W. G. HILL.

PROCESS OF VULCANIZATION.

APPLICATION FILED FEB. 12, 1913.

1,090,535.

Patented Mar. 17, 1914.

2 SHEETS—SHEET 1.

Fig. 1.

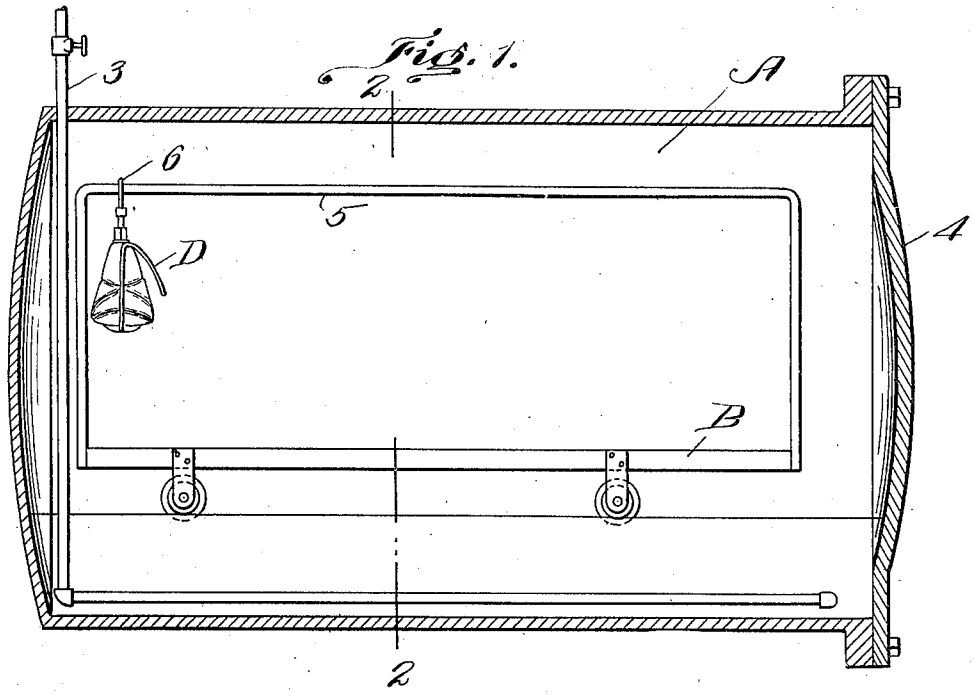
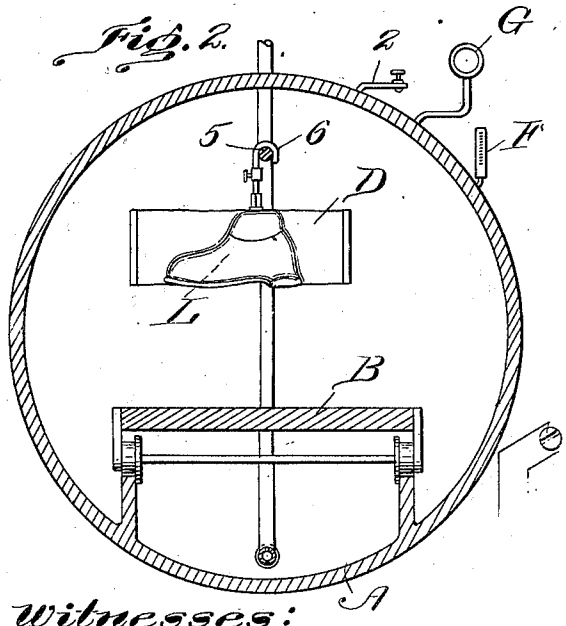


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 4.

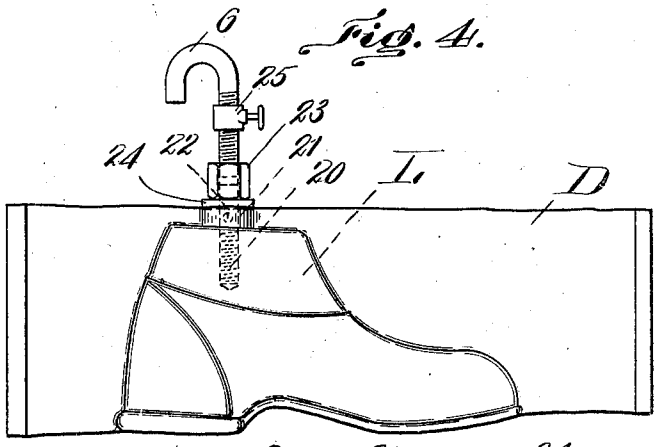


Fig. 7.

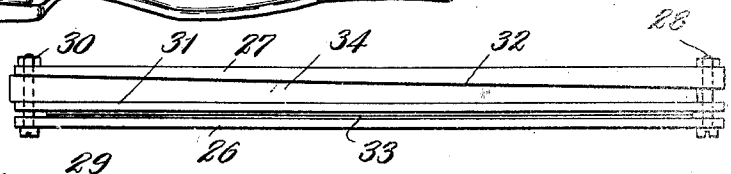


Fig. 6.

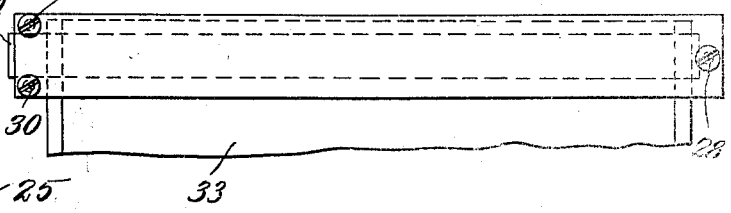


Fig. 5.

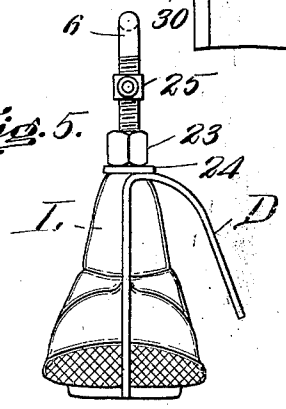
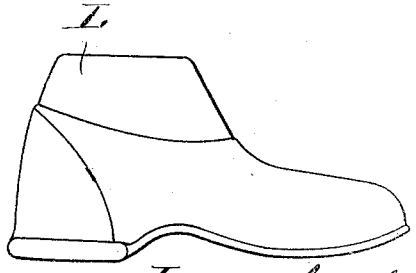


Fig. 3.



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UNITED STATES PATENT OFFICE.

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PROCESS OF VULCANIZATION.

1,090,535. Specification of Letters Patent. Patented Mar. 17, 1914.

Application filed February 12, 1913. Serial No. 747,898.

To all whom it may concern:

Be it known that I, WILLIAM G. HILL, a citizen of the United States, residing at Hudson, county of Middlesex, State of Massachusetts, have invented a certain new and useful Improvement in Processes of Vulcanization, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention has for its object an improved process for the vulcanization of rubber compounds or articles made therefrom.

The method will be clearly understood from the following description taken in connection with the accompanying drawings, of the way in which it is employed in practice, and the novel features thereof are pointed out and clearly defined in the claims at the close of this specification.

In the drawings, Figure 1 is a vertical lengthwise section of a vulcanizer adapted for steam vulcanization. Fig. 2 is a transverse section thereof on line 2—2 Fig. 1. Fig. 3 is a side elevation showing a rubber shoe assembled on a last ready for vulcanization. Fig. 4 is a side elevation showing a shoe on a last within a flexible envelop from which the air has been partially exhausted, and the connection through which the air may be exhausted. Fig. 5 is a front or end view of the envelop containing the shoe and last shown in Fig. 4. Fig. 6 is a plan and Fig. 7 a side elevation of a closure device for closing the flexible envelop to prevent the ingress of air.

In the vulcanization of articles, such for example as boots and shoes which are made from rubber compounds, the article is first formed from the unvulcanized material, the parts being completely assembled with the fabric lining, etc., in place on a proper last, as is well known to those skilled in the art. The shoe thus assembled is placed on a suitable support on a car which is run into a vulcanizer or chamber which is then closed and the temperature within the chamber is then gradually raised, usually by means of heat from steam coils, until it reaches about 270° Fahrenheit. This dry heat process is the one in common use, and the time consumed in vulcanizing an article such as a shoe by this process is from six to eight hours.

Another process in common use is the steam process, which is used chiefly in connection with the vulcanization of mechanical rubber goods. In this process the articles are surrounded by steam and the process is not therefore adaptable for the vulcanization of such articles as rubber shoes for the reason that the moisture and water of condensation has a bad effect upon the fabrics which are used as linings and also injures the surface of the shoes by causing it to be pitted and in general of poor finish.

Other processes contemplate the vulcanization of the goods while surrounded by air or other gases under pressure and still others combine the use of gases under pressure followed by the use of steam. The use of gases under pressure tends to compact and densify the material being vulcanized which is desirable. When air or gas has been used under pressure for a sufficient time to partially cure the material being vulcanized or until the character of the material being treated has to a degree become fixed, the danger of pitting from a subsequent application of steam is avoided, and the cure may then be completed by the employment of steam, proper precautions being taken to prevent the steam from access to the fabric linings which are used. Some of these methods are expensive in operation and a uniform vulcanizing temperature, which is desirable, is obtained with difficulty. They are further open to other objections of a more or less serious character.

By still another vulcanizing process which I have employed (as described in Letters Patent of the United States granted to me No. 661,178) I surround the article to be vulcanized by an inert gas under pressure that is a gas in which there is no free oxygen. This process is difficult of application and expensive although the results obtained are desirable, namely the compacting and densifying of the article due to the pressure of the inert gas and the prevention of all access of free oxygen to the article being vulcanized. In all the processes of vulcanization now used or contemplated so far as known to me, with the exception of my process referred to, in which I employ inert gas, the article being vulcanized is exposed to the deleterious effect of this free oxygen. For example in the process now commonly employed to which I have referred, and which is known as the dry heat process, the air surrounding the article being vulcanized

contains approximately 20% of free oxygen. This exerts a very harmful action upon the rubber compounds, especially when they are subjected to the high temperatures employed during vulcanization. While the necessary heat is being applied to cause the re-action between the sulfur and rubber to proceed, simultaneously the heat in connection with the oxygen contained in the air is oxidizing and injuring the rubber. If this oxidizing can be eliminated the beneficial results are most marked, and the strength and wearing qualities and general durability of the product are much increased. This is true when high grade rubber is employed in the compound, and more markedly so when the low grades are employed, since the cheaper rubbers are apparently less able to withstand oxidation.

By the employment of my improved process hereinafter described I exclude free oxygen wholly or in very large part from the article while it is being vulcanized; I subject the article to pressure thereby densifying and compacting it and by protecting the article I am enabled to use any heating agent as for example, steam, so that the necessary heat may be applied more quickly and the consequent time of vulcanization very materially reduced.

Referring to the drawings A designates a vulcanizing chamber which may be of any well known shape or construction. It is preferably however a chamber into which live steam may be introduced and therefore should be constructed to contain live steam to produce a temperature of 280 to 300 degrees with the accompanying pressures of from 30 to 40 lbs. or thereabout to the square inch. Such a chamber is shown Figs. 1 and 2. An air escape valve 2 is provided so that the air within the vulcanizer may be allowed to escape as the steam enters. Means, not shown, are also provided to take care of any water of condensation, and heating coils, (also not shown) are preferably placed within the vulcanizer so that the interior may be heated prior to the introduction of steam, and thus condensation diminished. A thermometer and gage F and G respectively are provided as is common in vulcanizers. All of these devices are of common and well known construction.

The steam inlet is shown at 3, and the door or closure device at 4.

B indicates a carriage which has a suitable rack or support for the articles to be vulcanized. This may be of any desired or suitable construction. I have shown a support in the form of a rod 5 from which the articles are suspended by hooked supports 6. Other well known means of supporting the articles to be vulcanized within the vulcanizing chamber may be employed.

The article to be vulcanized, for example a shoe, is prepared on a last L in the usual way, and when thus prepared will be of the appearance shown Fig. 3 if the shoe is of the shape there indicated. The shoe and last are then placed in a bag or envelop D of flexible material which is impervious to air or steam and which can be sealed against the ingress of air. As a material for the manufacture of this envelop I have employed a thin strong rubber fabric, the fabric face of the material forming the exterior of the envelop, while the interior is formed by the smooth rubber surface. This envelop may be simply of rectangular shape, but must be of ample size so that its interior may be brought into contact with the irregular sides of the shoe when the shoe is placed therein. The envelop may be provided with a simple exhaust connection by means of which when the envelop is sealed the air contained therein may be withdrawn or pumped out. A preferable form of air exhaust connection is shown Fig 4. This comprises a screw stud 20 which is screwed into the top of the last and which is provided with a boss 21 which lies on the top of the last when the screw stud 20 is in position. The top of the screw stud 20 is hollow and an opening connecting with the hollow interior top of the said screw stud 20 is shown at 22. This opening 22 is through the boss 21 above referred to. The purpose of the boss 21 is to hold the envelop off the top of the last and permit a space for the exhaust opening 22. A hooked connection 6 provided with a coupling union 23 is provided for connection with the stud 20 and underneath the union 23 is placed a washer 24 which when the union is screwed down will be forced against the envelop around the opening therein through which the stud 20 projects, and will serve to close and seal the opening. The connection 6 is provided with a shut-off valve 25 and the upper free end of the connection 6 is of the hooked shape as shown Fig 4 so that the connection may also be utilized to hang the shoe and envelop on the rack in the vulcanizer.

By the means above described a convenient exhaust connection is provided as also a convenient means for suspending the shoe in the vulcanizer, the weight of the suspension coming upon the wooden last and not upon the flexible surrounding envelop hereinafter described.

The shoe assembled on the last as above described is placed within the envelop, the open end of the latter through which the shoe and last have been inserted is then sealed in any well known manner as by means of rubber cement, or the like. To provide a means of quickly closing and sealing the open end of the envelop and one which may be repeatedly used (the envelop being designed for repeated use with suc-

cessive shoes,) I provide a device shown Figs. 6 and 7. This consists of a frame comprising a bottom strip of metal 26 and a top strip 27 connected at one end by means of a screw bolt 28 and at the other end by means of two screw bolts 29 and 30. Another intermediate clamping strip 31 is provided with a hole at one end through which the bolt 28 passes and with two holes at the other end through which bolts 29 and 30 pass. The clamping strip 31 is free to move on the said bolts toward or from the bottom strip 26. The top strip 27 has a wedge shape face 32 and after the ends of the envelop indicated at 33 Fig. 10 are inserted between the bottom strip 26 and the clamping strip 31, a wedge 34 is inserted from the end of the frame between the studs 29 and 30 and pushed home to the position shown in said Figs. 6 and 7. This wedge forces the clamping strip 31 firmly and uniformly against the two sides of the end 33 of the envelop which are clamped between the said clamping strip 31 and the bottom strip 26 and closes and seals the said end against the ingress of air. After the envelop has been thus closed and sealed an air suction device is coupled to the connection 6, if the air exhaust connection be of the form shown Fig. 4, and the air is exhausted from the envelop to a substantial extent.

It will be understood that in placing the shoe and last within the envelop when the last is provided with a fixed screw stud connection 20, as shown Fig. 4, there is an opening in one side of the envelop properly located which can be slipped over the projecting end of the stud 20 after which the washer 24 and the connection 6 with its union 23 are secured to the upper end of the stud 20 and the opening in the side of the envelop through which the stud projects is thus closed and sealed.

In practice I have found that I can readily obtain within the envelop from 20 to 21 inches of vacuum which corresponds with a pressure of about 10 lbs. to the square inch. As the air is exhausted the envelop will collapse, and the walls thereof are forced into intimate contact with the irregular exterior of the shoe, as shown Fig. 5. The operator manipulates the envelop so that it will lie as smoothly as possible over all parts of the exterior of the shoe and the sides or walls of the envelop will meet along a central line extending from the toe up the front of the shoe to the top and from the heel up the back of the shoe to the top. This is of importance, because where the two sides of the envelop unite there will be a slight space in which less pressure will be applied to the shoe surface and there will consequently be a slight projection or fin formed on the shoe. For this reason it is desirable that this meeting point of the sides of the envelop and the consequent projection or fin should be central of the shoe from the toe to the top and from the heel to the top. Such a projection, which is relatively slight, when thus located does not interfere substantially with the appearance of the shoe. By practice the skill of the operator in manipulating the envelop is increased and this together with the employment of certain aids in locating the shoe within the envelop which are hereinafter described, will tend to produce a more accurate and perfect union of the sides of the envelop over the shoe, and thus to diminish the consequent fin or projection which is formed. If considered desirable to wholly eliminate this fin or projection this may be accomplished by the employment of a narrow strip of vulcanized rubber or similar smooth material not affected by the heat of vulcanization which is laid on the shoe beneath the meeting point of the sides of the envelop. The shoe thus incased in its envelop is by the partial exhaustion of the air subjected to a pressure of about 10 lbs. to the square inch, which tends to densify and compact the rubber compound of which it is formed. Thus prepared the envelop containing the shoe is placed within the vulcanizing chamber A, see Figs. 1 and 2, and live steam allowed to enter until the temperature has risen to about 280 degrees with a consequent pressure of about 30 lbs. to the square inch. Under this temperature and pressure the curing or vulcanizing of the shoe will be effected in about two hours. Free oxygen is substantially excluded from the rubber compound being vulcanized, moisture is excluded, and no injury results therefore to fabrics employed, such as the linings of the shoe, or to the surface of the shoe. The compound is densified and firmly compacted by the molding pressure, and the application of the pressure through the envelop, no matter how flexible the envelop may be, causes a very perfect union of the parts of the shoe, for example the sole and upper, so that the parts are all blended into one homogeneous whole. Exhausting the air from the envelop removes the air from between the lining and the adjacent surfaces of the compound of the shoe. With this air removed the rubber is forced under the pressure employed into the interstices of the fabric lining, and a very intimate and close union of the lining with the rubber is secured which is of great importance.

It will be noted that the essential characteristics of my envelop are that it shall be as thoroughly flexible as possible, and shall be capable of excluding the air when the air has been withdrawn and the envelop sealed. As will be obvious the more nearly a complete vacuum is obtained within the envelop the better will be the result. However, for

practical purposes, a vacuum of from 20 to 21 inches which can be quickly and readily obtained and which will yield a pressure of about 10 lbs. to the square inch is very satisfactory in use. The slight remaining air in the envelop has so little free oxygen as to be almost negligible in its effect on the rubber compound being vulcanized. I have obtained very good results by removing most of the air, or the excess of air without the use of an air pump or other suction device by simply manipulating the envelop with my hands, after the shoe has been placed therein, to collapse the envelop forcing its sides against the shoe and then further expressing by manipulation as much of the air as possible from the envelop and closing the air connection, the envelop having previously been sealed. In this way although no vacuum is produced the air is substantially excluded from the space surrounding the article to be vulcanized and much of the benefit results which is obtained by vulcanizing in the absence of air. There is very little air within the envelop and the envelop serves as a protection against the injurious effects of the steam heretofore referred to, and also as a means of the more even and proper distribution of the pressure of the steam over the surfaces of the shoe, while quick vulcanization may, as will be obvious, be obtained. As will further be obvious, if no attempt is made even by hand manipulation of the envelop to press out the excess of the air, but the shoe is simply inserted and the envelop closed and the process of vulcanization is then carried out, there will under these conditions be a substantial exclusion of oxidization as compared with what ordinarily occurs, and to that degree a consequent beneficial effect, and all the benefits of the envelop in protecting the compound from the injurious effects of the steam and moisture will be obtained.

I have referred to the employment of steam as a heating agent, in vulcanizing by my process because when steam can be used without injurious effects, as it can be by my method, it is in my opinion the most desirable heating agent, yielding the heat and pressure desired conveniently and economically and is a medium known and understood by those skilled in this art. It will be obvious however that a shoe or other article incased in an envelop as heretofore described from which air has been withdrawn may be vulcanized by the application of heat in any well known manner, as for example, by the dry air process or by the employment of air or gas under pressure.

Although I have hereinbefore more particularly described my novel process as applied to the vulcanization of boots and shoes, it will be understood that this process is equally applicable to the vulcanization of other articles, such, for example, as rubber tires, fitted to suitable cores or forms, corresponding in function, in keeping the soft unvulcanized rubber articles in shape, to the lasts on which unvulcanized boots and shoes are fitted in the vulcanization process hereinbefore described.

What I claim is;

1. The herein described process of vulcanizing rubber articles which consists in placing an article of unvulcanized rubber, in soft condition, on a form, inclosing the form with the article thereon in an impervious bag-like flexible envelop which will exclude all air or steam, so that no air except what may be naturally contained within the envelop can come in contact with said article, placing the inclosed article in a vulcanizing chamber, and then submitting said article in said chamber to pressure and heat by means of a heated fluid, and maintaining the heat and pressure for a time sufficient to vulcanize the article.

2. The herein described process of vulcanizing rubber boots or shoes which consists in placing a boot or shoe of unvulcanized rubber, in soft condition, on a last, inclosing the last with the boot or shoe thereon in an impervious flexible envelop which will exclude air or steam, to avoid oxidation, placing the inclosed boot or shoe in a vulcanizing chamber, and then submitting said boot or shoe in said chamber to the simultaneous action of heat and pressure by a fluid heated to a vulcanizing temperature, and maintaining the heat and pressure for a time sufficient to vulcanize the boot or shoe.

3. The herein described process of vulcanizing rubber articles which consists in placing an article of unvulcanized rubber, in soft condition, on a form, inclosing the form with the article thereon in an impervious flexible envelop which will exclude air or steam, removing the excess of air from the envelop to avoid oxidation, placing the inclosed article in a vulcanizing chamber, and then submitting said article in said chamber to the simultaneous action of heat and pressure by a fluid heated to a vulcanizing temperature, and maintaining the heat and pressure for a time sufficient to vulcanize the article.

In testimony whereof I affix my signature, in presence of two witnesses.

WILLIAM G. HILL.

Witnesses:
WILLIAM A. MACLEOD,
ALICE H. MORRISON.