T. VON ZWEIGBERGK.

RESISTANCE.

APPLICATION FILED NOV. 28, 1906. RENEWED JULY 6, 1908.

912,267. Patented Feb. 9, 1909.

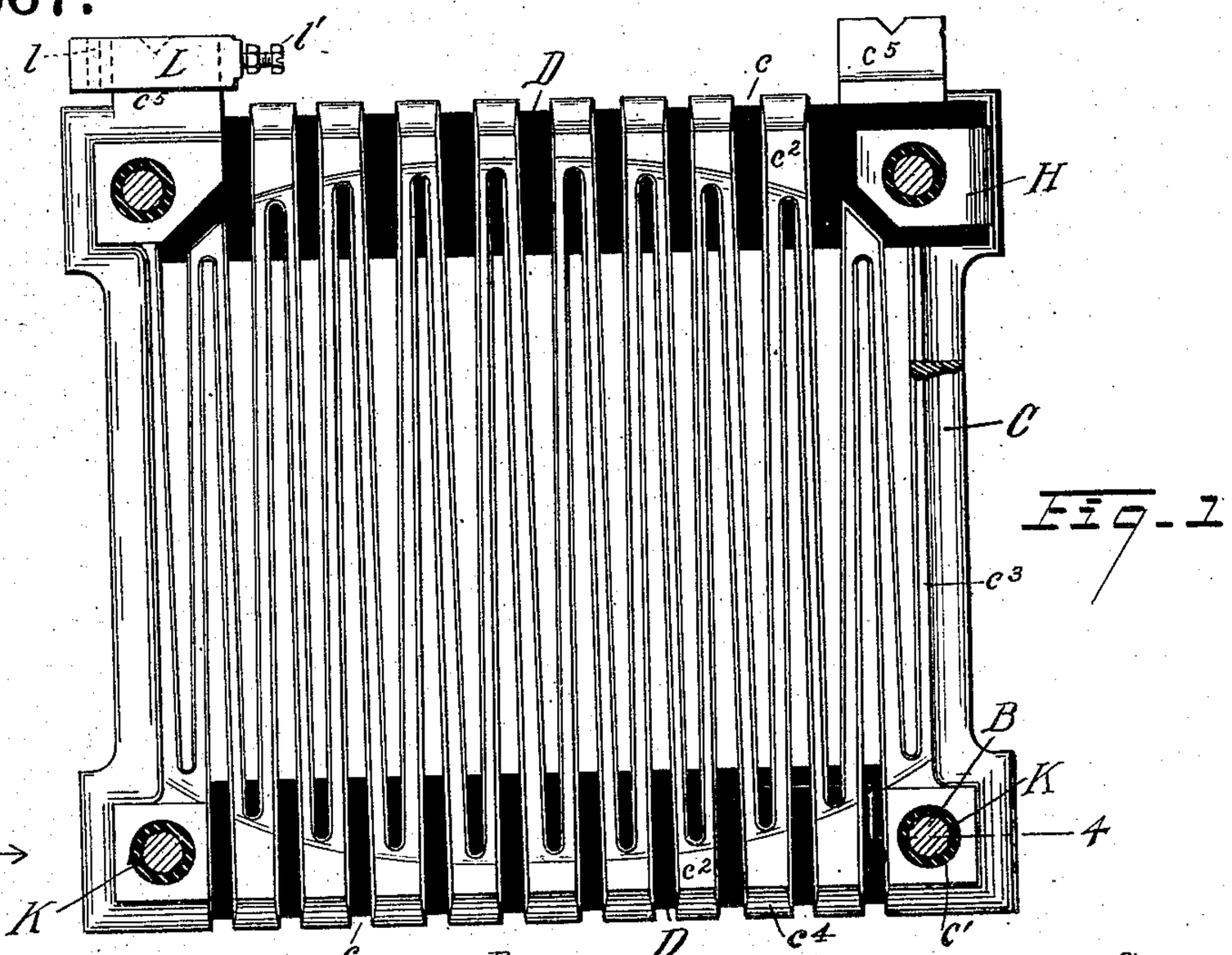


Fig. 1.

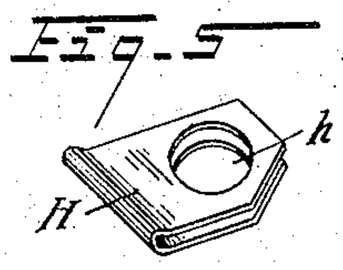


Fig. 5.

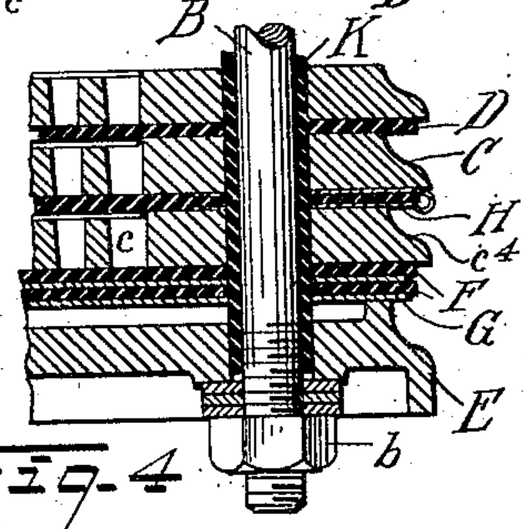


Fig. 4.

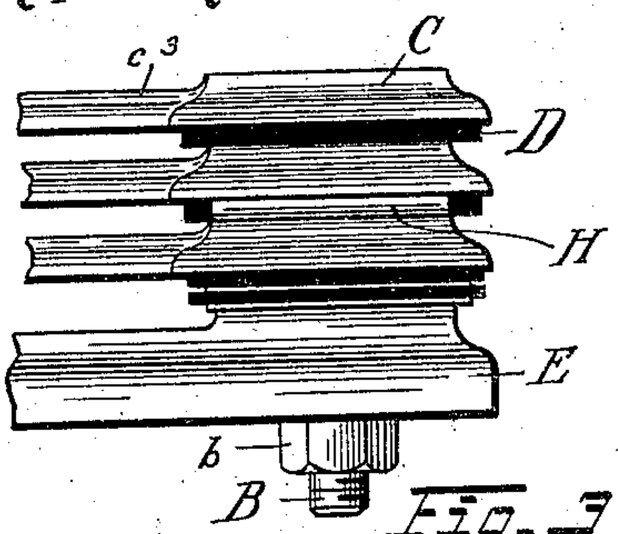


Fig. 3.

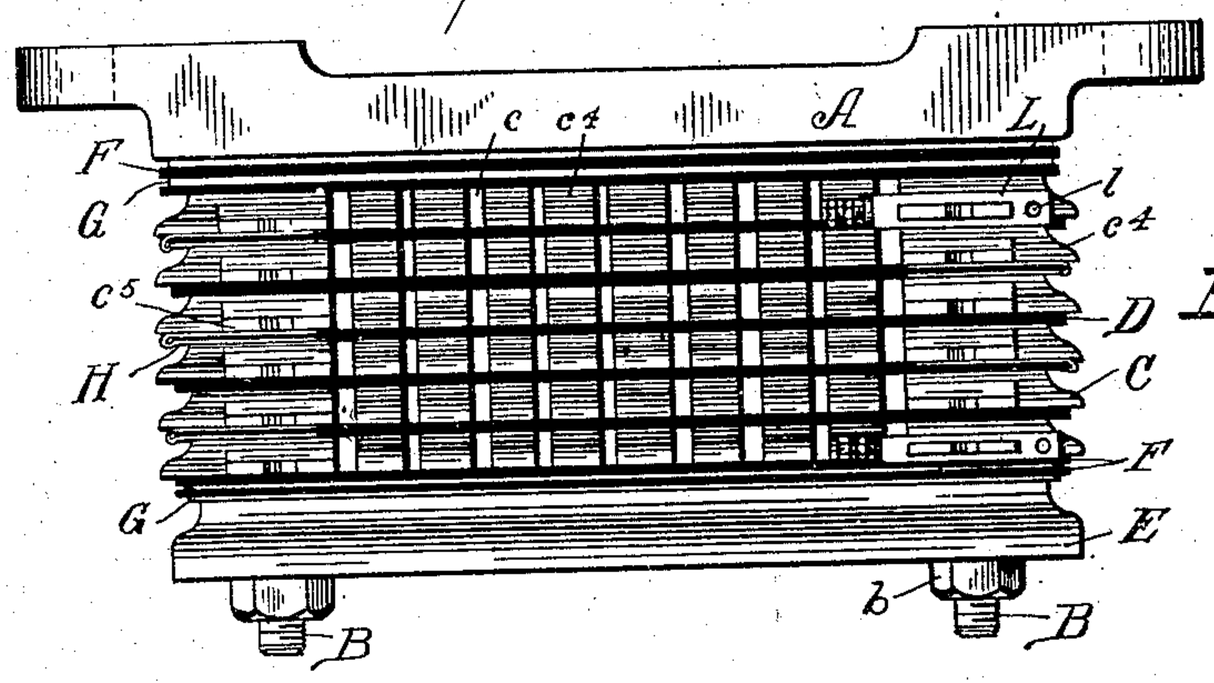


Fig. 2.

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# UNITED STATES PATENT OFFICE.

THORSTEN VON ZWEIGBERGK, OF PRESTON, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## RESISTANCE.

No. 912,267. Specification of Letters Patent. Patented Feb. 9, 1909.

Application filed November 28, 1906, Serial No. 345,438. Renewed July 6, 1908. Serial No. 442,248.

*To all whom it may concern:*

Be it known that I, THORSTEN VON ZWEIGBERGK, residing at Preston, in the county of Lancaster, England, have invented a certain new and useful Improvement in Resistances, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to resistance adapted to be used in connection with the control of electric motors.

One of the objects is to provide such resistance in the form of a series of superimposed grids insulated from each other (except at certain connecting points) and every strip of each grid positively and independently supported, whereby a long path for the current is provided through the various portions of each grid in series, while the whole structure constitutes a firm and rigid box which will withstand considerable abuse.

Another object is to so form the grids that ample ventilation is provided.

Another object is to protect the insulation against damage while allowing a considerable distance between the grids around the insulation, minimizing the danger of an arcing short circuit.

The invention includes also a simple and efficient means for making connections between consecutive grids.

These features are hereinafter more particularly described, as summarized in the claims.

In the drawings, Figure 1 is a horizontal section through the resistance box, showing one of the grids in plan. Fig. 2 is a side elevation of the complete resistance box. Fig. 3 is an enlarged fragmentary side elevation from the point 3 in Fig. 1. Fig. 4 is a vertical cross section through several of the grids, as on the line 4 of Fig. 1. Fig. 5 is a perspective view of one of the connecting plates.

Referring to the drawings by reference letters, A represents a suitable base or support adapted to be secured as desired,—on the underside of a car, for example. Depending from this support are a series of bolts B rigidly connected with the supporting plate. As shown, there are four of these bolts.

C represents one of the grids. Each grid is a casting having open-ended slots *c* alternating from opposite sides of the grid to divide the grid into a continuous serpentine conductor of comparatively small cross section. The bolts B pass through holes *c'* in the corners of each grid, the grids being mounted one upon the other with interposed insulation D, and the bolts being insulated from the grids by tubular insulation K.

Fig. 2 shows a suitable cover plate E extending across the bottom grid. Nuts *b* screwing onto the bolts B clamp the various parts together. As shown, suitable additional insulation F, with interposed strips of metal G to give firmness, may be mounted between the uppermost grid and the base and between the lowermost grid and the cover.

As shown in Fig. 2, the ends of the grid-forks $c^2$ are all of the same height, including the larger outermost forks, while between these ends the cross bars are of less height, as shown at $c^3$, Figs. 1 and 3. This enables the ends of each grid-strip to be independently supported, while giving ample space for ventilation between the grids, as well as between the strips of each grid.

The insulation D between the grids, consists preferably of strips of mica, which extend across the ends $c^2$, having holes through which the bolts B pass. These mica strips are of sufficient thickness to prevent their being punctured by the current. To prevent the current arcing from one grid to the other, or leaking across the end of the mica, while at the same time protecting the mica from damage at its edge, I form each grid with the outwardly beveled edge $c^4$. This allows one face of the grid (the lower face in the drawing) to overhang the mica, protecting it from damage, while, owing to the bevel on the adjacent grid, the two grids are such a distance apart that leakage or arcing around the edge of the mica is prevented.

I have referred to the edges of the grids as having the bevel $c^4$. As shown, this bevel is formed on a reverse curve. It may be made in any manner which will enable one surface of the grid to overhang the other. If the grids had vertical sides and the mica terminated flush with them, or inside of their outer edge, the space between the grids would be so small that there would be leakage and arcing. On the other hand, if to prevent this the mica projects beyond the grids, the mica is

liable to be damaged by contact from the outside. My invention obviates both difficulties and allows the advantage sought to be obtained.

To make the desired connection between the consecutive grids, I provide a flat strip of copper H which at the proper points is doubled around the mica and contacts with the grid above it and the grid below it. This strip is shown in Fig. 5. It has a hole *h*, through which the bolts B with the tubular insulation K passes. This copper strip forms a very effective connection between the consecutive grids and is easily mounted at desired points. No special provision need be made for it and it is protected by the overhanging edge of the adjacent grid.

The outside connections to the resistance are made by binding posts L which have openings *l* for the attachment of the circuit wires and are clamped by set screws *l'* on flat lugs $c^5$ extending from the grids. Each grid has two of these lugs, located respectively at the beginning and end of the series conductor which the grid provides. The binding posts will usually be attached to the top and bottom grids so that the current may pass in series through the whole box; though, if desired, they may be attached at other points, leaving some of the grids out of service.

The construction described enables the resistance to be built up with as many grids as desired, into a very compact resistance-box. Every strip of each grid is rigidly supported and the insulation protected, so that while the construction is very cheap it is likewise extremely durable. Moreover the ventilation and arc-preventing features make the resistance box very efficient in service.

Having described my invention, I claim:

1. A resistance composed of a series of grids formed with slots alternately from opposite sides, the strips thus produced being thicker across the ends of said slots, strips of insulation between the grids and extending across the thicker portions thereof, whereby the strips are independently supported while ventilation space is provided.

2. A resistance composed of a series of grids each grid having slots from opposite edges, whereby a series of forks are produced, the head of each fork being of substantially the same height throughout while intermediately the forks are of less height, strips of insulation extending across such heads between the grids, and means for holding the whole structure together in the form of a rigid box.

3. A resistance composed of a series of grids, each grid having slots from opposite edges, whereby a series of forks are produced, the heads of the forks being thickened continuously across the ends of the slots, thereby strengthening the grid and providing a raised seat for insulation, strips of insulation resting on such seats, means for holding the whole structure together in the form of a rigid box.

4. A resistance composed of a series of grids, each grid having slots from opposite edges whereby a series of forks are produced, the outermost forks of the grids having each two laterally extending bosses located substantially at the four corners of the grid, holes through said bosses, and four rods passing through said holes for holding the whole structure together in the form of a rigid box.

5. A resistance composed of a series of members and interposed insulation, the edge of the member on one side of the insulation overhanging it and on the other side terminating short of it.

6. A resistance composed of a series of grids separated by insulation, each grid having an edge overhanging the adjacent grid, the insulation between the grids projecting beyond one grid and being protected by the overhang of the other.

7. A resistance composed of a series of members whose edges are formed to consecutively overhang, and insulation placed between the members and extending beyond the adjacent edge of one member and protected by the adjacent member.

8. A resistance composed of a series of grids with beveled edges, insulation between the grids overhanging the inner edge of one adjacent grid and terminating short of the outer edge of the other adjacent grid.

9. A resistance composed of a series of grids formed with slots alternately from opposite sides, the edges of the grids between the ends of the slots being formed to consecutively overhang, strips of insulation placed between the grids and extending across the slots and projecting beyond the edge of one adjacent grid and protected by the edge of the other adjacent grid.

10. A resistance composed of a series of grids each grid having slots from opposite edges, whereby a series of forks are produced, the head of each fork being of substantially the same height, strips of insulation extending across such heads between the grids, the heads on one side of the insulation overhanging it and on the other side terminating short of it.

11. A resistance composed of a series of grids, with intermediate insulations, connecting U-shaped strips extending on to opposite sides of the insulation and around the edge thereof and contacting with adjacent grids, said strips having holes through them, and rods passing through said holes for holding the grids together and the strips in place.

12. In a resistance, the combination of a suitable support and rods carried thereby, a series of grids having holes through which said rods pass, said grids having beveled

edges, and strips of insulation between the grids having holes through which the rods pass, said insulation overhanging the edge of one adjacent grid and terminating short of the edge of the consecutive grid.

13. In a resistance, the combination of a support, a series of rods extending therefrom, insulation around said rods, a series of grids mounted on such rods and insulation, strips of insulation between the grids, and connecting strips between the grids and formed of U-shaped flat straps extending around the edge of the intermediate insulation and having holes through which the rods and tubular insulation pass.

14. In a resistance, the combination of a suitable support and rods carried thereby, a series of grids having holes through which said rods pass, said grids having slots from opposite edges, the heads of the forks thus produced being of substantially the same height and having beveled edges, strips of insulation extending across such heads and having holes through which said rods pass, each of said strips at its outer edge and ends overhanging the edge of one adjacent grid and terminating short of the edge of the other adjacent grid, and a metallic connecting strap passing around the edge of some of the insulating strips and contacting with the grids on opposite sides thereof.

15. In a resistance, the combination of a suitable support and rods carried thereby, a series of grids having holes through which said rods pass, said grids having slots from opposite edges, the heads of the forks thus produced being of substantially the same thickness, which thickness is greater than that of the intermediate portions of the forks, and strips of insulation extending across such heads and having holes through which said rods pass, each of said strips at its outer edge and ends overhanging the edge of one adjacent grid and terminating short of the other adjacent grid.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

THORSTEN VON ZWEIGBERGK.

Witnesses:
M. J. SULIS,
H. WATSON.