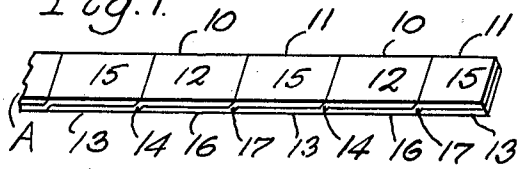
Feb. 6, 1940. N. L. DERBY 2,189,459

REVERSED BIMETALLIC THERMAL ELEMENT

Filed Aug. 10, 1937

Fig. 1.



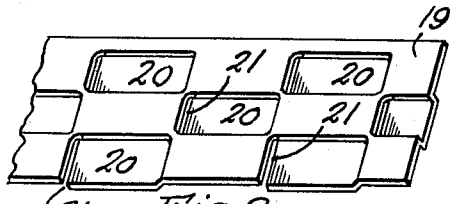


Fig. 3.

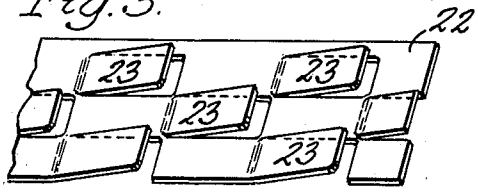


Fig. 2.

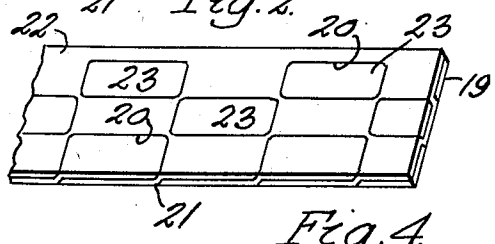


Fig. 4.

Fig. 5.

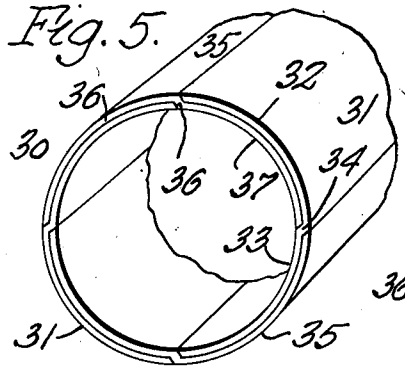


Fig. 6.

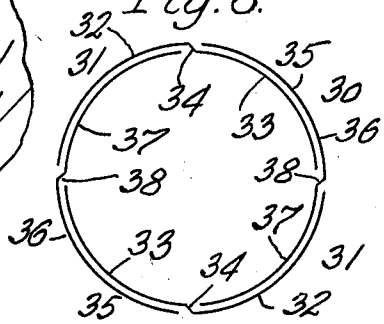
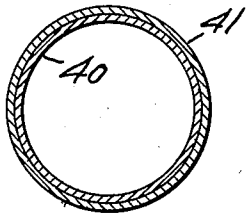


Fig. 8.



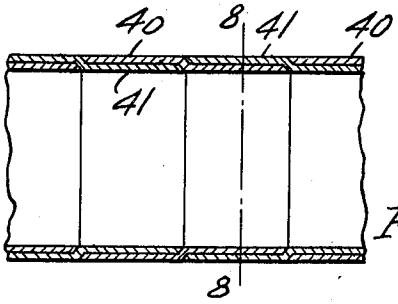


Fig. 7.

Fig. 9.



Fig. 10.

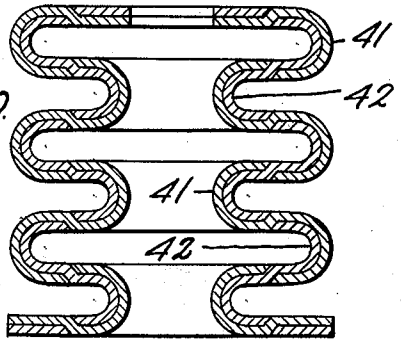
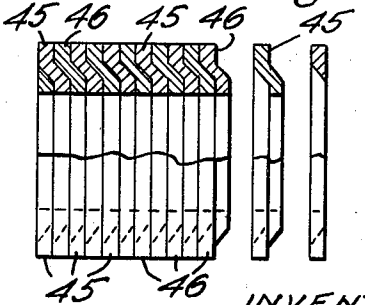


Fig. 11.



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UNITED STATES PATENT OFFICE

2,189,459

REVERSED BIMETALLIC THERMAL ELEMENT

Norman L. Derby, Philadelphia, Pa.

Application August 10, 1937, Serial No. 158,342

5 Claims. (Cl. 297—11)

This invention relates to reversed bimetal thermal elements. This application is a continuation in part of my copending application Serial No. 105,565, filed Oct. 14, 1936, for Bimetallic elements and stock for making same.

An object of the invention is to provide improved reversed bimetal thermal elements which will have new, novel and practical arrangements of the layers of metals of different rates of expansion, which will be relatively simple and inexpensive, and with which the pitch or distance from center to center of portions of the same metal on one face of an element and the thickness of the layers of metal may readily be altered to meet various requirements.

Other objects and advantages will be apparent from the following description of several embodiments of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawing:

Fig. 1 is a perspective view, with the thickness of the metal layers exaggerated, of a reversed, bimetal thermal element constructed in accordance with this invention, and illustrating one embodiment thereof.

Fig. 2 is a perspective view of a sheet of metal of one rate of expansion used in making one form of reversed bimetal thermal element in accordance with the invention, the thickness of metal of the sheet being exaggerated.

Fig. 3 is a perspective view of a portion of a sheet of another metal having a different rate of expansion, with tongues drawn therefrom for cooperation with the sheet of Fig. 2 to form therewith the bimetal thermal element of Fig. 1, the thickness of metal of the sheet being exaggerated.

Fig. 4 is a perspective view of a stock member from which reversed bimetal thermal elements may be made, and which may be produced by assembling the sheets of Figs. 2 and 3 face to face, with the tongues of one sheet interlocked in openings in the other sheet, and then brazing the abutting faces of the sheets to one another under pressure, the thickness of the sheets in this figure being exaggerated.

Fig. 5 is a fragmentary, perspective view of an element of modified form.

Fig. 6 is a diagrammatic representation of the parts of Fig. 5.

Fig. 7 is a longitudinal, sectional view of a tubular thermal element of still another form.

Fig. 8 is a cross section thereof on line 8—8, Fig. 7.

Fig. 9 is a side elevation of a thermal unit formed of a strip constructed as in Fig. 1.

Fig. 10 is a sectional elevation of a thermal unit which may be formed from an element such as shown in Fig. 7.

Fig. 11 is a sectional view of still another tubular form of element, a portion of the figure being in elevation.

Reversed bimetallic thermal elements of various forms can be produced in accordance with this invention, and I have illustrated several in the drawing.

Referring first to the embodiment of the invention illustrated in Fig. 1, I show a reversed bimetallic thermal element which is composed of layers of metal which overlap with one another progressively in a shingle-like manner. The area of each layer or section which is exposed on one face of the element is homogeneously integral with a similar area of the same metal exposed on the opposite face of the element in a next adjacent area.

In the embodiment shown in Fig. 1, the element A is composed of strips or sections 10 of one metal having a desired rate of expansion alternating with strips or sections 11 of a metal having a different desired rate of expansion. The strips 10 are formed of upper and lower parts 12 and 13 attached by continuous or integral and transversely offset portions 14, while the strips 11 are likewise formed of upper and lower parts 15 and 16 connected by portions 17.

The selection of the different metals for use in the making of element A may be from any of the metals commonly employed or desired for bimetal thermal elements, but the metals commonly in use for such purpose are "Invar" which is a steel containing about 36% of nickel, and a chrome-nickel-steel alloy which contains usually about 3% of chrome, 22% of nickel, and the balance of iron or steel. The "Invar" is a metal having a relatively low rate of heat expansion, that is a low coefficient of expansion, and the chrome-nickel-steel alloy has a relatively high rate or coefficient of expansion. It is immaterial which of the two metals is used for the strips 10 and 11, it being merely important that the strips 10 are made of one of the metals, and the strips 11 of the other metal. The strips 10 and 11 preferably have the grain running lengthwise thereof.

A suitable way in which to produce the reversed bimetal thermal element A of Fig. 1 is illustrated in Figs. 2, 3, and 4. In this arrangement, a sheet 19 of one of the metals of which the element is to be formed is provided with a plurality of depressed areas or depressions 20, (Fig. 2), arranged in rows, and with the depressions of one row staggered in relation to those of the next adjacent row, as shown clearly in Fig. 2. The extent of each depressed area is approximately the same as or slightly more than the thickness of the metal, and each depression at one end is provided with a slit or opening 21, which slit extends just around the corner at each end thereof.

The slits 21 are preferably provided at corresponding ends of the depressions, a slit 21 being preferably provided at only one end of each depression. A sheet 22, Fig. 3 of the other metal of which the element is to be made, has a plurality of tongues 23 drawn and struck from the same face thereof. The tongues 23 of the sheet 22 have a shape and size which enables them to fit somewhat snugly within or approximately fill the depressions 20, and they are arranged in rows and spaced apart in staggered relation to one another so as to have the same pattern of arrangement as the depressions 20 of the sheet 19 shown in Fig. 2.

After the sheets 19 and 22 have been separately formed in this manner, they are brought face to face, with the top face of the sheet 22, as shown in Fig. 3, brought against the under face of the sheet 19, as shown in Fig. 2. The sheets are then given a relative movement approximately parallel to their faces and the free ends of the tongues 23 are concomitantly passed through the slits 21 into the depressions 20 of the sheet 19.

Thus, we have now a composite sheet or member, as shown in Fig. 4, in which one metal is exposed on alternate portions or areas on one face of the composite sheet or member, and the other metal is exposed on the remaining alternate portions of the same face of the composite member, each metal on each face being in staggered relationship so that the composite member so produced thus has a checkered or basket weave appearance.

A binder, such as copper or silver solder, is applied as by spraying to the bottoms of the depressions 20 of sheet 19 and to the spaces between the tongues on the upper face of the sheet 22 previous to assembling the sheets.

A flux containing a high percentage of potassium fluoride is then applied to the binder coatings.

When the composite member has thus been treated in this manner, there will be a layer of binder and flux between all portions that are to be joined in the brazing process, which will be the abutting faces of the tongues 23 and depressions 20, on one face of the member, and the remaining staggered sections of the sheets at the other face of the member, and the other surfaces of the assembly or composite member will be free from binder.

The outer or exposed surfaces of the composite member are next coated with a resist material, such as talc, to prevent any molten binder from squeezing out and wetting or adhering to the outer surface of the composite member during the brazing operation. This composite member is then ready for brazing into a unitary structure. In the brazing operation, the composite member is preferably clamped between pressure plates and placed in an electric furnace containing a reducing atmosphere, such as hydrogen, and then heated to a temperature slightly above the melting point of the binder, after which the composite member is allowed to cool to room temperature or at least substantially below the melting point of the binder, while still under pressure in the reducing atmosphere. The pressure on the layers of metal during the brazing operation will squeeze out any excess binder and produce a smooth, level composite sheet or member.

As an alternative method of brazing, the assembly or composite sheet may be pressed between a pair of carbon blocks which are then heated to a white heat by electric resistance. After the binder becomes molten, the current is turned off and the composite member allowed to cool substantially below the melting point of the binder or to room temperature, while still under the pressure of the carbon blocks.

The pressure and heat used in either brazing process will depress all raised portions and produce a substantially flat, smooth, shoulderless composite sheet or stock, as shown in Fig. 4, except for the exaggeration of the layers of metal. After the brazing operation, the stock or composite sheet is cleaned, such as by a buffing or grinding operation, to remove excess binder, and then is cold rolled longitudinally to increase the toughness, strength and resilience of the stock. After the cold rolling operation, the stock is slit or cut longitudinally along the edges of the rows into a number of reversed bimetal strips A of the type shown in Fig. 1.

The copper and silver solder binders are those commonly used in the trade and are well known, and any suitable brazing flux may be employed. One very suitable for this purpose comprises approximately 60% of potassium fluoride, 30% of boric acid and 10% of potassium carbonate, the mixture being diluted with alcohol. It will be noted that the staggered or checkered relation of metals in the adjacent rows of the assembled member prevents excessive warping of the stock during the brazing and subsequent working or processing operations, particularly during temperature changes. It will also be understood that the various tongues and depressions may be preformed or recessed by suitable dies, previous to the brazing operation, which tends to make the brazing operation more positive and the finished member more uniformly level.

In all of the figures of the drawing, the thickness of the metal has been illustrated in exaggerated proportions, in order to illustrate the manner of assembly, but in order to make the matter entirely clear, it may be stated that the thickness of sheet metal most commonly employed is seldom more than .015 inch and usually about .012 inch, so that the deformation of the fixed sheets at the points 14 and 17 overrun is easily accomplished by the pressure on the sheets during the brazing operation.

Thermal elements cut to the form of Fig. 1, may be shaped to corrugated form, as indicated in Fig. 9, and when put to use, will expand or stretch lengthwise with a certain change in temperature adjacent the element and will shorten or contract lengthwise with an opposite change of temperature. Such an element, but formed by a different method, is shown in my Letters Patent No. 2,086,857, issued July 13, 1937, entitled Method of making bimetallic elements. In that patent, full explanation of the assembly and use of such elements is disclosed, and detailed explanation of such features is deemed unnecessary here.

In the embodiment of the invention in Figs. 5 and 6, I show a tubular member 30 formed in the novel manner of this invention, wherein high and low expansion sections are overlapped in shingle-like formation, as in Fig. 1. The member 30 may comprise strips or sections 31 of one metal having portions 32, 33 connected by offset parts 34, and strips of sections 35 of the other metal having portions 36 and 37 connected by offset parts 38. The diagram, Fig. 6, clearly shows the relative arrangement and disposition

of the sections 31 and 35. In this construction, the overrunning or overlapping of the sections is in a circumferential direction, with the lines of separation at the offset portions running lengthwise of the tube. Such a structure may also be formed from a sheet-like composite member, in which case the member is bent to tubular form and the abutting edges welded or otherwise secured, or the structure may be otherwise produced. This tubing is cut transversely into a plurality of ring type thermostats.

The member in Figs. 7 and 8 is likewise of tubular form, but in this case the high and low expansion metal sections 40 and 41 respectively are overlapped in the direction of the length of the tube. This member could also be formed from sheet stock, or it could be die-drawn from interfitted, tubular sections telescoped together, secured and brazed as in the manner of the first construction.

Tubular elements, such as shown in Fig. 7, can be formed into corrugated, finished tubular thermal units like that shown in Fig. 10, that being one formed from the structure of Fig. 7, wherein the low expansion metal sections 41 are preferably arranged at the outside or convex curved parts of the structure, while the high expansion metal sections 42 are disposed on the inner side or the concaved portions.

Still another unit, having some of the characteristics of the unit of Fig. 7, is shown in Fig. 11, but in this case the high and low expansion annular sections 45 and 46 are shown as being initially shorter than those in Fig. 7. However, the shingle-like manner of overlapping the parts is present in this form also, and this element, when die-drawn lengthwise to reduce its thickness, would approximate the form of Fig. 7.

It will be noted that by making the composite stock and thermal elements in the manner herein explained and illustrated, a decided saving of materials and time is effected over prior processes, and I have also eliminated the necessity of expensive equipment for the making of the stock. The pitch or distance from center to center of portions of the same metal on one face of the stock or element can readily be altered to meet various requirements, according to the present invention. The thickness of the stock produced may also be varied readily without expensive changes in equipment, and commercially rolled sheet metals, fabricated at the mills, may be used as the raw materials. Modifications may be easily made in the manner of making this improved composite stock whenever necessary for different purposes or uses, and mass production of this improved stock material is possible, with resulting relatively low cost.

It will be understood that various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art, within the principle and scope of the invention as expressed in the appended claims.

I claim as my invention:

1. A reversed, bimetal thermal element comprising a plurality of substantially similarly shaped sections of metals of two different rates of expansion arranged in progressively overlapping order along the element in the manner of overlapping shingles, with the sections formed of metal of one rate of expansion interposed alternately with the sections formed of the other metal, the sections being firmly joined on abutting faces, an intermediate portion of each section at the point of overlapping being offset and extending to opposite faces of the element so that the opposite faces of the element will be continuous, smooth and shoulderless.

2. A reversed bimetal thermal element comprising a plurality of substantially similarly shaped sections of alternating relatively high and low expansion metals disposed in overlapping order along the element, with each of the sections having substantially like portions exposed at opposite sides of the element and with each of these portions having its inner face joined to an inner face of a corresponding portion of a section of the other metal.

3. A reversed bimetal thermal element comprising a plurality of substantially similarly shaped sections of alternating relatively high and low expansion metals, certain of said sections having portions thereof exposed alternately in adjacent areas of said element with respect to like portions of the other sections and to which such portions are joined face to face, so that the metal of each area at one face of the element is a homogeneous extension of the metal of a next adjacent area which is exposed on the opposite face of the element.

4. A reversed, bimetal thermal element comprising a plurality of substantially similarly shaped sections of metals of two different rates of expansion arranged in progressively overlapping order along the element in the manner of overlapping shingles, each section having two oppositely extending plane portions connected by an offset portion forming a transverse shoulder at each side of the section the depth of which is equal to the thickness of said plane portions, some of said sections of metal of one rate of expansion being arranged alternately with the other sections of metal of a different rate of expansion, said plane portions of the sections of one metal being joined face to face with those of the other metal alternately at opposite sides of the element and with the ends of said oppositely extending plane portions abutting said shoulders at opposite sides of the sections, whereby said element will have opposite, smooth and continuous faces.

5. A reversed, bimetal thermal element comprising a plurality of substantially similarly shaped sections arranged in progressively overlapping order along the element, some of said sections being formed of metal of one rate of expansion and the other sections being formed of metal of a definitely higher rate of expansion than said other metal, said sections of one metal being interposed alternately with the sections of said other metal with the sections of the metal of high rate of expansion having portions extending along and exposed at opposite faces of said element and having integral parts extending through said element from one side to the other and connecting said exposed parts, whereby the sensitivity of the element is improved by the rapid transfer of heat from one side thereof to the other through said connecting parts of the metal of higher rate of expansion.

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