C. K. HARDING.

INVERTED INCANDESCENT MANTLE.

APPLICATION FILED DEC. 19, 1910.

993,334.

Patented May 23, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

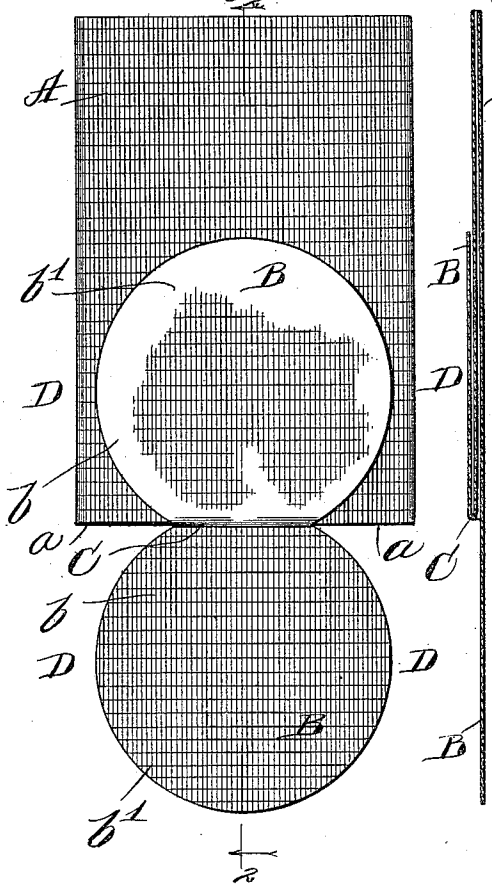


Fig. 2.

Fig. 3.

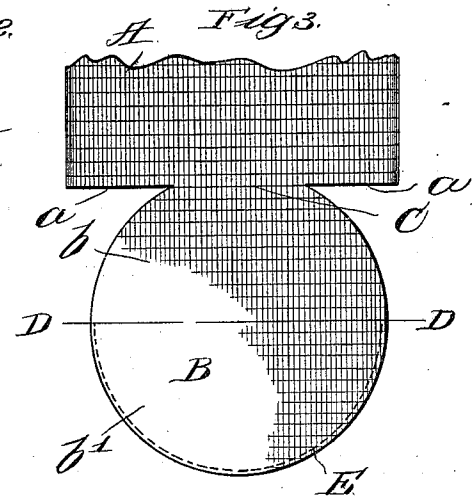


Fig. 4.

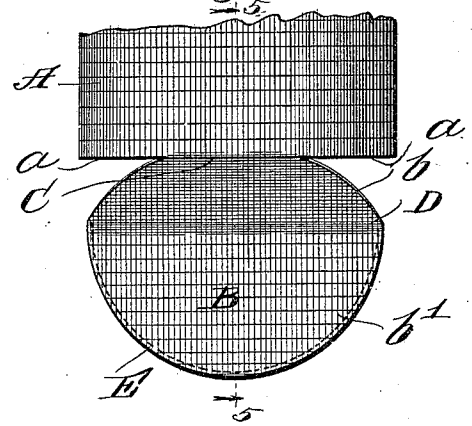


Fig. 5.

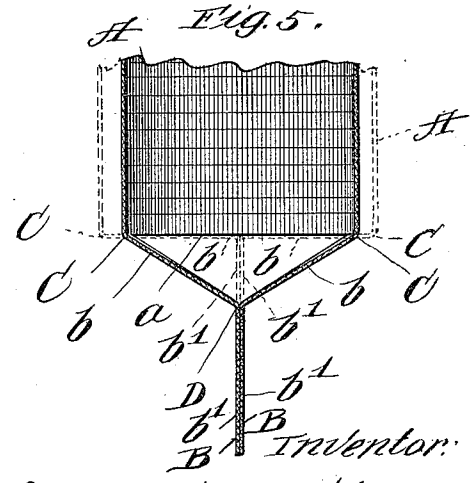
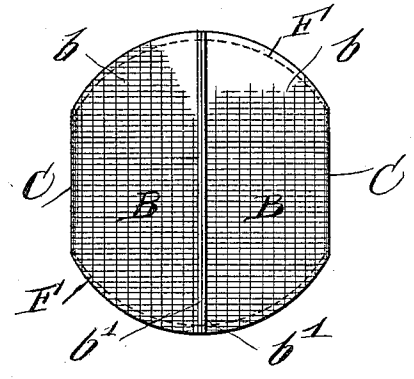


Fig. 6.



Witnesses:

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INVERTED INCANDESCENT MANTLE.

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993,334.

Patented May 23, 1911.

2 SHEETS—SHEET 2.

Fig. 7.

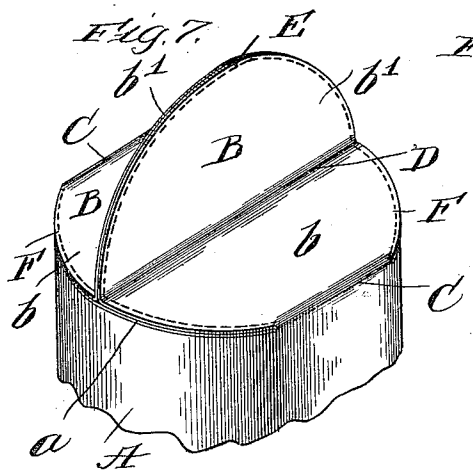


Fig. 8.

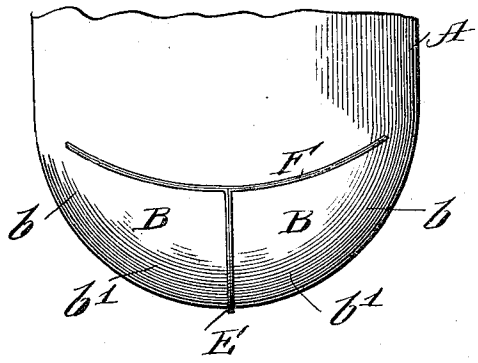


Fig. 9.

Fig. 12.

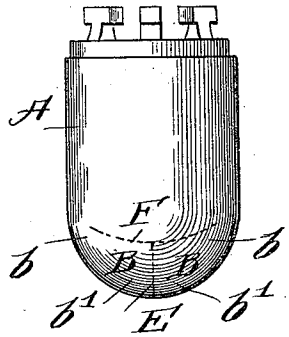
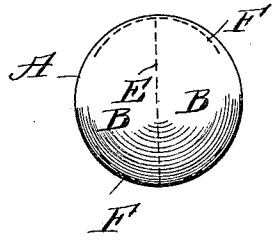


Fig. 13.



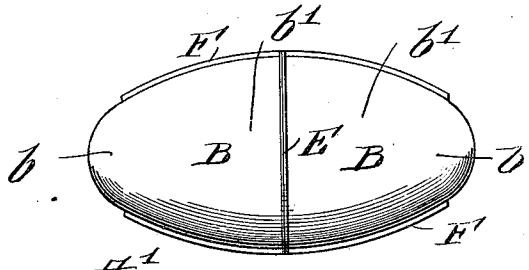


Fig. 10

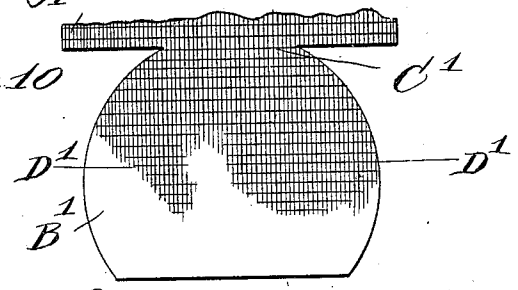
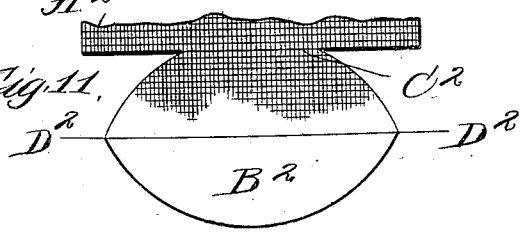


Fig. 11.



Witnesses:

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UNITED STATES PATENT OFFICE.

CHARLES KNOX HARDING, OF CHICAGO, ILLINOIS.

INVERTED INCANDESCENT MANTLE.

993,334. Specification of Letters Patent. Patented May 23, 1911.

Application filed December 19, 1910. Serial No. 598,241.

To all whom it may concern:

Be it known that I, CHARLES KNOX HARDING, a citizen of the United States, and a resident of Woodlawn, city of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Inverted Incandescent Mantles, of which the following is such a full, clear, and exact specification as will enable others skilled in the art or arts closely appertaining thereto to make and use the same.

This invention relates, generally, to incandescent structures for lighting made by what has been generally known as the Welsbach process, which consists of impregnating a knitted fabric of cotton or other fibrous cellulose with solutions of the refractory earths, which are to constitute the finished mantle. The dimensions of this impregnated fabric are usually from 100 to 200% greater than that of the finished product after the cellulose and other volatile matter is burned out, but this large structure is fashioned and formed to such a shape as will produce the desired form and size of the finished mantle after it has been shrunken. This invention takes advantage of the fact that the unequal shrinkage in the direction of the length and width of the knitted fabric enables a structure to be made therefrom of materially different shape from the shape that the finished mantle is to assume, and it is most desirable to shape the fabric mantle so that on burning out, it will, most naturally and easily, assume the more symmetrical shape desirable in the finished resulting structure when the combustible matter has been burned out without being subjected to unequal stresses and strains which would injure the finished structure.

My invention relates particularly to an improved construction of inverted mantles, having an upper cylindrical body portion and a semi-spherical closed lower end portion that possess advantages not attained by mantles manufactured prior to my invention.

Among the objects of my invention is to facilitate the production of inverted mantles of uniform and symmetrical shape which can be manufactured with the greatest economy of time, skill and labor without sacrificing any of the prerequisites necessary where the best results are required. To attain these ends and other useful results, I employ the features in the construction and arrangement and configuration of the several parts, which will appear hereinafter more fully described and claimed and shown in the accompanying drawing, which illustrates forms of mantles embodying my invention, in which—

Figure 1, shows a front elevation of a length of tubular fabric severed so as to form the mantle blank. Fig. 2, is a section of same on lines 2—2 of Fig. 1. Fig. 3, is a front view of a portion of same, showing the lower curved edges of the depending sections united by a seam running transversely across the lower segment shaped ends of the fabric. Fig. 4, is a view the same as Fig. 3 showing the projections folded on a line D—D with the upper tubular body portion A partially opened up. Fig. 5, is a section at right angles to Fig. 4, and shows the respective position of the parts as illustrated in Fig. 4, in the full lines, while in the dotted lines of Fig. 4, is indicated the position of the sides of the tubular portion when the fold line, D—D, is brought up to meet the lower end of the tubular body portion. Fig. 6, is a bottom plan view, showing the bottom in the position indicated by the dotted lines in Fig. 5, and having the remaining edges of the projections completely stitched by the curved seams to the unattached edges of the lower end of the body portion A. Fig. 7 is a perspective view of the bottom of same after the seams are sewed. Fig. 8. shows the lower end portion of my improved mantle after it is opened up. The upper tubular part of the fabric, which is to form the cylindrical body portion of the finished mantle, readily assumes an oval or elliptical form and the portion, which is to form the semi-spherical closed end portion of the finished mantle, readily assumes, when in the form of the sewn fabric, the form of the curved surface of the lower half of an ellipsoid; that is, a horizontally elongated rounded terminal end portion, having materially longer dimensions along a line extending across the center of the lower end of the mantle in one direction than the semi-circumference measured at right angles thereto across the center of the lower potrion. Fig. 9. shows a bottom view of the fabric mantle opened out as in Fig. 8, and illustrates the relative dimensions of the fabric projections B—B, each composed of the segments b and b' and the distribution of the fabric lengthwise and

crosswise in the elongated lower closed end of the mantle. Fig. 10. shows a slightly modified form of the depending double segment shaped section B—B. Fig. 11, illustrates a form of the double segment shaped sections which may be employed in cases where the threads of the knitted fabric are disposed more nearly uniformly lengthwise and crosswise of the fabric than is ordinarily the case with knitted fabrics as they come from the knitting machine, and when the sides of all the threads in the knitted structure are in contact with the sides of threads forming adjacent loops both endwise and crosswise of the fabric. Fig. 12. shows a side elevation of a finished burned out mantle attached to a carrying ring, and indicates one view of the portions formed by the depending projections B—B and illustrates the position the seams E and F assume in the finished mantle. Fig. 13. is a bottom view of the finished mantle, shown in Fig. 12, and shows the semispherical closed lower end portion formed by the union of the two double segment shaped projections B—B united to each other at their adjacent edges by the seam E, and having the unattached portion of their outer edges attached to the lower edge of the tubular body portion by the seams F.

Both upright and inverted incandescent mantles have generally been made from tubular knitted fabric, which has special properties which peculiarly fit it for the purpose. The typical mantle fabric is knitted on a circular machine having from 88 to 96 needles in its circumference, each needle forming a chain of loops lengthwise of the fabric so that the fabric has about 92 loops around a circumference of about 5″, and each loop is composed of a pair of threads extending lengthwise of each loop, and has about 11 chains of loops to the inch of length of the fabric, so that a square inch of fabric has more than three times as many threads running lengthwise as it has crosswise. This unequal distribution of the amount of threads materially facilitates the forming of cylindrical mantles, and gives them a preponderance of strength in an up and down direction, and in burning out the fabric the shrinkage is partly resisted by the force of gravity and partly by the pressure of the gas flame within the mantle, so that the mantle having the greatest strength and least resistance shrinks much more in a vertical direction than it does circumferentially. It has been demonstrated that a square section of knitted fabric, best adapted for upright mantles, and having the major portion of its threads running lengthwise of the fabric, when burned off and subjected to a uniform gas pressure, would produce a rectangular section in the resulting burned out structure, having dimensions at least 50% greater along the lines of least resistance.

Most of the inverted mantles in practical use have been made from a section of tubular knitted fabric, the lower end being formed by gathering the lower edge of the tube and drawing it to the center. This resulted in a thickening or bunching of the goods at and around the center of the lower portion of the mantle, which was objectionable. To obviate this, especially for larger and heavier mantles made of coarser thread, goring has been employed; that is, from two to six curved seams have been sewn through two adjacent layers of fabric from a point above the bottom where the diameter was to be retained to a point in the central axis at the bottom. These gores permit a quantity of stock to be cut out, but the seams, themselves, interfere with the incandescence at the central point, which is the most abundantly supplied with gas from its favorable location to the center of the flame. As a greater number of these gores are employed, the shape of the sewn fabric as well as the shape of the resulting mantle after burning off, becomes progressively more symmetrical, but the seams running to the center of the lower portion of the mantle are objectionable, and the more seams employed, the more objectionable they become, so that in many self-shaping mantles, commonly called fabric mantles, put on the market, the symmetry is often sacrificed by decreasing the number of gores.

Prior to my invention it was customary to cut and form the mantle fabric to closely approximate the shape of the finished burned out mantle, and to dispose the fabric, which was to form the closed end portion, symmetrically, around the central axis at the end. According to my invention, I cut and sew the fabric without regard to securing a symmetrical hemispherical closed end where a knitted fabric is employed for the fabric mantle, and secure additional advantages as well as perfect symmetry in the finished product.

Where inverted mantles were made from a length of tubular fabric, the gores were cut out mostly at a point adjacent to the center of the closed lower end of the mantle, the object being to reduce the quantity of goods in the circumference of the lower end of the tube so that the edges of the gores could be drawn together, and the curved sections, between them, form a dome shaped, closed, lower end, these sections being formed the same size, shape, length and width, and identically disposed in relation to the percentage of threads running lengthwise and crosswise of each section, it is obvious that, as each section has the same number of threads disposed lengthwise, and that each one of all of the sections extend the same

length; from the lower end of the cylindrical body portion to the center of the round and lower end. The shrinkage will have a uniform effect on each of the sections, and if there are any large number of sections, the lower semi-circumference of the unburned fabric mantle would be nearly equal, measured at any angle across the center of the dome shaped lower end, while the finished mantle would also have a similar dome shaped closed end, and its symmetry would depend largely upon the number of sections and the corresponding equal number of seams radiating from the lower central axis of the mantle.

According to my present invention, I cut out a major portion of the stock for the gores at a point in the fabric at some distance above and away from the center of the lower end, and surrounding two points on diametrically opposite sides of the mantle, at the lower end of the cylindrical body portion. I cut and sew the sections that are to form the closed end in the fabric mantle so as to form an elongated, rounded, terminal closed lower end portion having considerably longer horizontal dimensions in one direction than it has in the other at right angles thereto, but so arranged that the maximum shrinkage of all the sections is combined to act in one direction; that is, the direction of the greatest length of the horizontally elongated bottom portion, and in the direction in which the major portion of the threads of the mantle fabric extend, and in the direction in which the shrinkage is normally 50 or 60% greater than it is in a direction at right angles thereto, and so arranged that the minimum shrinkage acts on and in the direction of the length of each individual section at right angles to the longest dimension, of the elongated lowered closed end of the mantle, whereby a semi-spherical shape closed end portion is produced in the finished burned out mantle without having a symmetrical hemispherical body portion in the unburned fabric mantle with the attendant disadvantages of having all of the gores cut out from points close to the center of the bottom portion of the mantle, and all of the seams radiating from the same point in the center of this most useful portion of an inverted incandescent mantle. As illustrated in the drawings, I have retained the full length of the fabric in and up and down direction, extending around the closed end of the mantle in one direction, in which the greatest shrinkage takes place, and cut out most of the gores surrounding two points at the ends of a semi-circumference extending at right angles from the center of said line of maximum shrinkage in the direction where the shrinkage is the least.

In a preferred embodiment of my invention, I employ a piece of tubular netted fabric of the ordinary or typical construction, as illustrated in Fig. 1, severed on a curved line to the points C—C, where the bottom of a tubular body portion is to terminate, leaving the two double segment shaped projections, B—B of a single thickness of mantle fabric, depending from opposite sides of the tubular body portion. In many cases, according to the disposition of the thread lengthwise and crosswise of the fabric, these depending projections, B, may be of approximately circular form as they run or extend in the direction in which the most of the threads are disposed, and in which the most of the shrinkage takes place.

The length of an incandescent structure produced from burning out impregnated knitted fabric, is commonly about 50% of the length of such a structure before the combustible elements were removed, and two, approximately, circular sections of fabric united together, would have a length sufficient to produce a burned out structure, whose length was approximately the diameter of one of said circles. In any case, however, the length of the two depending projections, which are to form the elongated closed end of the knitted fabric mantle, will be very materially greater than the width of said elongated closed end portion, and will preferably be made up of double segment shaped projections approximating more or less closely to a circle, the variation being somewhat dependent upon the percentage of shrinkage in the fabric in the two directions. The depending projections, B, as illustrated in the drawings, are divided by the fold line, D—D, into the two segment shaped sections, *b*—*b'*. The two lower edges of the sections *b'* and *b'* are shown in Fig. 3, as being united by a seam running across their lower edges from D to D. In the next operation the projections are each folded along a line from D to D, and along a fold line from C to C; the tubular body A is opened up, and the segments *b* and *b* are spread apart at their tops as shown in Fig. 4 and Fig. 5. The dotted lines in Fig. 5 show the position the sides of the tube and the segments *b*—*b* will occupy when fully rounded out, and the fold line, D—D, brought up to the bottom of the tubular body portion A. This will bring the parts into the position shown in Fig. 6, and the curved seams, F—F, may be sewn around and united to the curved edges of *b* and *b*, with the lower edges of the tubular body portion A. The fabric may be placed over a cylindrical form, and the projecting edges of the tube and end sections revolved under a suitable sewing machine, and thus united in an expeditious manner.

In the art of knitting a fabric is produced by forming a row of loops with a single

thread through which loops another row of loops are linked, and so on consecutively. The rows of loops crosswise of the fabric are properly referred to as rows of loops, and the series of loops endwise of the fabric are called chains of loops. In knitted mantle fabric the length of each loop is greater lengthwise of the fabric, and the width of each loop is less crosswise. As each loop has two sides and one end formed from a short piece of thread, and its other end formed by the end of an adjacent loop, the shrinkage in the length of the thread in burning out, acts to reduce the length of the loops more than it does their width, and as there are many more loops to the inch of fabric measured crosswise than lengthwise, it results that the fabric has many more threads disposed lengthwise than it has crosswise of the fabric.

As heretofore mentioned, the superficial area of a given surface of impregnated mantle fabric, best suited for the manufacturing of incandescent mantles, would be about 150% larger than the superficial area of the desired structure remaining after the combustible and volatile mantle has been burned out, but it is clearly pointed out that the shrinkage is very materially different in the length and width of knitted fabric or in the direction in which the most or the least of the threads are disposed, especially if the most desirable form of knitted fabric is chosen to produce the strongest and most desirable finished incandescent mantle. The area of a section of impregnated mantle fabric would be represented by its length multiplied by its width, and the area and shape of the structure resulting from burning out the same, would be represented and calculated by multiplying, approximately, 80% of its width by 50% of its length. The increased amount of shrinkage in the direction of its length of tubular knitted fabric does not interfere with the symmetry of the cylindrical body portions of inverted mantles, as this increased shrinkage takes place on all sides of a cylindrical body which are of equal length, but I have discovered that the best results from inverted mantles are produced by making the fabric portion, which is ultimately to form the bottom of a distinctly different shape, having widely different dimensions in length and width, by which means I have been able to produce a perfectly hemispherical symmetrical lower end portion of a finished mantle without producing stresses and strains and unequal stretching and distorting of its mineral filaments which constitute the finished mantle.

The manufacture of inverted mantles by the process of goring, the use of seams for uniting adjacent edges of the sections of fabric often introduces some difficulty and disadvantage in the subsequent manipulation in forming and finishing the mantle. The shrinkage along the line of the seam being less than that of the normal fabric, reduces the stretching effect on the fabric adjacent to the seams.

In manufacturing my improved mantle, I cut out and sew the parts for the closed bottom portion from the two depending projections from the tubular fabric of the body portion and of exactly such an area as will produce a proper shape in the finished mantle without regard to a symmetrical shape in the fabric except that if it is almost twice as long in one of its horizontal dimensions as it is in the other, it tends to promote the simplicity and accuracy of manufacture, because it will permit the seams to take the shape of arcs of the circle, where the curved edges of the segments are united to each other, and, also, where the curved edges of the segments are united to the lower edge of the cylindrical body portion; but it must comprise a fixed area which I have found approximately equal to the area of two circles, the diameter of the tubular fabric combined or integrated side by side endwise of the chains of loops of the knitting, the area of two circles so combined would be the area of an ellipse having the minor axis, the diameter of one of the circles, and a major axis equal to diameter of the two circles. The two double segment shaped projections tend to integrate themselves into an elliptical rounded form having the correct area and relation to each other, and tend, when opened out, to produce a horizontally elongated closed end portion of approximately a semi-ellipsoidal form, which has its threads disposed in such a manner that when the shrinkage takes place in the different directions it results in producing a symmetrical semi-spherical closed lower end in the finished mantle.

The oblong or elliptical rounded form of the lower end portion of the fabric mantle, may be referred to as being of a semi-ellipsoidal shape or form or corresponding closely to the curved surface of about one-half of the surface of an ellipsoid, and the relative dimension of the fabric, on the length and width, would be approximately proportionate to the difference between the major and minor axis of such an ellipsoid. I do not wish to confine my invention to any precise percentage of difference in the dimensions, as the major axis of the semi-ellipsoidal lower end of a fabric mantle may be as little as 12½ to 25% greater than the minor, and with some kinds of thread and chemicals the major axis should be more than 100% greater than the minor.

While I have described the peculiar properties of knitted fabrics in order to enable the details of my improvement to be understood, I do not wish it to be understood that

the invention is confined to details, as I regard this invention as specifically embodying a part of my generic inventions in gored bottom inverted mantles. Prior to my invention, as hereinbefore mentioned, gores were cut out mostly from a point adjacent to the central axis of the closed lower end of the mantle and a quantity of goods removed from the circumference of the lower end of the tube, if less than four gores and four corresponding seams radiating from the center were employed enough area of fabric was not removed nor the remaining sections left symmetrically disposed to produce the most desirable shape in the finished mantle. In my United States Patent No. 982,958, I described a form of construction in which four gores were cut out from the corners of a rectangular fabric leaving an oval portion, the edge of which is directly attached to the lower end of a tubular fabric having the gores and seams entirely away from the central axis. My United States Patent No. 960,638 illustrates a construction in which eight gores or triangular sections are cut out from knitted fabric mostly adjacent to two points on diametrically opposite sides of the lower end of the tubular portion of the mantle and the two seams leading to said points serve to unite the edges of three sections and thus produce an effect equal in symmetry to six sections radiating from one central point as in the prior art. In the present invention eight substantially triangular sections or gores as in Fig. 11 are cut out from the opposite sides of the lower end of the tube leaving the two depending sections of suitable size and shape and area so that when their adjacent free edges are united to each other and the remaining free edges united to the free lower edges of the tube produced by cutting out the upper gores the end of the mantle will be completely closed and the proper amount of fabric removed at points sufficiently distributed, mostly away from the lower central axis of the mantle. The seams uniting the edges of the upper gores will extend transversely of the direction of the lower cross seam and at a point sufficiently above and away from the central lower portion of the mantle, it is obvious to one skilled in the art that one of the depending sections may be cut longer than the other, and if a double length of tube sufficient for two mantles were severed on a zigzag line, the longer projections would extend past each other and economize stock, and the cross seam could be located at one side of and away from the axial plane of the tubular body portion. The two double segment shaped sections which form the closed lower end portions of the mantle may be cut from only one projection extending from one side of the tubular fabric and the two adjacent edges of the sections left attached to or not cut apart from each other, so that the cross seam would not extend to the central axis, and one of the side seams would be carried on around the curved free edge of the end section and unite it with the free lower edge of the body portion. With the modern mechanical methods of manufacturing, the employment of curved seams for uniting circular and cylindrical parts of mantles is desirable and convenient.

Because of the elasticity and flexibility of knitted fabric, it can be formed or forced into a shape desired even when it is cut and sewed in a very unsuitable manner as to shape, form, sectional area or proper configuration of the various parts. But I have found that a properly constructed mantle will last many months longer in actual use when constructed in such a way that the combustible matter could be burned out and the ashed partly fusible nitrids converted into refractory oxids without being subjected to stresses and strain which would injure the finished structure.

It is well understood that with any structure having a cylindrical body and a hemispherical end, the superficial area of the end would be twice that of a circle having the diameter of the sphere, and if the circumferential shrinkage of the tubular part of an inverted mantle is equal to the vertical, about 1% of the rectangular edge of the tube would have to be cut out in the gores, but with knitted fabric nearly 50% should be removed. With an ellipse the four gores are equal to the area of the eight gores where two substantially circular sections are formed. It might be thought that one semi-circular seam sewn across the end of the tube would produce a satisfactory mantle but the applicant, has found such not to be the case, as the seam is about 50% too long, but when four additional gores are cut out and sewed up with curved seams at the ends of said cross seam, a mantle is produced having the proper amount of stock removed corresponding to the amount cut out where four gores or eight triangular pieces were cut out all from the lower end of the mantle and their edges united by four seams radiating from the lower central axis as was the best practice prior to my invention.

Having now described my invention and illustrated one method by which it may be carried out, what I claim is:

1. An inverted mantle, having a tubular open topped body portion, and a hemispherical shaped closed end formed of two double segment shaped sections of knitted fabric, seamed to each other, and to the lower edge of said body portion.

2. An incandescent mantle, constructed from tubular knitted fabric, having a cylindrical open topped body portion, and a

hemispherical shaped closed lower end portion formed of two double-segment shaped end sections of said knitted fabric, having their edges united to each other, and to the lower edge of said cylindrical body portion.

3. An incandescent-structure, having a cylindrical open topped body portion, formed from tubular fabric, and a hemispherical shaped closed lower end portion formed of two double-segment shaped sections each of a single thickness of said fabric, said sections having their adjacent edges united to each other, and their outer edges united to the lower edge of said body portion.

4. An inverted mantle having an open topped cylindrical body portion and a hemispherical shaped closed lower end portion consisting of two sections, each of the general form of a quarter of a sphere having their adjacent edges attached to each other and their outer edges attached to the lower edge of said body portion.

5. An inverted mantle having an open topped cylindrical body portion and a hemispherical shaped closed lower end composed principally of two sections each of the general form of a double segment having their adjacent edges united to each other and their outer edges united to the lower edge of said body portion, said sections being of such dimensions that the combined width of the two sections approximately equals the length of the united adjacent edges of the two sections.

6. An inverted fabric mantle consisting of an open topped body portion formed from a tube of knitted fabric said mantle having a horizontally elongated rounded closed lower end portion formed by uniting the edges of two double segment shaped sections of mantle fabric to each other and to the lower edge of said tubular body portion.

7. An improved article of manufacture, a fabric mantle consisting of an open topped body portion formed from a tube of knitted fabric having the major portion of its threads disposed lengthwise of the tube, said mantle having an approximately semi-ellipsoidal shaped closed lower end portion formed from two approximately double segment shaped sections cut from a single thickness of knitted fabric having the major portion of the threads of its fabric disposed in the direction of the major axis of the ellipsodial closed lower end; whereby a semi-spherical shaped closed end is produced in the finished mantle after the combustible part of the fabric has been burned out and the refractory mineral is shrunken into condition for use.

8. An incandescent fabric mantle having an open topped body portion constructed from a tubular knitted fabric said body portion having two double segment shaped sections of said knitted fabric depending from its lower end, said mantle having a horizontally elongated semi-ellipsoidal shaped closed lower end portion formed from said two double segment shaped sections by uniting their edges to each other and to the lower edge of said body portion.

9. An incandescent fabric mantle formed from knitted fabric having a tubular body portion and a semi-ellipsoidal shaped closed lower end portion formed by uniting the edges of two double segment shaped sections of said knitted fabric to each other and to the lower edge of said body portion, each one of said double segment shaped sections having a length of about the minor semi-circumference of said semi-ellipsoidal closed end, and each of said two sections having a width such that the combined width of the two sections will equal the semi-circumference of the semi-ellipsoidal closed end portion in the direction of the major axis of said elongated closed end.

In witness, whereof I have hereunto set my hand this 19th day of December, 1910, in the presence of two witnesses.

CHARLES KNOX HARDING.

Witnesses:

C. T. JOHNSON,

AMELIA M. SCHERTZER.