A. D. WARNER.

RUBBER TUBING FOR TIRES, &c.

APPLICATION FILED APR. 16, 1909.

945,353. **Patented Jan. 4, 1910.**

Fig. 1.

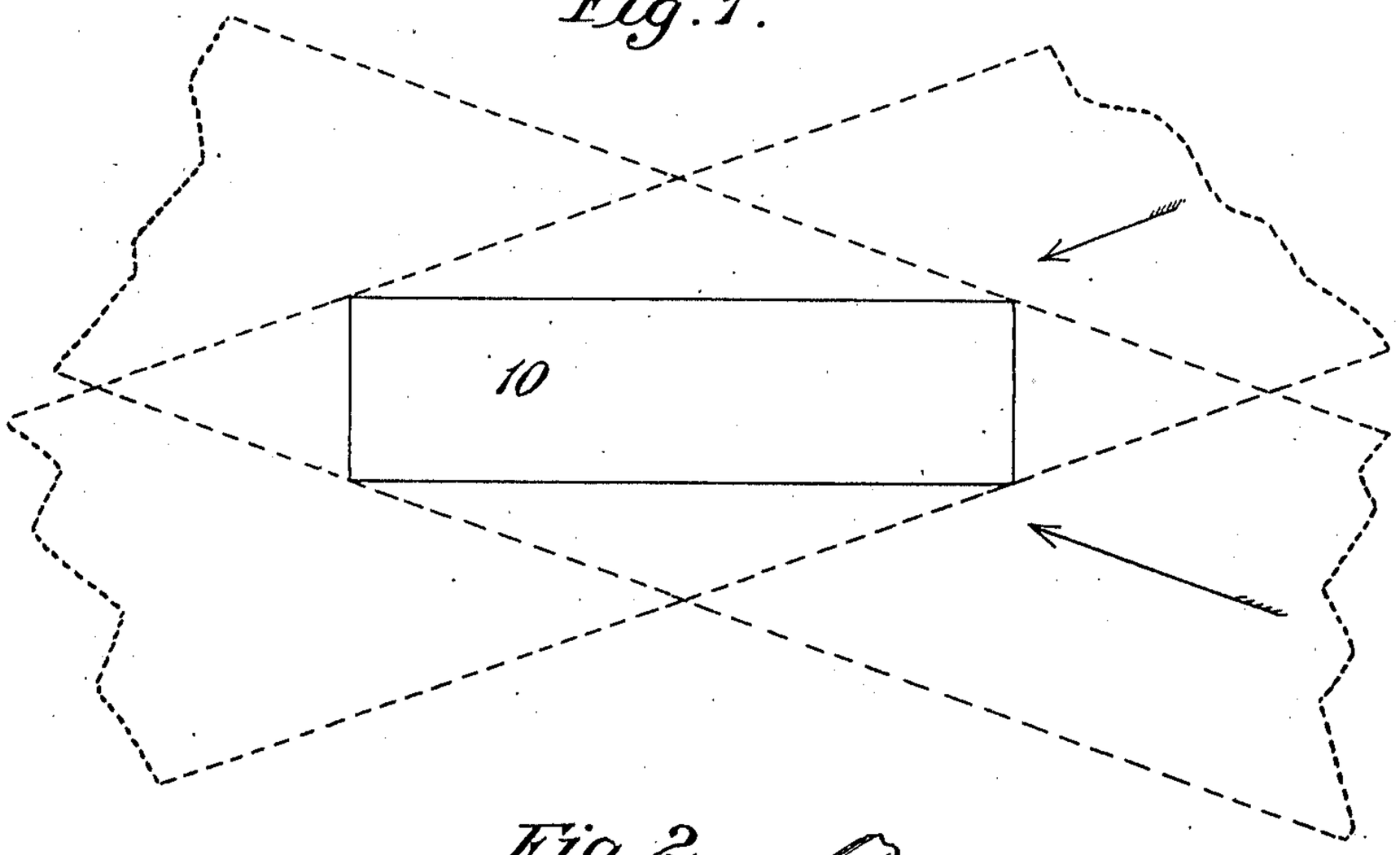


Fig. 2.

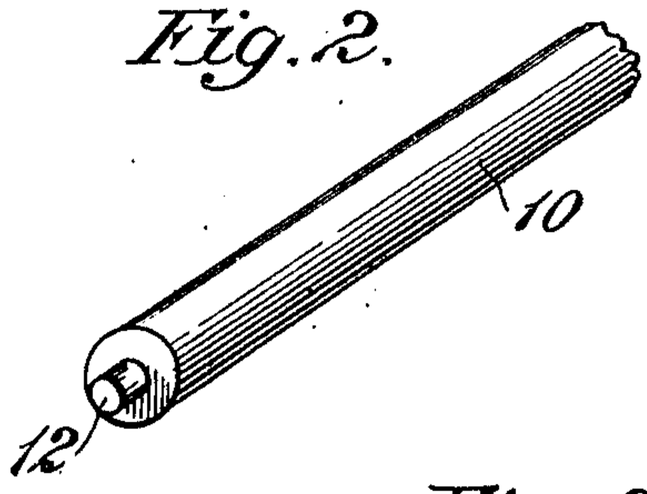
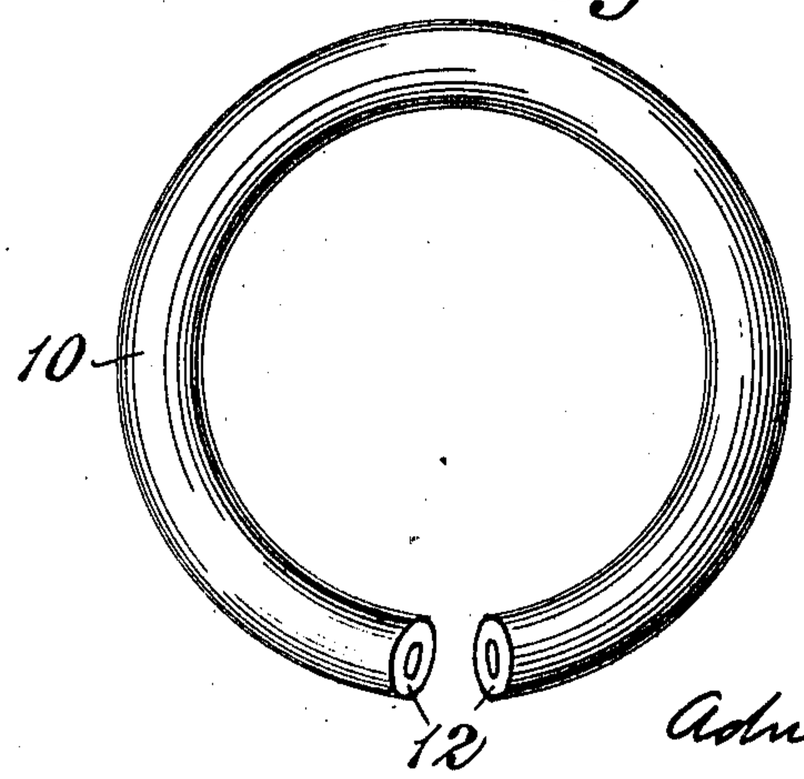


Fig. 3.



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RUBBER TUBING FOR TIRES, &c.

945,353. Specification of Letters Patent. Patented Jan. 4, 1910.

Application filed April 16, 1909. Serial No. 490,224.

To all whom it may concern:

Be it known that I, ADNA D. WARNER, a citizen of the United States, residing in Mishawaka, county of St. Joseph, and State of Indiana, have invented a certain new and useful Improvement in Rubber Tubing for Tires, &c., of which the following is a specification.

In a pending application of even date herewith Serial No. 490,223 I have claimed a certain improved method or process for making rubber fabric.

The present invention relates to an improved form of rubber tube especially useful for pneumatic tires for automobiles and the like; and the principal object of this invention is the production of such a tube which shall possess superior reliability and durability without material increase of expense.

The principal advantages found in tubing made according to my improved process are—first: superior durability as compared with former tubes of the same material and thickness—second: no increase in the cost of production—third: the tubes are made and applied by existing types of machines and therefore their manufacture involves no change in existing plants—fourth: a thicker tube is producible without impairing the quality of the material. These advantages result from two principal features of improvement which I prefer to combine as hereinafter described. The first of these features, which has reference to the mode of relating what I term the line of rolling of the material in different layers, has for its object the prevention of breaking or checking in the fabric, and the distribution of the material so as to adapt it to successful resistance to the strains to which pneumatic tires are subjected in practice. The second feature, having reference to cold rolling of the sheets while building up the fabric, has for its object the entire avoidance of air cells in the completed fabric, and makes it possible (especially in the preferred arrangement described) to build up very thick tubes without danger of imperfections.

It is obviously desirable to make pneumatic tubes for heavy vehicles of such a weight and thickness as will require the least possible inelastic covering to reinforce the rubber. But it is found in practice that the thicker a single sheet of rubber is rolled in calendering the greater is the proportion of air cells, and, as these cells are opened by process of wear, they cause rapid disintegration of the material. On the other hand, where tubes are built up, as hitherto, of separate calendered sheets united by cement, the utmost care cannot prevent formation of similar cells, due to the volatile ingredient of the rubber cement (generally benzene) permeating the mass of the rubber and producing a spongy texture by its expansion. I have discovered that separate calendered sheets of green or uncured rubber may be united perfectly by rolling cold under increased pressure as compared with the calendering pressure, and that, where this process is resorted to, practically all spongy texture is done away with. I have further discovered that by use of this process the peculiar internal structure of the material originally caused by the calendering rolls is not materially disturbed. This discovery has rendered possible the arrangement of the various sheets or layers as hereinafter described without sacrificing any of the advantages pointed out.

Where rubber compounds are formed into sheets by passing them between hot calendering rolls the internal structure is modified, and I have found that the following qualities are observable.

First: The tensile strength is greater in the direction in which the rolling has occurred. This direction I have termed the "line of rolling."

Second: The elasticity or resilience is greater at right angles to this direction.

Third: The tendency to split or check is greater when a sheet is bent on curves whose axis is parallel to the line of rolling than when bent at right angles to this direction.

I have also discovered that, where calendered sheets of rubber compound are united by cold rolling as above described, this internal structure is not interfered with by the excessive pressure necessary in connection with this process. Furthermore, I have found by practical commercial use that, by uniting sheets with their lines of rolling making material angles the one with the other, the advantageous qualities belonging to each direction of the lines may be united, as hereinafter more fully set forth.

Hitherto in building up rubber tires or other rubber tubing it has been the practice to roll the sheets around a mandrel lengthwise of the sheet, because, where tubes of

any convenient length are desired, it would not be practical to make rollers wide enough to produce a sheet which could be rolled crosswise. Consequently the lines of rolling in rubber tubes thus formed, run lengthwise of the tube, and the bonding of the fabric to form the tube thus causes a permanent strain across the grain, which tends to split the sheet lengthwise. In pneumatic tires for wheels the very great strains brought upon the rubber tube in process of use soon cause small, longitudinal openings to show themselves, which give rise to leakage and rapidly cause the tire to become useless. The discoveries above pointed out in connection with the advantages of proper arrangement and mode of uniting of rubber sheets are peculiarly useful in providing a remedy for these evils in pneumatic tubes. I have found that, by making rubber tubing of a number of united superposed thin sheets placed so that the rolling line of at least one sheet shall make a material angle with that of others, a greatly increased life is secured and the tendency to open up along the line of rolling is greatly diminished. In order to produce this result consistently with the use of rollers of reasonable width, I prefer the specific construction indicated in the accompanying drawings, wherein—

Figure 1 shows the method of superposing the sheets and of cutting out the piece to be rolled to form the tire or other tube, Fig. 2 is a perspective view of a portion of a straight tube on a mandrel, and Fig. 3 is a perspective view of such a tube bent around in a circle to bring the ends together to be joined in forming a tire.

In Fig. 1 the edges of two ordinary rolled sheets of uncured rubber are indicated in dotted lines and the direction of the line of rolling in each is shown by the arrows. It will be seen that, with uncured sheets so placed, the line of rolling of each makes a material angle with the other, and this angle will be determined by the necessary length and width of the final composite piece to be used and by the practical width of the rollers for forming the original sheets. By cutting appropriate lengths from the two original sheets and placing them substantially as shown in Fig. 1, it will be possible to cut a composite piece 10 (shown in full lines) from those portions of the two which are superposed, and the length of such a piece will be much longer than the width of either original sheet. In the drawing the proportion is about as seven to four. The portions 10 having been thus cut out, the separate sheets are united in a suitable manner, but, in order to avoid distortion or change of molecular arrangement, as well as to prevent the formation of air cells within the fabric, I prefer to unite these sheets by application of my discovery above pointed out. That is to say, I prefer to run the sheets together cold, in uncured condition, through laminating rollers of a well known type, having a yielding pressure caused by the use of weights or springs. The pressure used is four or five times as great as that employed where mere cementing is to be accomplished, or where sheets are united hot. The sheet thus produced is a composite one having the lines of rolling of the component parts placed at an angle to each other. It is bent over a mandrel 12, as shown in Fig. 2, and is then removed therefrom and bent around as shown in Fig. 3, when a tire is to be made. The edges and ends having been properly joined in any well known manner, the whole is vulcanized, and the tire is complete.

I find that by making a rubber tube or tire in the manner above described the tendency to split through and leak is much diminished, thus greatly increasing the durability of the article.

It is to be understood that this invention is not limited to the use of two layers or of any other specific number. Also the particular relative widths of sheets; the particular angle between lines of rolling, and the particular shape of the composite sheet are not essentials of my invention.

In my claims the term "rubber" applies to any of the well known compounds to which that term is commercially applied, capable of treatment as above described. The expression "united integrally" indicates union of adjacent sheets without the intervention of foreign material such as the benzene or other volatile constituents of rubber cement which causes sponginess and consequent weakening of the fabric.

What I claim is—

1. As an article of manufacture, a rubber tube composed of a plurality of sheets of rolled rubber superposed and united at their surfaces with the line of rolling of at least one of said sheets making a material angle with that of another, substantially as described.

2. As an article of manufacture, a rubber tube composed of a plurality of sheets of rolled rubber superposed and united integrally at their surfaces with the line of rolling of at least one of said sheets making a material angle with that of another, substantially as described.

3. As an article of manufacture, a rubber tube composed of a plurality of calendered sheets of rubber superposed and united integrally with the line of rolling of one or more of said sheets set across the line of rolling of another, substantially as described.

4. The process of making rubber tubing which consists in laying a plurality of sheets of uncured rolled rubber across each other with the line of rolling of one or more of

said sheets making a material angle with the grain of others, cutting out and uniting a suitably shaped piece from the overlapping portions of said sheets, bending said piece into tube shape, and uniting the edges, substantially as described.

5. The process of making rubber tubing which consists in superposing a plurality of calendered sheets of rubber with their lines of rolling crossed, uniting the same integrally without disturbing their molecular arrangement, bending them into a tube and uniting the edges, substantially as described.

6. The process of making rubber tubing which consists in superposing a plurality of calendered sheets of rubber with their lines of rolling crossed, subjecting them while cold to a rolling pressure greatly in excess of the calendering pressure, bending them into tube shape and vulcanizing and uniting them, substantially as described.

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