Nov. 3, 1936. J. H. HERTNER 2,059,349

RESISTANCE UNIT

Filed Feb. 12, 1932

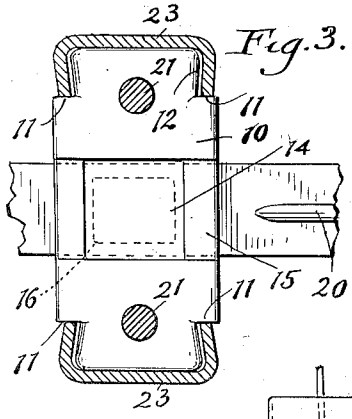


Fig. 3.

Fig. 2.

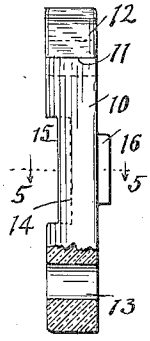


Fig. 4.

Fig. 5.

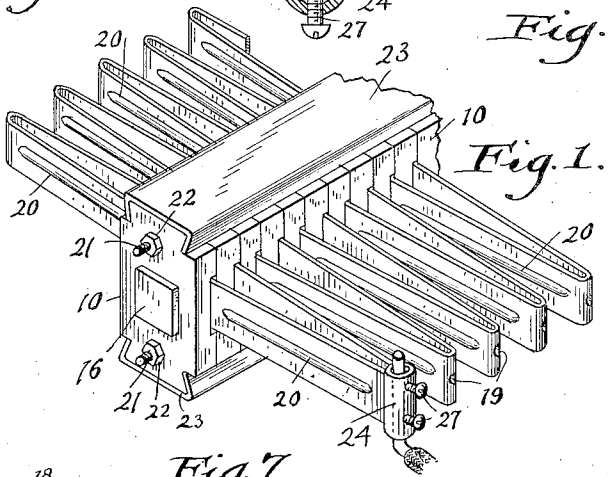


Fig. 1.

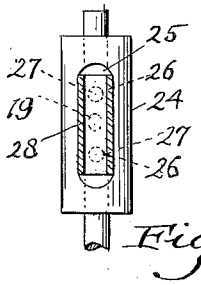


Fig. 6.

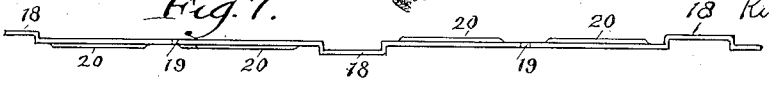


Fig. 7.

Inventor:
JOHN H. HERTNER.
Kerr Hudson & Kent
Attys.

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RESISTANCE UNIT

John H. Hertner, Lakewood, Ohio, assignor to The Hertner Electric Company, Cleveland, Ohio, a corporation of Ohio

Application February 12, 1932, Serial No. 592,570

4 Claims. (Cl. 201—69)

This invention relates to improvements in electrical resistance units, such as are employed in various forms of electrical control or regulating apparatus, or in electrical heating devices.

An object of the invention is to provide an electrical resistance unit which is so constructed that maximum radiation is obtained.

A further object is to provide an electrical resistance unit constructed so that the resistance elements of the unit may be disposed in a minimum space, yet so arranged as to provide maximum radiation for the element.

An additional object is to provide an electrical resistance unit constructed so as to require a minimum amount of material with the resistance element of the unit disposed in a minimum space, yet arranged to provide maximum radiation for said element.

Another object is to provide an electrical resistance unit having a continuous resistance element from terminal to terminal.

An additional object is to provide an electrical resistance unit wherein the resistance element is supported so as to reduce to a minimum those stresses in the supporting frame and element occasioned by the expansion and contraction of the element due to the repeated heating and cooling thereof in use.

A still further object is to provide an electrical resistance unit so constructed as to substantially obviate any possibility of the resistance element of the unit slipping or falling out of its support and short-circuiting or grounding the unit.

Another object is to provide an electrical resistance unit which is mechanically strong, simple in construction and capable of economical manufacture and maintenance.

Another object is to provide an electrical resistance unit wherein the resistance element is capable of carrying relatively heavy loads in comparison to its weight.

A still further object is to provide an electrical resistance unit wherein the resistance element is shaped so as to have increased structural strength which reduces to a minimum the susceptibility of the element to vibration.

A further object is to provide an electrical resistance unit which is so formed as to readily cooperate with an improved terminal construction.

Additional objects and advantages will become apparent hereinafter during the detailed description that is to follow of an embodiment of the invention which is illustrated in the accompanying drawing, wherein,

Fig. 1 is a fragmentary perspective view of a resistance unit embodying the invention;

Fig. 2 is a view on an enlarged scale of the resistance unit shown in Fig. 1, a portion of this view being in top plan, another portion having the metal sheath or covering broken away to show several of the porcelain mats or supporting members in top plan, and a still different portion being a transverse sectional view through several other of the mats or supporting members and a portion of the resistance element;

Fig. 3 is a transverse vertical section taken substantially on line 3—3 of Fig. 2 looking in the direction of the arrows with the straight length of the resistance element immediately adjacent to the section line removed;

Fig. 4 is a detail side elevation of one of the porcelain supporting mats, a portion of said mat being broken away and shown in section;

Fig. 5 is a detail section taken substantially on line 5—5 of Fig. 4, looking in the direction of the arrows;

Fig. 6 is a fragmentary sectional view taken substantially on line 6—6 of Fig. 2, looking in the direction of the arrows, and

Fig. 7 is a fragmentary side elevational view of the resistance element after the same has been provided with offsets, but prior to the time that it is bent into is final form.

In carrying out the objects of the present invention, it is proposed to have the resistance element of the resistance unit arranged in zigzag form, that is, the element is continuous from end to end and includes a plurality of substantially straight portions connected at their ends by reversely curved, bent or turned portions, such resistance element being supported intermediate the ends of the straight portions by a support built up of a plurality of similar complementary members or mats clamped together so that the assembled support for the unit may be conveniently formed to the desired length.

Although the resistance unit constituting the present invention possesses certain advantages irrespective of the type of resistance element used therein, that is, either a round wire element or a flat or ribbon element may be employed in the unit under various conditions, the unit will be described herein as employing a flat or ribbon resistance element, since this type of element has the advantage over the round wire type of element of providing greater radiating surface per unit of cross-section, which enables an element of this type, as compared to an element of the round wire type, to carry heavier loads for the

same weight, or to carry the same load although of lighter weight.

The support for the resistance element of the unit is made up of a plurality of similar members or mats 10 formed of porcelain or other suitable material. These members or mats are illustrated as being substantially rectangular in shape, although it will be appreciated that they may have different shapes, if desired. The mats 10 have cut out portions adjacent their opposite ends and at each side edge thereof which provide shoulders 11 formed at the base or inner end of a downwardly and inwardly inclined surface 12, so that there is provided at each end of the mats what might be termed a dovetail portion. Each mat is also provided, adjacent its opposite ends, with an opening 13, the center of which lies substantially in the plane of the shoulders 11. Intermediate the openings 13 on one side face of each of the mats there is arranged a recess 14, preferably rectangular in shape and having two of its sides formed by portions 15 depressed with respect to the outer side surface of the mat. The opposite side face of each of the mats is provided with a projection 16 aligned with the recess 14 on the opposite side face of the mat and of a size such as to be capable of fitting within the recess 14 with a clearance between the walls of the recess and the projection. The projections 16 are preferably of substantially the same shape as are the recesses 14, although they do not necessarily have to be, since they may take other shapes so long as they will fit in the recesses with a clearance therebetween.

In assembling the mats or members 10 to form the support for the resistance element the required number of mats to furnish a support of the requisite length are arranged together in alignment so that their side faces are juxtaposed and the projection 16 on each mat (except, of course, one of the end mats) will fit into the recess 14 in the mat immediately adjacent to it on one side and will receive in its recess 14 the projection 16 of the mat immediately adjacent to it on its other side. Before proceeding with the description of how the mats are clamped together in assembled relationship; the construction of the resistance element of the unit will be described.

The resistance element 17 is in the form of a continuous substantially flat metallic ribbon having suitable resistance characteristics in which a plurality of equally spaced offsets 18 are arranged alternately on opposite sides of the ribbon, such offsets 18 being of a size to receive the projections 16 of the mats 10 and to fit into the recesses 14 with an amount of clearance therebetween. The element 17, midway between the offsets 18, has openings 19 formed therein to facilitate the bending of the ribbon and to cooperate with the clamping screws of the terminals, as will later be explained. The element 17 is further provided with longitudinally extending depressions forming reinforcing beads 20 arranged along the longitudinal center line of the ribbon between the openings 19 and offsets 18, it being noted that the beads 20 terminate short of the offsets 18 and openings 19 and are located alternately on opposite sides of the ribbon between said offsets.

The resistance element 17 may be readily manufactured by feeding the ribbon from a roll through a machine which stamps therein the offsets 18 and beads 20 and punches the openings 19. The same machine might also put preliminary bends in the ribbon at desired points. The ribbon or element 17, substantially midway between adjacent offsets 18, is reversely bent first in one direction and then in the opposite direction, the openings 19 lying at the middle of the bends and the beads 20 lying between the bends and the offsets 18. It will be noted that the bends are formed on a relatively large radius so that the lengths of the ribbon, adjacent to the bends, are substantially separated to the end that good radiation will be provided. In assembling the resistance element 17 and the mats 10, the substantially straight lengths of the ribbon which connect the bent portions are arranged between adjacent mats with the projection 16 on one mat fitting in the offset 18 of the ribbon, while said offset, with the projection therein, extends into the recess 14 in the adjacent mat 10. When the ribbon and the mats 10 have been thus arranged, bolts 21 are passed through the openings 13 in the mats and the mats are drawn together in assembled relationship by means of nuts 22 screwed upon the opposite ends of the bolts 21. When the mats are thus drawn together, the straight lengths of the ribbon are supported between adjacent mats, it being remembered that there is clearance between the offsets 18 of the ribbon and the projections 16 and recesses 14 of the mats to provide for the expansion and contraction of the ribbon, it being noted that the ribbon adjacent each of the offsets 18 extends laterally outwardly of the mats through the openings provided by the depressed portions 15. When the ribbon is assembled in the support the straight lengths or portions of the ribbon between the reversely bent portions are all in spaced alignment longitudinally of the support with the flat sides of the ribbon juxtaposed with respect to each other.

In order to more securely retain the mats 10 in assembled and ribbon supporting position, metal sheaths or covers 23 are arranged at the opposite ends or the top and bottom of the mats and are so shaped as to have an interlock with the dovetail portions formed by the shoulders 11 and surfaces 12, such sheaths also protecting the porcelain mats from breakage.

The terminal clamps for the unit comprise short metallic tubular members 24 having an elongated longitudinal opening 25 formed therein on one side and a pair of threaded openings 26 formed therein on the opposite side and in line with the elongated opening 25 and in which are arranged set screws 27. The terminal clamps are secured to the resistance element by passing one of the bends of the element through the opening 25 while the copper conductor 28 extends longitudinally through the tubular member 24 and within the bend of the ribbon or resistance element, as clearly shown in Fig. 2. The set screws 27 are then screwed inwardly against the ribbon, until they engage the bent portion thereof above and below the opening 19 sufficiently tight to securely clamp the conductor 28 in engagement with the ribbon, which, because of the opening 19, is readily deformed by the engagement of the set screws therewith into clamping relationship with the conductor 28. It will be seen that this form of terminal clamp provides a construction enabling the terminal wiring to be rigidly clamped to the element and one wherein there is small likelihood of the connection becoming loosened or destroyed.

The resistance unit may be used singly or it may be arranged in a suitable housing or support in banks and a convenient way of supporting such unit in the housing is to have the bolts 21

extend beyond the ends of the unit as indicated in Fig. 2, the extending portions of the bolts fitting into suitable sockets in the housing and clamped therein between the clamping nuts **22** and second nuts on the outer end of the bolts **21**.

It will be seen that a resistance unit, constructed as that disclosed and described herein, provides maximum radiation for the resistance element thereof, since said element is supported only at the middle points of the straight lengths thereof with the remainder of the element entirely free for the dissipation of heat. In addition, the turns or bends at the ends of the straight lengths of the element being on a relatively large radius, no portion of the element is closely adjacent to any other portion thereof and the radiation is further increased for that reason. Furthermore, by using a resistance element of the ribbon type, said element has a greater radiating surface, which radiating surface is increased by providing the reinforcing beads **20** therein.

In addition to this provision of ample radiation, it will be seen that the construction of the unit is such that the resistance element is disposed in a minimum space, but yet the turns and straight lengths of the element are kept a substantial distance apart so as not to interfere with proper radiation. It will further be noted that the construction is such as to require the use of a minimum amount of material, but which at the same time provides a construction that is mechanically strong, simple and capable of economical manufacture and maintenance. Since the mats **10** are separate it is possible, should one of the mats become broken, to readily disassemble the unit and replace the broken mat with a new one.

The resistance element can be continuous from terminal to terminal and, since there is a clearance between the offsets **18** of the element and the recesses **14** and projections **16** of the mats, the element will be free to expand and contract under its repeated heating and cooling without creating excessive stresses in the supporting frame and the element itself. It will be clearly seen that the construction of the unit is of a character wherein there is substantially no likelihood of the resistance element slipping or falling from its support and short-circuiting or grounding the unit. The reinforcing beads **20** greatly increase the structural strength of the ribbon and thus reduce to a minimum the susceptibility of the element to vibration and that such susceptibility is further diminished due to the manner in which the ribbon extends back and forth through the supports and is supported midway of the straight lengths of the ribbon.

Although a preferred embodiment of the invention has been illustrated and described herein, it should be appreciated that the invention is susceptible of various modifications and adaptations within the scope of the appended claims.

Having thus described my invention, I claim:

1. In a resistance unit, a resistance element, a support, said support comprising a plurality of similar members having recesses on one side thereof and aligned projections on the other side, said members being arranged in alignment with a projection of one engaging in the recess of another, and means for clamping said members together, said resistance element having a plurality of reversely bent portions connected by substantially straight portions, said straight portions being arranged between the adjacent members of said support and having offsets formed therein which extend into said recesses and receive said projections.

2. In a resistance unit, a resistance element in the form of a substantially flat ribbon, a support, said support comprising a plurality of similar members having a recess on one side thereof and an aligned projection on the other side, said members being arranged in alignment with each other with a projection of one extending into the recess of the other, and means for clamping said members together, said resistance element having a plurality of reversely bent portions connected by substantially straight portions provided with offsets intermediate their ends, said straight portions extending between the adjacent members of said support with the offsets thereof extending into the recesses in one of the adjacent members and receiving the projections of the other of the adjacent members.

3. In a resistance unit, a resistance element in the form of a substantially flat ribbon, a support, said support comprising a plurality of similar members having a recess in one side and an aligned projection on the opposite side thereof, said members being arranged in alignment with each other with the projection of one extending into the recess in the adjacent member, and means for clamping said members together, said resistance element having a plurality of reversely bent portions connected by substantially straight portions provided with offsets intermediate their ends, said straight portions extending between adjacent members of the support with the offsets thereof entering the recesses of one of the adjacent members and receiving the projections of the other of the adjacent members, said recesses, projections and offsets being of a size such as to provide a clearance therebetween.

4. In a resistance unit, a resistance element in the form of a substantially flat ribbon, a support, said support comprising a plurality of similar members having dovetail portions at their opposite ends and provided on one side face with a recess and on the opposite side face with an aligned projection, said members being arranged in alignment with each other with the projection of one extending into the recess in the other, means for clamping said members together, and coverings extending the longitudinal length of said support at the opposite ends of said members and interlocked with the dovetail portions thereof, said resistance element having a plurality of reversely bent portions connected by substantially straight portions, said straight portions having offsets intermediate their ends and being provided with longitudinally extending reinforcing beads intermediate said offsets and the ends of said portions, said straight portion extending between said members with the offsets thereof extending into the recesses in certain of the members and receiving the projections of other of the members.

JOHN H. HERTNER.