Nov. 29, 1932. E. N. LIGHTFOOT 1,889,445

ELECTRICAL RESISTANCE DEVICE

Filed Feb. 19, 1930 2 Sheets-Sheet 1

Fig. 1

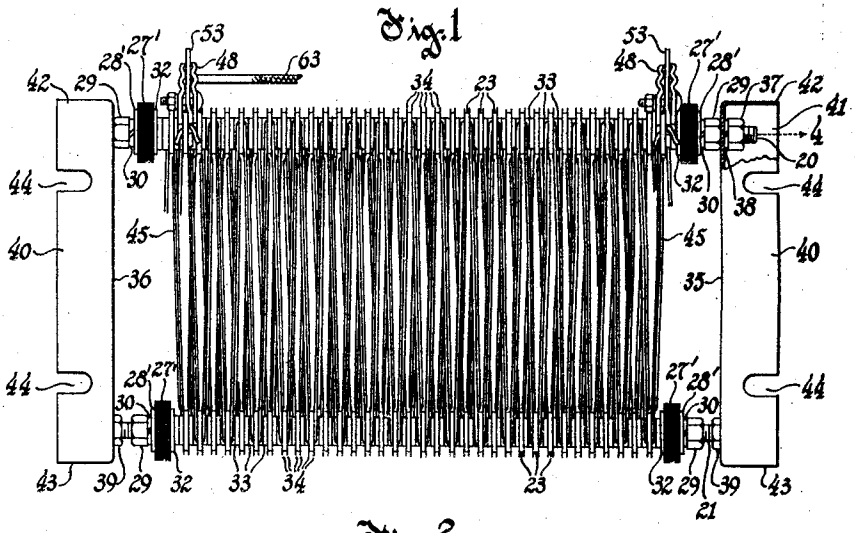



Fig. 2

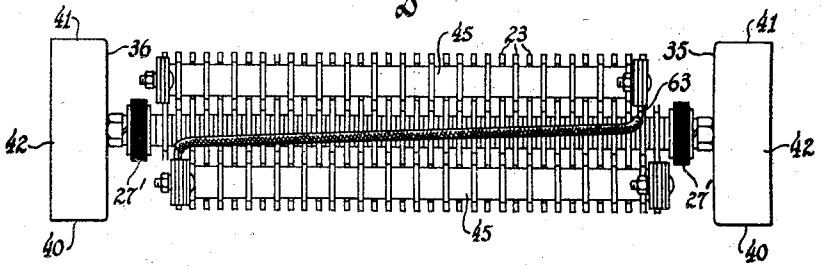



Fig. 3

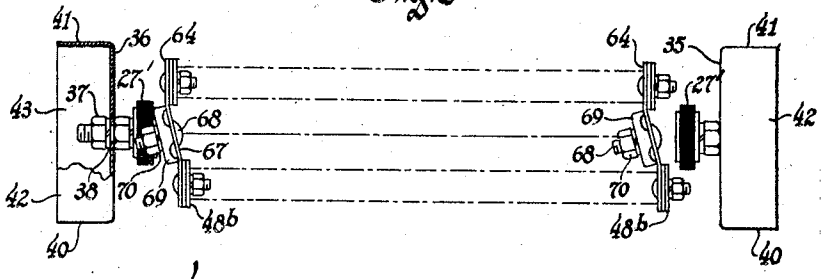
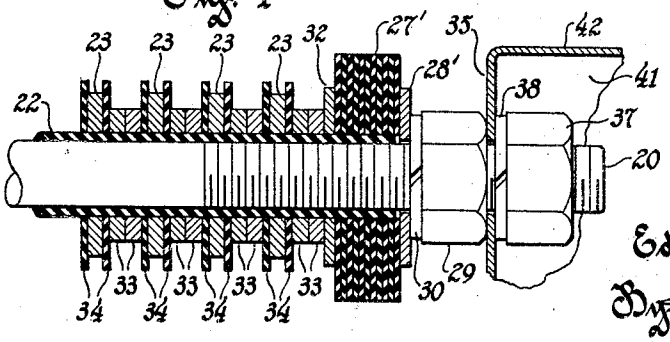



Fig. 4




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ELECTRICAL RESISTANCE DEVICE

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Fig. 5

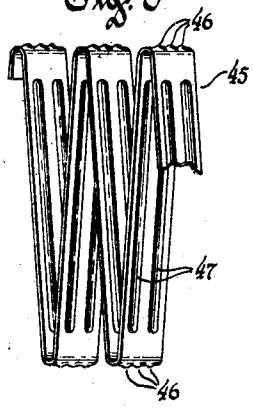



Fig. 6

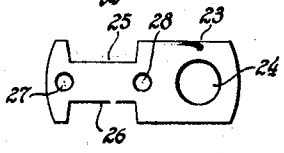



Fig. 7

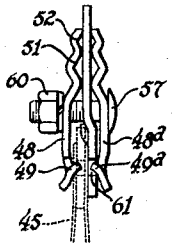



Fig. 8

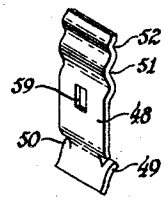



Fig. 9

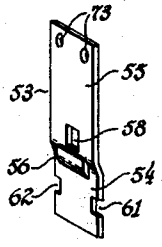



Fig. 10

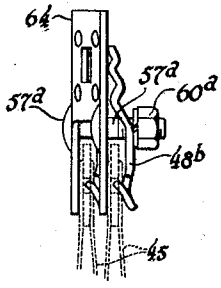



Fig. 11

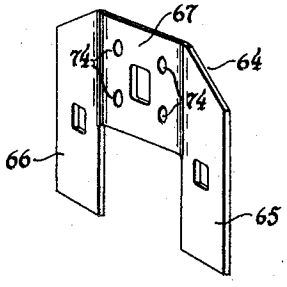



Fig. 12

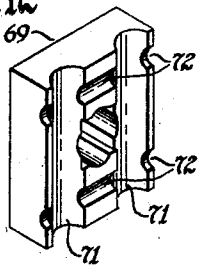



Fig. 13

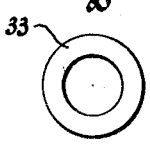
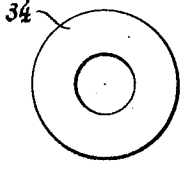



Fig. 14




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Patented Nov. 29, 1932 1,889,445

# UNITED STATES PATENT OFFICE

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## ELECTRICAL RESISTANCE DEVICE

Application filed February 19, 1930. Serial No. 429,575.

This invention relates to improvements in electrical resistance devices, and more particularly to devices wherein resistances of ribbon or strip type are employed.

An object of the invention is to provide improved supporting means for resistors of the ribbon type.

Another object is to generally improve and simplify the details of construction of the parts of resistance devices of the aforementioned character.

Another object is to provide such a device wherein the parts may be readily and inexpensively assembled, or quickly disassembled for renewal or replacement.

Another object is to provide improved wiring terminal elements and attaching means therefor.

Another object is to so form and support the resistance strip or ribbon as to avoid any possibility of warping or sagging thereof irrespective of the manner of mounting of the device as a whole.

Another object is to minimize the number of different types and cost of the parts required to produce a device of the aforementioned character.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that the embodiment illustrated is susceptible of modification within the scope of the appended claims.

In the drawings, Figure 1 is a side elevation of a resistance device constructed in accordance with my invention.

Fig. 2 is an end elevation of the device illustrated in Fig. 1, and showing terminal elements and a bus wire providing for series connection of the two resistance ribbons.

Fig. 3 is a view similar to Fig. 2, but partly diagrammatic; and showing a type of terminal element providing for parallel connection of the resistance ribbons.

Fig. 4 is an enlarged fragmentary sectional view on the line 4 of Fig. 1, showing the manner of assembling and insulating the resistor supporting elements with respect to the frame rod, and showing the means for spacing and insulating said elements with respect to each other.

Fig. 5 is a fragmentary perspective view of one of the one-piece resistance ribbons, showing the flatwise reflexed or zigzag formation effected prior to assembly thereof with respect to the supporting elements.

Fig. 6 is a plan view of one of the punched sheet metal supporting elements,—all of which are of identical form and size.

Fig. 7 is a side view of one form of terminal device.

Figs. 8 and 9 are perspective views of the two forms of punched and stamped sheet metal plates required to produce the terminal device of Fig. 7.

Fig. 10 is a side view of one of the terminal devices which may be employed to connect the resistance ribbons in parallel relation to each other.

Fig. 11 is a perspective view of one of the punched and stamped sheet metal plates shown in Fig. 10,—the other plates shown in Fig. 10 being identical with that shown in Fig. 8.

Fig. 12 is a perspective view of the terminal wire clamping member to be employed with the terminal device of Figs. 10 and 11.

Fig. 13 is a plan view of one of the punched metal spacing elements or washers shown in section in Fig. 4, and

Fig. 14 is a plan view of one of the insulating washers shown in Fig. 4.

Referring to the drawings, the numerals 20 and 21 designate a pair of straight cylindrical metal rods which are preferably of equal length, and each having relatively long threaded portions at opposite ends thereof. Slidable onto and rather closely fitting each rod is a tube or covering 22 (Fig. 4) of a tough and substantially unbreakable insulating material such as laminated mica. The tube 22 surrounding rod 20 is preferably of somewhat greater length than the corresponding tube surrounding rod 21, for a purpose to be described.

The resistor supporting elements to be strung upon the rods 20 and 21 are all of the form shown in Fig. 6 and consist of flat

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punched sheet metal plates 23 each having a relatively large circular perforation 24 adjacent to one end thereof, and a pair of relatively wide alined notches 25 and 26 adjacent to the other end thereof. Located in a line midway between the notches 25, 26 and spaced apart a distance slightly greater than the width of the latter are a pair of perforations 27 and 28. As will appear, only one of the notches 25, 26 is utilized when the parts are assembled, but by employing the form of supporting element shown either of said notches may be used, and this feature greatly facilitates assembly of the parts.

In assembling the parts upon the rod 20, for instance, it may be assumed that the insulating tube 22 of the required length has been positioned upon the rod so that the ends of the tube will be spaced substantially equal distances from the ends of the rod. Thereupon a relatively thick washer 27′ of insulating material, preferably laminated mica, is strung upon rod 20 and over one end of the insulating tube 22,—a metal washer 28′ having a perforation of less diameter than that of tube 22 being positioned in abutting relation to washer 27, and a nut 29 being threaded onto rod 20 to back up or prevent endwise movement of said washer 28. If desired a split or lock washer 30 may be interposed between nut 29 and washer 28.

Thereafter the other elements may be strung upon rod 20 from the opposite side of washer 27. Thus a metal washer 32 having a perforation to accommodate the diameter of tube 22 is brought into abutting relation to washer 27. Thereafter a pair of spacing washers 33 are strung upon the tube 22, then an insulating washer 34, preferably of laminated mica, then one of the supporting elements 23, then another insulating washer 34, and so on until the desired number of supporting elements 23 have been placed in position upon the rod. Then the end washers 32, 27, 28 and 30 and nut 29 are brought to position. Prior to tightening the last mentioned nut 29 and either during or after stringing of the supporting elements upon the rod said elements are arranged so that they extend alternately in diametrically opposite directions. When such arrangement of elements 23 has been effected either or both of the nuts 29 may be tightened until all of the parts strung upon rod 20 are securely held against movement relatively to the rod and also against movement with respect to each other.

The required number of resistor supporting elements 23 are strung upon the rod 21 and the same are insulated from rod 21 and spaced and insulated from each other in exactly the same manner as described in connection with the assembly of parts on rod 20. It will be noted, however, that in an arrangement of the character illustrated in Figs. 1 and 2 the number of resistor supporting elements upon the rod 21 is two less than the number required upon rod 20. Consequently the number of spacing washers 33 required upon rod 21 is decreased by four. Moreover, to facilitate assembly of the resistor elements with respect to the supporting elements I prefer to have the nuts 29 on rod 21 only partly tightened so that the supporting elements 23 on opposite sides of the latter may be temporarily positioned at predetermined upwardly divergent angles with respect to each other.

Thereupon the opposite threaded ends of rods 20 and 21 may be inserted into correspondingly shaped perforations in a pair of rectangular end plates 35 and 36 to provide for support of said rods in spaced parallel relation to each other. Nuts 29 on rod 20 may be utilized to insure proper spacing of the end plates 35 and 36,—nuts 37 and split washers 38 being employed to rigidly secure the end plates and rods to each other. As shown, additional lock nuts 39 are required upon the rod 21 to insure proper alinement of said end plates. It will be understood, of course, that the end plates might be more widely spaced from each other, in which event additional nuts corresponding with those indicated at 39 would also be required upon the rod 20.

End plates 35 and 36 are provided with integral flanges extending in parallel relation from the two longer edges thereof, as shown at 40 and 41,—said end plates being also preferably provided with end flanges 42 and 43, and the adjacent edges of the flanges 40 to 43 may be tack welded or otherwise rigidly secured to each other. The flanges 40 and 41 are each provided with notches 44 to provide for securing a plurality of units to each other when the same are in stacked or banked relation as by means of suitable clamping bolts, not shown. In practice, however, when a number of complete units are stacked or banked with respect to each other it is preferred to interpose between the same suitable spacing members, which may conveniently consist of elements identical with or similar to the flanged end plates 35 and 36.

As shown each unit preferably includes two one-piece strips or ribbons composed of a suitable metal alloy resistance, such for instance as the usual nickel-chromium or copper-nickel alloys. Each strip is bent or reflexed flatwise at a multiplicity of points to provide a resistor of zigzag form, as shown at 45 in Fig. 5. When a strip or ribbon of relatively thin stock is employed I preferably provide a plurality of relatively short reinforcing beads or corrugations 46 at each localized point of bending thereof, and I also provide one or more longitudinally extending reinforcing beads 47 between the respective bends and spaced endwise with respect to the

latter. On the other hand, if the strip is formed of sufficiently thick stock certain or all of said reinforcing beads may be omitted.

With the aforedescribed supporting elements 23 assembled upon the respective rods 20 and 21 and with the latter secured to the end plates 35 and 36 in such manner that the supporting elements on the same side of the respective rods are symmetrically offset or in staggered relation to each other, as best shown in Fig. 2, each pre-formed resistance ribbon may be hung or seated upon the supporting elements carried by the rod 20, for instance,—the upwardly angled supporting elements carried by rod 21 being then tapped or driven either individually or jointly into interlocking engagement with the opposite loops or bends of the resistor. When each of the resistors has thus been assembled upon the respective sets of supporting elements either or both of the nuts 29 on rod 21 may be tightened to securely clamp said elements in fixed position.

The terminal elements herein disclosed are of extremely simple and efficient form, and as shown in Figs. 7, 8 and 9 each comprises essentially a punched and stamped sheet metal plate 48 having lugs 49 and 50 struck outwardly from one side thereof and adapted for interlocking engagement with the walls of perforations 27 and 28 in any one of the supporting elements 23. Plate 48 is provided at the lower end thereof with an inwardly bowed portion adapted for clamping engagement with the resistor ribbon 45 at one side of a bend in the latter, and the upper end of plate 48 is corrugated as shown at 51 and 52 to provide for clamping engagement thereof with terminal wires of different dimensions.

Opposed to plate 48 is a punched and stamped plate 53, the lower portion 54 of which is offset outwardly with respect to the upper portion 55 thereof, said plate having a partially severed portion 56 pressed inwardly therefrom to interlock with the walls of the notch 25 or 26 which supports the particular bend of the resistor. A bolt 57 penetrates registering openings 58 and 59 in plates 53 and 48, and a nut 60 is threaded upon the end of said bolt to draw said plates into clamping engagement with the resistor bend and the terminal wire and into interlocking engagement with the supporting element.

When it is desired to provide clamping means for a plurality of terminal wires of like dimensions, a plate 48ª, which is an exact duplicate of plate 48, may be employed,—the plate 53 being provided with notches 61, 62 in the side edges thereof to receive the projecting lugs on plate 48ª, one of which is shown at 49ª.

Four of the terminal devices (two of which have the plate 48ª omitted) are shown attached to the supporting elements at the respective ends of the two resistor ribbons,—a relatively heavy bus wire 63, preferably having a heat resisting covering of woven asbestos or the like, being shown as connecting the resistor ribbons in series relation to each other, and the terminal devices at diagonally opposite corners of the unit being arranged for attachment of the circuit or lead wires, not shown.

As will be apparent, the terminal devices may be attached to the supporting elements at the points illustrated in Figs. 1 and 2 or to any other alternative or additional points on the respective resistors. This arrangement provides for tapping off or wiring the resistance unit in any desired manner, thus rendering the same of extremely flexible utility.

If it is desired to electrically connect the resistors in parallel relation to each other the combination terminal devices illustrated in Fig. 3 and in detail in Figs. 10 and 11 are preferably employed. These terminal devices each comprise essentially a punched and stamped sheet metal plate 64 having flat portions 65 and 66 offset with respect to each other in parallel planes, with an integral angular connecting portion 67. Plates 48ᵇ of the identical form shown at 48 in Figs. 7 and 8 are employed for cooperation with portions 65 and 66 whereby plate 64 and plates 48ᵇ are rigidly secured to a pair of supporting elements 23 and in clamping relation to a pair of resistor bends when the bolts 57ª and nuts 60ª are tightened.

The intermediate portion 67 of plate 64 is perforated to accommodate a bolt 68 (Fig. 3), said bolt being also adapted to penetrate a wire terminal clamping element 69 to draw the latter toward portion 67 when nut 70 is tightened. Element 69 may be formed of cast iron, and as shown in Fig. 12 the same is preferably provided with at least two sets of substantially semi-circular wire-receiving grooves 71 and 72 of different dimensions, whereby wires of different sizes may be properly clamped thereby.

The perforations 73 in plates 53 and the perforations 74 in plate 64 are utilized for attachment of suitable metal tags (not shown), which tags may be embossed or stamped to indicate the ohmic value or other characteristic of the resistance unit as a whole or at any particular point at which a tapping-off terminal is provided.

In practice it is preferred to mount the complete units in superimposed relation to each other in the plane illustrated in Figs. 2 and 3, with any desired degree of spacing therebetween. Effective ventilation of the resistor elements may thus be insured, since the arrangement provides for rapid and substantially unobstructed movement of air around and between the folds of the resistors

with consequent rapid dissipation of heat and low temperature of the resistors.

Also it will be apparent that the spacing of the resistor supporting elements may be readily varied as desired to thereby increase or decrease the space between the resistor folds. In some cases close spacing is desirable, as for starting duty. In other cases wide spacing is desirable, as for continuous duty and for assembly of the resistor units in large banks or stacks. Moreover, the novel manner of supporting the resistor elements herein disclosed effectively provides for expansion and contraction of the latter without danger of distortion or displacement thereof with respect to the supporting members or the clamping terminal members of the device.

What I claim as new and desire to secure by Letters Patent is:

1. As an article of manufacture, an electrical resistance device comprising a one-piece metal strip resistor bent flatwise at a plurality of points to provide an element of zigzag form, supporting means for said element comprising a pair of metal rods and a plurality of sets of one-piece flat punched sheet metal supports carried thereby, the individual supports of each set being insulated from said rods and from each other, and said sets of supports being so arranged and maintained at such distance apart that the supports engage the resistor at or near its respective bends.

2. As an article of manufacture, an electrical resistance device comprising a one-piece metal strip resistor bent flatwise at a plurality of points to provide an element of zigzag form, supporting means for said element comprising two sets of one-piece flat punched sheet metal supports, each set of supports being mounted upon a metal rod, and means for insulating the individual supports in each set from each other and from their respective metal rods, the two sets of assembled supports being so arranged and maintained at such distance apart that the supports engage the resistor at or near its respective bends.

3. As an article of manufacture, an electrical resistance device comprising a metal strip resistor bent flatwise at a plurality of points to provide an element of zigzag form, supporting means for said element comprising two sets of supports formed of punched sheet metal, each set of supports being mounted upon a metal rod, means for spacing and insulating the individual supports in each set from each other and including means for insulating the same from their respective metal rods, each of said supports having a notched portion within which the respective bends of the resistor element are adapted to seat, and the two sets of assembled supports being so arranged and maintained at such distance apart that the resistor bends are retained within said notches.

4. As an article of manufacture, an electrical resistance device comprising a metal strip resistor bent flatwise at a plurality of points to provide an element of zigzag form, supporting means for said element comprising two sets of supports formed of punched sheet metal, each set of supports being mounted upon a metal rod, means for spacing and insulating the individual supports in each set from each other and including means for insulating the same from their respective metal rods, each of said supports having a notched portion within which the respective bends of the resistor element are adapted to seat, and the two sets of assembled supports being so arranged and maintained at such distance apart that the resistor bends are retained within said notches, said resistor element having one or more longitudinally extending reinforcing beads formed therein between the respective bends thereof to prevent sagging of said element under relatively high temperature conditions.

5. As an article of manufacture, a resistance unit comprising a pair of metal rods located in spaced parallel relation to each other, a plurality of punched sheet metal supporting members strung upon the respective rods, means for spacing and insulating said supporting members from each other and from the respective rods, the groups of supporting members upon the respective rods having portions projecting from the latter in parallel planes and the supporting members in the respective groups being positioned in staggered relation to each other, and a one-piece ribbon resistor bent flatwise to zigzag form, each bend of said resistor being adapted for interlocking engagement with one of said supporting members.

6. In a device of the character described, in combination, a metal rod having threads at the opposite ends thereof, a multiplicity of resistor supporting elements strung upon said rod, spacing members interposed between the respective supporting elements, each of said supporting elements and said spacing members consisting of a flat sheet metal punching, insulating members for electrically separating said sheet metal supporting elements from said rod and from each other, the resistor supporting portions of said elements being arranged to extend laterally in diametrically opposite directions from said rod whereby two sets of resistor supports are provided, and adjustable means having threaded engagement with the rod inwardly of the respective ends thereof to clamp said supporting elements in fixed position on said rod.

7. As an article of manufacture, a supporting element for a resistor of the ribbon type, said element consisting of a flat sheet metal punching having a relatively large opening

adjacent to one end thereof to provide for stringing thereof upon a suitable support, said element having a relatively wide and relatively deep notch adjacent to the other end to provide a shouldered support for the reflexed portion of a resistor, and a pair of relatively smaller openings located on opposite sides of said notch, for the purpose set forth.

8. As an article of manufacture, a supporting element for a resistor of the ribbon type, said element consisting of a flat sheet metal punching having a relatively large circular opening adjacent to one end thereof to provide for stringing thereof upon a supporting rod, said element having a pair of relatively wide notches in alinement with each other adjacent to the other end thereof, and a pair of relatively smaller openings located in a line intermediate said notches and spaced apart a distance slightly greater than the width of the latter.

9. A resistance unit comprising a pair of metal rods located in spaced parallel relation to each other, a tube of insulating material surrounding each of said rods, a plurality of one-piece flat punched sheet metal supporting members strung upon the respective rods and separated therefrom by said insulating tubes, the supporting members on each rod being spaced and insulated from each other and said members being located upon the respective rods in staggered relation to each other, a one-piece ribbon resistor bent flatwise to zigzag form, each bend of said resistor being adapted for engagement with one of said supporting members, certain of said supporting members being movable in the planes thereof respectively into interlocking relation with said resistor, and adjustable securing means on the respective rods for jointly holding said members in relatively fixed position.

10. A resistance unit comprising end plates and a pair of metal rods rigidly secured thereto in spaced parallel relation, each of said rods having a relatively long tube of insulating material strung thereupon, a multiplicity of one-piece flat punched sheet metal supporting members strung upon the respective insulating tubes and insulated from each other, the supporting members of the two groups being symmetrically offset with respect to each other, a one-piece resistor strip bent flatwise to zigzag form and having each bend thereof in cooperative engagement with an edge portion of one of said supporting members, and a terminal member adapted for positive interlocking engagement with any one of said supporting members, said terminal member also having clamping engagement with the adjacent bend of said resistor.

11. In combination, a metal rod and a resistor supporting member carried thereby but insulated therefrom, said supporting member consisting of a flat punched sheet metal piece having a relatively deep notch formed in an edge thereof to receive and retain the bent portion of a resistor of the ribbon type while permitting free expansion and contraction of said resistor, said supporting member having perforations on opposite sides of said notch, and a clamping terminal device comprising a pair of punched sheet metal plates respectively provided with portions adapted for interlocking engagement with the walls of said perforations and said notch when said plates are drawn toward each other by their common fastening means, each of said plates also having portions adapted for clamping engagement with said bent portion of the resistor, to thereby provide a good mechanical support for said terminal device and to provide a good electrical connection between the latter and the resistor.

12. In combination, a metal rod and a resistor supporting member carried thereby but insulated therefrom, said supporting member consisting of a flat punched sheet metal piece having a relatively deep notch formed in an edge thereof to receive and retain the bent portion of a resistor of the ribbon type, said supporting member having perforations on opposite sides of said notch and a clamping terminal device comprising a pair of punched and stamped sheet metal plates of identical form and a third punched and stamped sheet metal plate to be interposed between said first mentioned plates, one of said first mentioned plates having projecting portions for interlocking engagement with the walls of said perforations and said third plate having a projecting portion for interlocking engagement with the walls of said notch, said third plate having notches in the opposite side edges thereof with the walls of which notches the projecting portions of the other of said first mentioned plates are adapted to engage, said third plate and one of said first mentioned plates also having portions adapted for clamping engagement with said bent portion of the resistor, and common means for holding all of said plates in assembled and adjustable relation to each other.

13. In combination, a metal rod and a resistor supporting member carried thereby but insulated therefrom, said supporting member consisting of a flat punched sheet metal piece having a relatively deep notch formed in an edge thereof to receive and retain the bent portion of a resistor of the ribbon type, said supporting member having perforations on opposite sides of said notch and a clamping terminal device comprising a pair of punched and stamped sheet metal plates of identical form and a third punched and stamped sheet metal plate to be interposed between said first mentioned plates, one of said first mentioned plates having projecting portions for inter-

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locking engagement with the walls of said perforations and said third plate having a projecting portion for interlocking engagement with the walls of said notch, said third plate having notches in the opposite side edges thereof with the walls of which notches the projecting portions of the other of said first mentioned plates are adapted to engage, said third plate and one of said first mentioned plates also having portions adapted for clamping engagement with said bent portion of the resistor, and common means comprising a bolt and a nut for holding all of said plates in assembled and adjustable relation to each other, said plates also having cooperative portions to provide for clamping engagement thereof with one or more terminal wires.

14. In combination, a frame comprising metal end plates and a pair of metal rods rigidly secured to each of said plates in parallel spaced relation to each other, a multiplicity of resistor supporting elements each consisting of a flat sheet metal punching, said elements being initially loosely strung upon the respective rods but insulated from the latter and from each other, the elements on said rods having portions to extend outwardly in parallel relation to each other and the alternate elements on each rod being arranged to extend in opposite directions from the latter whereby two groups of supporting elements are provided on each side of the pair of rods, a pair of one-piece ribbon type resistors bent flatwise to zigzag form, each rod having common means to clamp all of the elements thereon in fixed relation thereto, all of said supporting elements having notches to receive and retain the bent portions of the respective resistors and all of said elements also having perforations on opposite sides of said notches, and terminal members each comprising a plurality of plates having portions adapted for joint interlocking engagement with any one of said supporting elements, each terminal member having common means for securing the plates thereof in assembled relation to each other, and certain of said terminal elements being arranged in pairs with a wiring terminal plate or bus connection common thereto.

15. An electrical resistance unit comprising a metal frame consisting of end members and two rods rigidly secured to said end members in spaced parallel relation to each other, a covering tube of insulating material extending throughout the major portion of the length of each of said rods, a multiplicity of supporting elements strung upon the respective rods and insulated therefrom by said tubes, said supporting elements consisting of punched metal plates of identical form and size, metallic spacing members interposed between the respective supporting elements and insulating members interposed between the respective supporting elements and said spacing members, the alternate supporting elements on the respective rods extending from the latter in opposite directions to provide two spaced parallel groups of supporting elements on each side of said frame rods, a pair of flexible resistance ribbons each of which is bent flatwise at a multiplicity of points into zigzag form, said supporting elements having notches to receive and retain the bent portions of said resistance ribbons, and clamping terminal members adapted for attachment to any one or more of said supporting elements, said terminal members having positive interlocking engagement with the respective supporting elements and also having clamping engagement with the corresponding bends of said resistance ribbons.

16. An electrical resistance unit comprising a metal frame consisting of end members and two rods rigidly secured to said end members in spaced parallel relation to each other, a covering tube of insulating material extending throughout the major portion of the length of each of said rods, a multiplicity of supporting elements strung upon the respective rods and insulated therefrom by said tubes, said supporting elements consisting of punched metal plates of identical form and size, metallic spacing members interposed between the respective supporting elements and insulating members interposed between the respective supporting elements and said spacing members, the alternate supporting elements on the respective rods extending from the latter in opposite directions to provide two spaced parallel groups of supporting elements on each side of said frame rods, a pair of flexible resistance ribbons each of which is bent or reflexed at a multiplicity of points into zigzag form, said supporting elements having notches to receive and retain the bent portions of said resistance ribbons, and clamping terminal members adapted for attachment to any one or more of said supporting elements, said terminal members having positive interlocking engagement with the respective supporting elements and also having clamping engagement with the corresponding bends of said resistance ribbons, said supporting elements being arranged to retain said resistance ribbons in proper position in any angular position of said frame and said notches being sufficiently deep to provide for maximum expansion of said resistance ribbons when in use without displacement of the latter from said supporting elements.

17. In an electrical resistance unit, in combination, a pair of punched sheet metal end plates, said end plates having integral flanges extending outwardly at right angles from at least two edges thereof to provide for assembly of said units in groups, a pair of rods extending between and rigidly secured to said

end plates in spaced parallel relation to each other, a multiplicity of punched sheet metal supporting elements strung upon the respective rods, punched sheet metal spacing members also strung upon said rods and interposed between the respective supporting elements, insulation separating said supporting elements from the respective rods and from said spacing members, common means on each rod for securing said supporting elements in relatively adjusted positions, the supporting elements on each rod extending alternately in opposite directions from the latter and said rods being adjusted with respect to said end plates to provide an offset or staggered relationship of the two groups of supporting elements on each of the respective sides of said pair of rods, and one-piece flexible resistor ribbons supported respectively by each two groups of supporting elements, each of said ribbons being bent flatwise into zigzag form and said supporting elements having relatively deep notches to receive the respective bends of said ribbons while permitting freedom of expansion and contraction of the latter, wiring terminal means comprising a plurality of punched metal plates adapted for positive interlocking engagement with any one of said supporting elements when said plates are drawn toward each other by their common fastening means, said plates also having portions adapted for clamping engagement with the corresponding bends of the resistor ribbons.

18. In an electrical resistance unit, in combination, a pair of punched sheet metal end plates, said end plates having integral flanges extending outwardly at right angles from at least two edges thereof to provide for assembly of said units in groups, a pair of rods extending between and rigidly secured to said end plates in spaced parallel relation to each other, a multiplicity of punched sheet metal supporting elements strung upon the respective rods, punched sheet metal spacing members also strung upon said rods and interposed between the respective supporting elements, insulation separating said supporting elements from the respective rods and from said spacing members, common means on each rod for securing said supporting elements in relatively adjusted positions, the supporting elements on each rod extending alternately in opposite directions from the latter and said rods being adjusted with respect to said end plates to provide an offset or staggered relationship of the two groups of supporting elements on each of the respective sides of said pair of rods, one-piece flexible resistor ribbons to be supported respectively by each two groups of supporting elements, each of said ribbons being bent flatwise into zigzag form and said supporting elements having relatively deep notches to receive and retain the respective bends of said ribbons, wiring terminal means comprising a plurality of punched metal plates adapted for positive interlocking engagement with any one of said supporting elements when said plates are drawn toward each other by their common fastening means, said plates also having portions adapted for clamping engagement with the corresponding bends of the resistor ribbons, and each of said ribbons having one or more reinforcing ribs extending throughout the major portion of the length thereof between the respective bends.

19. In a resistance unit, the combination with a strip resistor bent flatwise at intervals to provide an element of zigzag form, of supporting means for said resistor comprising a pair of metal rods and a plurality of sets of one-piece flat punched sheet metal supports carried thereby, the individual supports of each set being insulated from said rods and from each other, the formed resistor being freely insertable over said sets of supports for engagement of the alternate bends of the former with one set of the latter, and means providing for movement of the other set of supports into engagement with the other bends of said resistor to secure the latter in position.

20. In a resistance unit, the combination with a strip resistor bent flatwise at intervals to provide an element of zigzag form, of supporting means for said resistor comprising a pair of metal rods and a plurality of sets of one-piece flat punched sheet metal supports carried thereby, the individual supports of each set being insulated from said rods and from each other, the formed resistor being freely insertable over said sets of supports for engagement of the alternate bends of the former with one set of the latter, and means providing for movement of the other set of supports into engagement with the other bends of said resistor to secure the latter in position, the supports of each set having notches to be engaged by the respective bends to insure proper support of the resistor under conditions of expansion and contraction of the latter when in use.

21. In a resistance unit, the combination with a strip resistor bent flatwise at equally spaced points to provide an element of zigzag form, of a pair of metal rods each having a set of notched supports extending laterally therefrom, said formed resistor being movable bodily onto one of said sets of supports, means providing for movement of the other set of supports into interlocking engagement with the respective bends of the resistor to properly support the latter, and means common to each set of supports for clamping the same in relatively fixed relation.

In witness whereof, I have hereunto subscribed my name.

EDWIN N. LIGHTFOOT.