PATENT SPECIFICATION

Application Date: March 23, 1938. No. 8903/38. **512,257**

Complete Specification Left: Jan. 18, 1939.

Complete Specification Accepted: Aug. 31, 1939.

PROVISIONAL SPECIFICATION

Improvements in Gas-tight Seals wherein Electric Conductors pass through Quartz and like Vitreous Material

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and KARL GUSTAV SCHNETZLER, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a German citizen, do hereby declare the nature of this invention to be as follows:—

This invention relates to gas-tight seals wherein electric conductors pass through quartz or like vitreous material; the term "like" means having a coefficient of thermal expansion much less than that of the conductor.

The well-known strip seal, made by collapsing a quartz tube onto a sufficiently thin metal strip, is highly satisfactory so long as the conductor has to carry a current no greater than one or two amperes. But if currents of ten or more amperes have to be carried, either an inconveniently wide single strip has to be used or a plurality of narrow strips have to be combined into a multiple seal. The object of this invention is to provide strip seals in which, though the strip is conveniently narrow (say not more than 10 mm. wide), it will carry much larger currents than can be carried by known single strip seals in which the strip is also conveniently narrow.

According to the invention in a strip seal conductors are connected to the strip so that, when the strip is carrying current, the stream lines are highly inclined to the length of the strip. The thickness of the strip is the narrowest dimension. The width is then the least dimension of the strip perpendicular to its thickness; the length is the greatest dimension perpendicular to its thickness.

The invention will now be explained further with reference to Figures 1, 2, 3 of the accompanying drawings, each of which shows, by way of example, one embodiment of the invention.

In each figure, 1 is a strip of molybdenum about 0.15 mm. thick; 2, 3 are the said conductors welded to it being also of molybdenum, 4 is the quartz into which the strip is sealed in the usual manner. In all cases the conductors have, as usual, a cross section much greater than the cross section of the strip containing its width and thickness.

In Figure 1 the strip is 6 mm. wide and 12 mm. long. The conductors 2, 3, entering the seal from opposite ends, are each wires 0.7 mm. in diameter; they are welded along the opposite edges of opposite sides of the strip; preferably each extends near to, but not quite to the end of the strip opposite that at which it enters. The quartz will adhere to both sides of the strip between the conductors and will thus form a barrier between them, so that the seal is air-tight. The stream-lines are roughly along the shortest lines between the conductors 2, 3; they are nearly parallel to the width of the strip and highly inclined to its length.

In Figure 2 the dimensions of the strip and conductors are the same as in Figure 1. But the conductor 2 is forked, the two limbs of the fork being welded to opposite edges of the same side of the strip; the conductor 3 is welded along the middle of the opposite side. The stream lines are again nearly parallel to the width of the strip.

In both these examples the object of the invention is obtained because the area of the cross section of the strip perpendicular to the stream lines is nearly the product of the length and the thickness, instead of (as is usual) the product of the width and the thickness. Since the cross section is greater; the current density is less, and therefore the rise of temperature, liable to crack the seal or destroy the weld, is less.

In Figure 3, there is shown at (a) a plan viewed along the thickness of the seal, at (b) a section by a plane perpendicular to the plan (a). Here the conductors 2, 3, of the same dimensions as before, lie along the centre of the strip on opposite sides of it, overlapping where they meet; they are welded to the strip along this overlapping portion, but preferably not elsewhere. The stream lines now pass along the thickness of the strip; the area

[Price ...]

PRICE 2/-

of the cross section perpendicular to the stream lines is the area of the welded portion and is independent of the thickness of the strip.

The invention is not limited to narrow strips or single seals. The advantages obtained, relative to known methods, are independent of the width of the strip or the multiplicity of the seal. But of course the advantages are greatest when narrow strips and single seals are adopted for ease of construction.

Dated the 23rd day of March, 1938.
~~For the Applicants,~~
NORMAN R. CAMPBELL,
For the Applicants.

COMPLETE SPECIFICATION

Improvements in Gas-tight Seals wherein Electric Conductors pass through Quartz and like Vitreous Material

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and KARL GUSTAV SCHNETZLER, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a German citizen, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to strip seals, that is to say, seals for passing current through the wall of a vitreous vessel of the type wherein a strip of metal, not much more (and usually less) than 0.02 mm. thick, to which relatively stout conductors projecting from each end of the seal are attached, is embedded in, and makes a gas-tight junction with, vitreous material, whose thermal expansion is much less than that of the metal, by collapsing a tube of the vitreous material onto the strip. The term "length of the strip" will hereinafter be used to denote that dimension of the strip which is parallel to the axis of the tube that was collapsed onto it.

Hitherto the said stout conductors have usually been attached to the ends of the strip, so that, when current is passing from one conductor to the other, the stream lines in the strip are approximately parallel to the length of the strip. Stream lines mean, as usual, lines whose tangents are everywhere parallel to the direction of the current at the points of the lines at which they are drawn.

According to the invention the said stout conductors are attached to the strip along lines extending along a considerable part of the length of the strip so that, when current is passing from one conductor to another, the stream lines in the strip are approximately perpendicular (at least over most of their length) to the length of the strip.

The advantages attending the invention are likely to be greatest when the strip is flat and the seal is made in the most usual manner, namely by collapsing opposite walls of the tube onto opposite sides of the strip. For then there is an upper limit to the internal diameter of the tube that can be conveniently collapsed; this limit is in the neighbourhood of 10 mm. (The tube before collapse is usually flattened; the limit then applies to the maximum diameter.) Accordingly the width of the strip (i.e. its dimension perpendicular to its length) cannot be conveniently more than this limit; on the other hand there is no such limit to the length of the strip, which can be, and conveniently is, greater than the width. The current that the strip will carry is limited by the area of its cross-section perpendicular to the stream lines; in the usual arrangement, this area is the product of the width and the thickness of the strip; in the arrangement according to the invention, it is more nearly the product of the length and the thickness and can therefore be greater. Consequently the current that can be carried by a seal made by collapsing a tube of given diameter is greater; single seals can be used to carry currents of (say) 20 amp., where, in the usual arrangements, no more than 10 amp. could be carried.

The invention will be further explained with reference to Figures 1 and 2 of the drawing accompanying the provisional specification, each of which shows, by way of example, one embodiment of the invention.

In each figure, 1 is a strip of molybdenum 0.015 mm. thick, 8 mm. wide and 15 mm. long. 2, 3 are molybdenum wires, 0.8 mm. in diameter, being the said stout conductors, whose cross-section is (as usual) substantially greater than the cross-section of the strip perpendicular to the stream lines. 4 is quartz in which the strip has been embedded by collapsing a tube slightly wider than the strip onto the strip.

In Figure 1, the conductors 2, 3, entering the seal from opposite ends, are attached to the strip (in a manner

described more fully hereinafter) along the opposite edges of opposite sides of the strips; each conductor extends nearly, but not quite, to the end of the strip opposite to that at which it enters. The quartz will adhere to both sides of the strip between the conductors, and thus form an air-tight barrier between them. The stream lines are roughly the shortest lines between the conductors 2, 3; they are thus nearly perpendicular to the length of the strip.

In Figure 2, the conductor 2 is forked, the two limbs of the fork being attached to opposite edges of the same side of the strip; the conductor 3 is welded along the middle of the opposite side. The stream lines are again roughly the shortest lines between the conductors.

But the invention may be useful also when the strip is not flat and when its width is not necessarily less than the bore of the collapsed tube. Thus, it has been proposed, in Patent Specification No. 489,630, to make a multiple seal by arranging several strips in the cylindrical space between a vitreous core and a vitreous tube, and collapsing the tube onto the seals and core. It is obvious that each of these strips might have the stout conductors attached to it according to the invention, for example as just described with reference to the said Figures 1 and 2; the advantage would still be obtained that each strip would carry more current than if, as proposed in the said specification, the conductors were attached at the ends.

But an obvious development of this plan, illustrated in Figures 4 and 5 of the accompanying drawing, which show, by way of example, another embodiment of the invention, leads to a single seal equivalent to such a multiple seal. The original form of the strip is shown in Figure 4. 1 is again the strip. 2 are a plurality of wires, entering the strip from one end and attached to it along a considerable part of its length; 3 are a plurality of similar conductors entering from the other end and intercolated between the conductors 2. The strip is now wrapped round a vitreous cylindrical core 5, whose circumference is slightly longer than the width *a* of the strip, so that its edges do not quite touch. A vitreous tube 4 is then collapsed onto the core and strip so that a seal is formed whose cross-section is shown in Figure 5. The conductors 2 are all connected in parallel, and so are all the conductors 3. In this arrangement the advantage of the invention is obtained, although the width of the strip is greater than its length, because many paths though different parts of the strip are connected in parallel.

In all seals according to the invention, the dimension of the conductors, particularly in the direction parallel to the thickness of the strip, must not exceed some limit; for otherwise the seal will be liable to crack. The conductors may therefore be strips whose larger dimension is parallel to the surface of the strip. In the embodiment described with reference to Figures 4 and 5, these strips can conveniently be curved so as to follow the circumference of the circle on which the conductors lie in Figure 5.

Again, in all seals according to the invention it is desirable that the conductors should be in good electrical contact with the strip along the whole of their extension along it. Such contact can be secured by spot-welding at a sufficient number of places. But, at least if the strip and the conductors are of molybdenum, electrical union can be promoted by nickel-plating the conductors before they are attached to the strip, where (but not necessarily only where) they are to be so attached; the nickel acts as a solder and secures contact all along the join, even if the welding is done at only a few places. The nickel has the further advantage that it prevents quartz from sticking to the conductors; it should therefore extend over every part of them that comes into contact with the fused vitreous material. The nickel coating must not be so thick that excess nickel can eat away the strip.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A strip seal of the type specified wherein the said stout conductors are attached to the strip along lines extending along a considerable part of the length of the strip so that, when current is passing through one conductor to another, the stream lines in the strip are approximately perpendicular (at least over most of their length) to the length of the strip.

2. A strip seal according to Claim 1 wherein the said conductors are connected one along each of the opposite edges of opposite sides of the strip.

3. A strip seal substantially as hereinbefore described with reference to Figure 1 of the drawing accompanying the provisional specification.

4. A strip seal according to Claim 1 wherein one of the conductors is forked, its limbs being connected one along each of the opposite edges of the same side of

described more fully hereinafter) along the opposite edges of opposite sides of the strips; each conductor extends nearly, but not quite, to the end of the strip opposite to that at which it enters. The quartz will adhere to both sides of the strip between the conductors, and thus form an air-tight barrier between them. The stream lines are roughly the shortest lines between the conductors 2, 3; they are thus nearly perpendicular to the length of the strip.

In Figure 2, the conductor 2 is forked, the two limbs of the fork being attached to opposite edges of the same side of the strip; the conductor 3 is welded along the middle of the opposite side. The stream lines are again roughly the shortest lines between the conductors.

But the invention may be useful also when the strip is not flat and when its width is not necessarily less than the bore of the collapsed tube. Thus, it has been proposed, in Patent Specification No. 489,630, to make a multiple seal by arranging several strips in the cylindrical space between a vitreous core and a vitreous tube, and collapsing the tube onto the seals and core. It is obvious that each of these strips might have the stout conductors attached to it according to the invention, for example as just described with reference to the said Figures 1 and 2; the advantage would still be obtained that each strip would carry more current than if, as proposed in the said specification, the conductors were attached at the ends.

But an obvious development of this plan, illustrated in Figures 4 and 5 of the accompanying drawing, which show, by way of example, another embodiment of the invention, leads to a single seal equivalent to such a multiple seal. The original form of the strip is shown in Figure 4. 1 is again the strip. 2 are a plurality of wires, entering the strip from one end and attached to it along a considerable part of its length; 3 are a plurality of similar conductors entering from the other end and intercolated between the conductors 2. The strip is now wrapped round a vitreous cylindrical core 5, whose circumference is slightly longer than the width *a* of the strip, so that its edges do not quite touch. A vitreous tube 4 is then collapsed onto the core and strip so that a seal is formed whose cross-section is shown in Figure 5. The conductors 2 are all connected in parallel, and so are all the conductors 3. In this arrangement the advantage of the invention is obtained, although the width of the strip is greater than its length, because many paths though different parts of the strip are connected in parallel.

In all seals according to the invention, the dimension of the conductors, particularly in the direction parallel to the thickness of the strip, must not exceed some limit; for otherwise the seal will be liable to crack. The conductors may therefore be strips whose larger dimension is parallel to the surface of the strip. In the embodiment described with reference to Figures 4 and 5, these strips can conveniently be curved so as to follow the circumference of the circle on which the conductors lie in Figure 5.

Again, in all seals according to the invention it is desirable that the conductors should be in good electrical contact with the strip along the whole of their extension along it. Such contact can be secured by spot-welding at a sufficient number of places. But, at least if the strip and the conductors are of molybdenum, electrical union can be promoted by nickel-plating the conductors before they are attached to the strip, where (but not necessarily only where) they are to be so attached; the nickel acts as a solder and secures contact all along the join, even if the welding is done at only a few places. The nickel has the further advantage that it prevents quartz from sticking to the conductors; it should therefore extend over every part of them that comes into contact with the fused vitreous material. The nickel coating must not be so thick that excess nickel can eat away the strip.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A strip seal of the type specified wherein the said stout conductors are attached to the strip along lines extending along a considerable part of the length of the strip so that, when current is passing through one conductor to another, the stream lines in the strip are approximately perpendicular (at least over most of their length) to the length of the strip.

2. A strip seal according to Claim 1 wherein the said conductors are connected one along each of the opposite edges of opposite sides of the strip.

3. A strip seal substantially as hereinbefore described with reference to Figure 1 of the drawing accompanying the provisional specification.

4. A strip seal according to Claim 1 wherein one of the conductors is forked, its limbs being connected one along each of the opposite edges of the same side of

* C L M S *

the strip and the other conductor is connected along the middle of the opposite side.

5. A strip seal substantially as hereinbefore described with reference to Figure 2 of the drawing accompanying the provisional specification.

6. A strip seal according to Claim 1 wherein the said strip extends nearly the whole way round the circumference of a vitreous core onto which an outer tube is collapsed and wherein a plurality of said conductors enters the seal from each end, the conductors of one said plurality being attached to the strip between the conductors of the other said plurality.

7. A strip seal substantially as hereinbefore described with reference to the accompanying drawing (Figures 4 and 5).

8. The method of manufacturing a strip seal according to any preceding claim wherein the said strip is and the said conductors are of molybdenum and the said conductors are nickel-plated where, but not necessarily only where, they are to be attached to the strip before they are so attached.

Dated the 18th day of January, 1939.
NORMAN R. CAMPBELL,
For the Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1939.

* C L M S *