July 29, 1930. A. E. PENFOLD 1,771,861

TENNIS BALL AND THE LIKE AND THE MANUFACTURE THEREOF

Filed Dec. 6, 1924 2 Sheets-Sheet 1

Fig. 1.



Fig. 2.

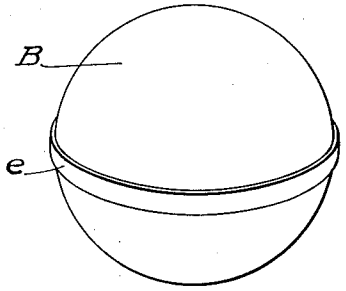


Fig. 7.

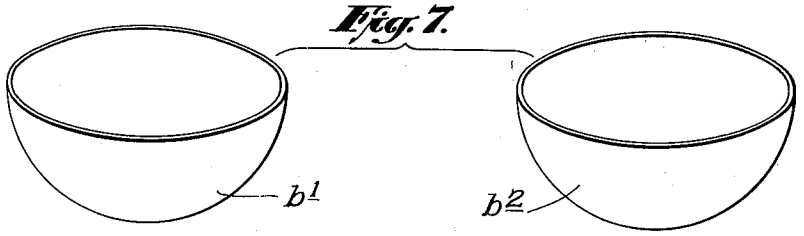
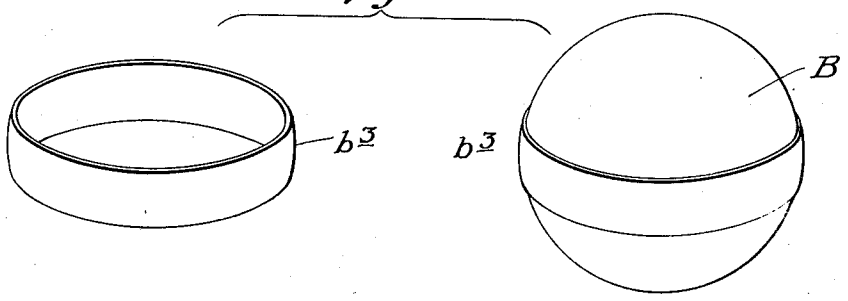


Fig. 8.



Inventor
ALBERT ERNEST PENFOLD
By his Attorney.
A. D. Anthony Usina

July 29, 1930. A. E. PENFOLD 1,771,861

TENNIS BALL AND THE LIKE AND THE MANUFACTURE THEREOF

Filed Dec. 6, 1924 2 Sheets-Sheet 2

Fig. 5.

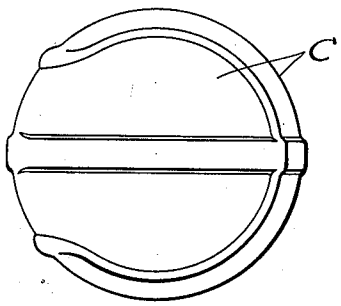


Fig. 4.

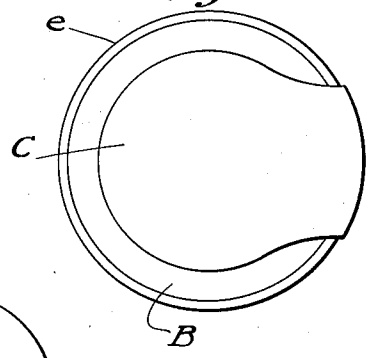


Fig. 3.

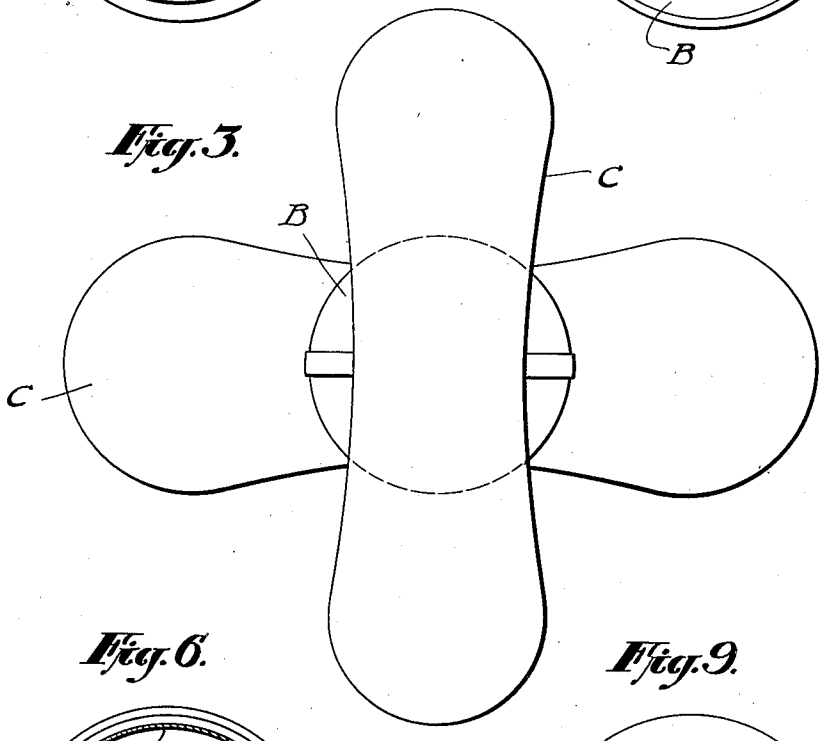


Fig. 6.

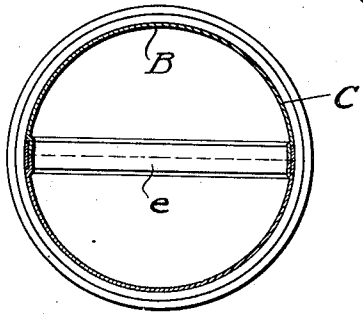
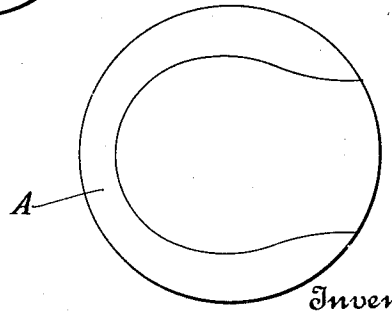


Fig. 9.



Inventor
ALBERT ERNEST PENFOLD
By his Attorney
W. Anthony Usina

Patented July 29, 1930 1,771,861

UNITED STATES PATENT OFFICE

ALBERT ERNEST PENFOLD, OF BIRMINGHAM, ENGLAND, ASSIGNOR TO DUNLOP TIRE AND RUBBER CORPORATION OF AMERICA, OF BUFFALO, NEW YORK, A CORPORATION OF NEW YORK

TENNIS BALL AND THE LIKE AND THE MANUFACTURE THEREOF

Application filed December 6, 1924, Serial No. 754,263, and in Great Britain March 13, 1924.

This invention relates to balls of that type or description which have a gas content, such, for example, as tennis balls.

Tennis balls consist essentially of an inner core or foundation of elastic material to contain gas by which the ball is inflated, having an outer covering composed of material such as felt which is adapted to resist wear and at the same time provide a surface by which the desired "grip" may be obtained upon the ball when struck by a tennis racquet.

To constitute a satisfactory ball it is essential that the inner core or foundation shall be free from porosity and absolutely gas-tight, but it has been found in practice to be extremely difficult and indeed impossible to avoid the production of large numbers of leaky and therefore defective balls by the use of the materials and methods of manufacture hitherto employed.

Such inner cores or foundations have hitherto been usually constructed of three shaped pieces of highly pigmented sheet rubber containing in some instances as much as 75% of solid matter, each of the three pieces being bevelled at its edges by skilled operatives before they are joined to form an approximately spherical core or gas container. The jointing of the first two shaped pieces is not very difficult although it calls for extreme cleanliness and care, but the application of the third piece is more difficult especially in the final sealing of the aperture after gas forming material has been placed within the core or retainer, and it has been customary to inspect the joint inside the core or gas retainer and for this purpose to use a small electric torch to give a good light.

Most of the difficulties of jointing are due to extreme flexibility of the material heretofore used in the construction of the inner spherical core or gas container. Porosity is caused by the slightest defect in jointing and is also due to the pigments which are mixed with the rubber, and it is also due to ineffective sealing of the aperture through which gas is placed within the container by well known means, such as a hypodermic needle. Gas for the initial inflation, is, however, in some cases produced from gas forming materials placed within the container before it is finally sealed during the subsequent vulcanization, which, however, are not intended to create a sufficient volume of gas to inflate the container to its final size.

The joined cores or gas containers ready for vulcanization are then placed in a spherical cavity which they fit loosely, but in order that a good ball may be produced it is necessary that it should expand uniformly. Should local expansion occur during this period when it is not restrained by the mould the vulcanized core or gas container is useless for a tennis ball and must be scrapped. And should it be found that any of the joints are weak and porous so that the container cannot be inflated to extend to the surface of the mould, it is also useless.

The next step in the process is to inflate the core or container to the size and pressure required to produce a tennis ball conforming to limits specified by the tennis association. In practice the manufacturer inflates to slightly more than the correct diameter. The inflated containers are then put into stock and allowed to stand for a period of several months. After a given period they are tested for size and pressure and those which have leaked to such an extent that their size and pressure are less than those specified are put aside and sold at very low prices, being classified as unfit for tennis balls. Those passed as correct as regards size and pressure are issued for felt covering, and those still above the regulation size are put back for a further period. The loss of inflation pressure is due to one or more of three causes:—

1. Porosity of the highly pigmented compound.
2. Weak joints.
3. Plug leakage.

It sometimes occurs that whole batches of balls prove faulty, as many as 50% proving useless, with the risk of the remainder proving leaky after they are covered with felt and issued for sale to the public. Such faults as I have referred to are defects discovered in manufacture, but it is well known that tennis balls as manufactured today cannot be stocked for more than a few months before

they lose their resiliency and are unfit for use by expert exponents of the game.

It has been proposed to manufacture a tennis ball comprising two hemispherical cups composed of highly pigmented rubber compound, but this method is open to the same objections as the three piece method excepting that no plug is used, the gas being generated within the core. The troubles due to faulty plugs are, therefore, avoided, but when the container is built up of highly pigmented rubber under high gas pressure the joint around the seam which unites the two cups is not so positive. The defects are considerably greater than those experienced with the three piece process, and balls so constructed lose their inflation pressure in the same manner.

The objects of this invention are to overcome these defects and to produce tennis balls and similar balls having a gas content, which shall be non-porous and retain their inflation pressure, by the use of improved materials and an improved process by which accuracy of manufacture and absence of porosity may be ensured and at the same time the necessity for the employment of highly skilled operatives will be obviated.

In carrying my invention into practice I build up or construct the inner core or spherical gas container of a ball of the type described of two or more component parts composed of non-porous material, joined and sealed with an air-tight joint. For ease and accuracy of manipulation I prefer that such component parts should also be of a semi-rigid character. A suitable material from which to form such component parts having the characteristics of non-porosity and semi-rigidity is obtained from gutta percha or balata or a rubber mixture containing a proportion of gutta percha and/or balata. Such component parts are preferably moulded in the desired sizes and shapes and preferably they are suitably marked to ensure accuracy of joining and sealing and the formation of gas tight seams.

Inflation gas may be inserted into the jointed container after it is moulded and vulcanized, and in which case a plug composed of uncurable rubber is secured to the interior surface of one of the component parts of the container before the latter is completely joined in spherical form. In this case the nature of the material of which it is composed, and the greater accuracy of jointing secured by the greater rigidity of the component parts will ensure the absence of porosity everywhere but in the plug, but in order to reduce the risk of deflation to an absolute minimum I prefer to avoid the use of a plug and instead thereof to insert gas-producing chemicals in one or both cups during the formation of the spherical container and to produce the requisite gas therefrom while the container is vulcanized in a mould. The said mould being closed prevents over-expansion of the gas during vulcanization, and is allowed to cool before the moulded and vulcanized container is withdrawn therefrom, thus obviating subsequent over-expansion under the influence of heat.

The process of vulcanization in a restraining mould eliminates all irregularities in the configuration of the exterior surface of the container, such for example, as those at the joints or seams. It will, moreover, cause the container to lose its semi-rigidity and become more elastic and, under the influence of the inflation gases, exceedingly resilient. The said gas container may be coated with a covering of rubber when desired either before or after vulcanization, after which it may be provided with a covering of felt or other suitable material applied in any convenient manner.

In the accompanying drawings, I have shown how my invention may be conveniently and advantageously carried into practice in the manufacture of one ball of the type described, a tennis ball.

Referring to the drawings, Fig. 1 illustrates two semi-rigid hemispherical cups, one of which is provided with an overlapping ridge;

Fig. 2 illustrates the two semi-rigid hemispherical cups united to form a spherical gas-tight container;

Fig. 3 illustrates the spherical gas-tight container showing a convenient method of attachment of india rubber strips to form a rubber coating on its external surface;

Fig. 4 illustrates the spherical gas-tight container with one strip of rubber affixed to its surface;

Fig. 5 illustrates a spherical gas-tight container coated with rubber and unvulcanized;

Fig. 6 illustrates a section of a rubber coated container after vulcanization;

Figs. 7 and 8 illustrate a modification in which the spherical gas-tight container is composed of two cups joined together by means of a circular strip of the same or similar material as that of which the cups are formed;

Fig. 9 illustrates a ball in which the vulcanized spherical gas-tight container is covered with felt.

A is a tennis ball constructed from a thin hollow sphere B of semi-rigid character such as can be obtained from gutta percha or balata or a rubber mixture containing a proportion of gutta percha and/or balata and inflated to the required degree by the provision therein of a suitable gas. The said hollow sphere B may be coated with a suitable layer of soft rubber laid on in the usual form of strips C, Figs. 3, 4 and 5, and after it has been vulcanized a suitable coating of felt

may be applied to form the outer covering of the ball A.

The hollow sphere B is preferably formed of two hemispherical cups b^1, b^2, or it may be formed of two or more component parts comprising two cups. A suitable material from which to form the said component parts of the hollow sphere B is a prepared mixture containing:—

	Per cent by weight
Purified balata	25
Washed balata	15
Smoked sheet rubber	30
Sulphur	10
Zinc oxide	20

from which all traces of grit or other foreign matter of similar character have been removed.

Such material suitably prepared is preferably moulded in the form of cups b^1, b^2, the cup b^1 being of hemispherical shape, whilst the cup b^2 is of similar shape provided with an overlapping ridge *e*. The cup b^1 may be provided with a suitable marking to indicate when it is properly seated upon the inside of the overlapping ridge *e*.

A convenient method of moulding the cups b^1, b^2, is to extrude the material or dough containing gutta percha and/or balata of which they are formed in a condition in which it is softened under gentle heat, into cord form, and whilst the cord is maintained in a soft plastic state, to cut it into pieces of the correct weight and to place the pieces in warm moulds wherein they are pressed into the desired shape, with the material evenly distributed.

Although the complete spherical gas-tight container may be supplied with gas by injecting the same after vulcanization, I prefer to use a plugless ball inflated by the generation of gas produced from gas producing chemicals within it during the process of vulcanization. Satisfactory results are obtained by placing a mixture of 0.4 grammes of sodium nitrate and 0.4 grammes of ammonium chloride to which mixture three or four drops of water have been added in one of the cups b^1, b^2, the rims of which are cleaned with a petroleum spirit or other cleaning solvent and smeared with a solution of rubber dissolved in petroleum spirit and fitted and joined together.

The cups b^1, b^2, or component parts of the spherical container B, being of semi-rigid character are conveniently handled during the operations and very little skill on the part of the operative is required to ensure accuracy of manipulation and perfect jointing.

The hollow spherical gas-tight container B thus formed is then allowed to stand until the rubber jointing solution is dry when it will be found that both cups b^1 and b^2 have contracted together round the seam, giving a satisfactory joint and producing a semi-rigid container on which to apply when desired a coating of soft rubber, and after vulcanization it will be found that the semi-rigidity of the container has disappeared and under the influence of the inflation gas has become extremely resilient.

In making the shells b^1, b^2, and after vulcanizing the container B, it is necessary to thoroughly cool the moulds before the articles are removed therefrom.

This is specially important after vulcanization because the gas content is influenced by changes of temperature, and it is necessary to avoid unrestricted expansion of the gas contained therein under the influence of heat and the consequent production of oversized balls.

As above stated the gas container may before or after vulcanization be coated with a covering of rubber applied in any convenient manner when desired.

A suitable covering of felt or other material may be applied to the outer surface of the container when desired in any convenient manner.

In Figs. 7 and 8 I have illustrated a modification in which the container is constructed of three component parts comprising two cups b^1, b^2, with an intermediate piece b^3.

Although I have described my invention as particularly applied to the manufacture of a tennis ball of my improved construction it will be obvious that my invention is not limited thereto, and that it may be applied to the manufacture of any similar ball having a gas content.

Tennis balls constructed according to my invention and as herein described possess great resiliency, are extremely durable and offer great resistance to wear. Moreover by their construction and the method thereof they can be manufactured by unskilled operatives so as to retain their inflation gas thus reducing to a minimum the very large proportion of rejects which has hitherto been inseparable from the production of tennis balls and they can be relied upon not to deteriorate during the time they are stored between manufacture and use.

Though I have described with great particularity of detail certain embodiments of my invention, yet it is not to be understood therefrom that the invention is restricted to the particular embodiments disclosed. Various modifications may be made by those skilled in the art without departing from the invention as defined in the following claim.

What I claim is:

The method of making tennis balls which comprises forming a relatively thin gas container made of two semi-rigid halves of a composition of rubber containing balata and vulcanizing materials, joining said halves

with a gas tight joint, applying relatively thick sheets of rubber over the container with their joints displaced relatively to the joint between said halves and vulcanizing and expanding the assemblage.

In witness whereof, I have hereunto signed my name.

ALBERT ERNEST PENFOLD.