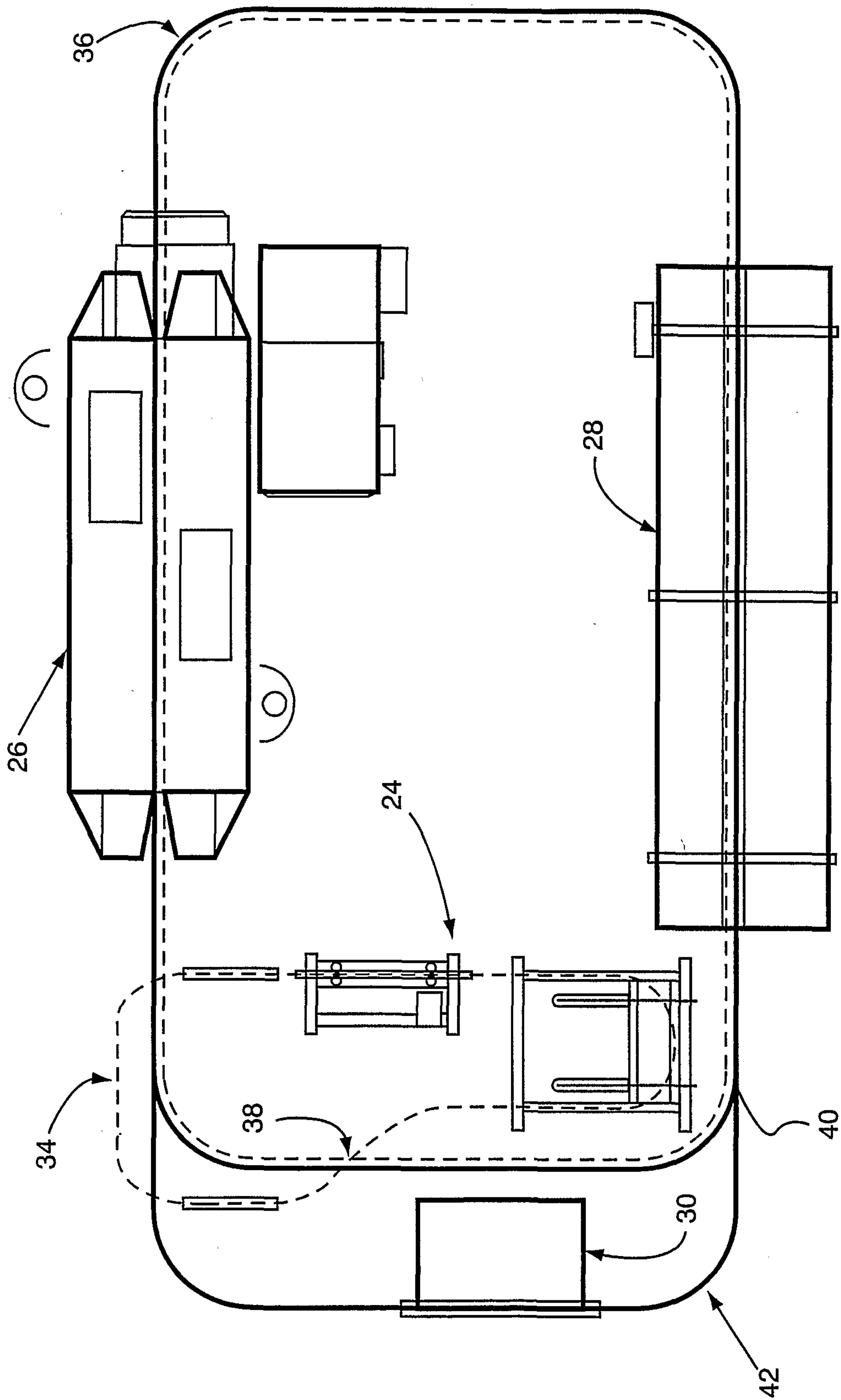


Fig. 2

