ABSTRACT: Flexible plug rubber is cured into the void formed by retaining the rubber between inner and outer plates, while holding the plates together by tension strands passed through the casing. The strands are cut off after the plug is set. The strands may pass centrally through the void and the plug material, or in spaced relation through uninjured parts of the casing.

A variation shows the tension strand also passing through an inner patch so that the patch is attached to the inside of the casing at the same time that the plug rubber is cured in place.
APPARATUS FOR REPAIRING TIRE CASINGS

The object of the invention is to reduce the cost of repairing large breaks in the casings of heavy-duty tires by:

1. Providing inexpensive mold plates that hold the break-filling plug rubber in place by means of tension strands passed through the casing wall while the rubber is cured.

2. Providing a plug rubber filling for a break in a casing that is substantially imperforate and ready to receive a load-bearing patch over its inner surface.

3. And by providing a load-bearing inner patch with a tension member extending perpendicularly through its center, so that the tension member can act as an inner mold surface for the plug rubber, and be attached to the casing at the same time that the plug rubber is cured in the break in the casing.

The drawings, of which there are three sheets, illustrate three variations of the repairing method of the invention, and three variations of the apparatus for performing the patching operation.

FIG. 1 is an edge elevational view of a tire casing.

FIG. 2 is an enlarged, fragmentary, cross-sectional view taken through the plane of the line 2-2 in FIG. 1, and through a break in the casing.

FIG. 3 is a cross-sectional view showing the edges of the break prepared for patching.

FIG. 4 is a cross-sectional view showing one form of the repair apparatus in place for performing a second step in the patching operation.

FIG. 5 is a cross-sectional view showing the apparatus removed after completion of the plugging operation.

FIG. 6 is a cross-sectional view showing the casing with the plug plugged and with a load-bearing patch in place over the newly formed plug.

FIG. 7 is an elevational view of one form of tension strand used to hold the plug-forming molds in place.

FIG. 8 is a cross-sectional view taken along the line 8–8 in FIG. 7.

FIG. 9 is a perspective view of the retaining clip used in Figs. 4 and 12.

FIG. 10 is a cross-sectional view through a modified form of the repair apparatus as applied to a casing.

FIG. 11 is a cross-sectional view showing a casing repaired with a plug applied by the apparatus shown in FIG. 10, with a load-carrying patch applied over the plug.

FIG. 12 is a cross-sectional view through a second modified apparatus for plugging a break in a casing.

FIG. 13 is a perspective view of a load-carrying patch for use in cooperation with the apparatus of FIG. 12.

FIG. 14 is an enlarged, fragmentary, cross-sectional view taken along the plane of the line 14–14 in FIG. 12.

This invention additionally illustrates a break in a heavy-duty tire casing 1 with an irregular break therein at 2. The break is shown in the sidewall portion of the tire but may occur at any position. As is shown more clearly in FIG. 2, the edges of the break are irregular and before attempting to repair the casing the surfaces of the break are cut away to provide a smooth surface opening 3 as shown in FIG. 3. After the break opening has been smoothed, the void in the casing wall is filled with a mass of uncured plug rubber 4 as shown in FIG. 4. The term "rubber" is used to indicate natural or synthetic rubber or similar elastic materials which can be cured to a permanent flexible condition by chemical action or by application of heat.

The apparatus for forming and curing the plug rubber 4 comprises an outer mold member or plate 5 which may have heating elements 6 embedded therein for applying heat to the uncured plug rubber. An opposed inner mold member or plate 7, also provided with heating elements 8, is positioned against the inner surface of the plug rubber and extends therebetween to engage the inside of the casing surrounding the break. The mold members are held in clamped relation against the inner and outer surfaces of the casing by a central tensile strand 9 which passes through holes 10 formed centrally in the mold members to anchor pins 11 and 12 thereof which are removably passed through loops at the ends of the tensile strand 9. As appears more clearly from FIGS. 5, 7 and 8, a preferred form of the tensile strand consists of a continuous length of cord material made of either natural or synthetic fibers and wound into a loop of several turns. The center of the loop is collapsed to form the tensile strand leaving end loops 13 through which the anchor pins 11 and 12 extend. The several cords 14 of the tensile strand are individually coated and embedded in uncured rubber indicated at 15. The rubber surrounding the tensile strand is cured simultaneously and bonded with the rubber of the plug.

A tensioning member, indicated generally at 16, is positioned between one of the anchor pins and one of the mold plates to stretch the tensile strand and compress the plates on the opposite sides of the casing. The example of the tensioning member consists of a torus-shaped pneumatic cylinder having an inner member 17 bearing against the inner mold member 7 and an outer member 18 in sealing and slideable relation to the inner member. A valve indicated conventionally at 19 is provided for introducing compressed air into the tensioning member to draw the tensile strand 9 tight and to press the mold members against the casing. In order to prevent the uncured plug rubber 4 from escaping into the openings 10 in the mold members, U-shaped sealing clips 20 are positioned in crossing relation to each other and to the tensile strand at the surface of each of the mold members. One of the sealing clips is illustrated more particularly in FIG. 9.

After the plug rubber 4 has been cured in the retained position shown in FIG. 4 the expanding or tensioning member 16 is deflated to permit the removal of the anchor pins 11 and 12 and after which the mold members 5 and 7 and the expanding member 16 are removed leaving the casing in the condition shown in FIG. 5 with the tensile strand cured into the plug rubber 4 and with the loops 13 projecting from the surface of the casing. The projecting portions of the tensile strand are cut off flush with the surfaces of the mold rubber as shown at 21 in FIG. 6, and a load-carrying patch indicated generally by the numeral 22 is applied to the inner surface of the casing and across the inner surface of the plug rubber. Desirably the load-carrying patch is of the type having a plurality of fabric-reinforced plies 23 arranged in crossing relation, with an inner coating of rubber 24 covering the inner surface of the patch and extending beyond the peripheries of the plies.

FIGS. 10 and 11 illustrate a modified form of method and apparatus for patching a similar break in a tire casing. The casing is again indicated at 1 with the plug rubber 4 in place in the trimmed break. The outer mold member 25 and the inner mold member 26 are flat metallic plates with heating elements 27 therein if desired. The plates have no central holes or openings but instead are provided with spaced bores 28 which pass thru tensile strands 29. The tensile strands 29 may be of any material having sufficient tensile strength to hold the mold plates against the sides of the casing. In the example illustrated the strands 29 are wires having one end wrapped around anchor pins 30 on the outer side of the outer mold plate. The inner ends of the strands are passed through holes 31 in the sides of an expansible pressure cylinder 32 and wrapped around inner anchor pins 33. A valve stem conventionally illustrated at 34 permits the cylinder 32 to be expanded to tension the strands 29 and clamp the mold plates against the tire.

After the mold rubber is cured the anchor pins 30 and 33 are removed together with the expansible cylinder and the mold plates and the ends of the tensile wires 29 are cut off as at 35 in FIG. 11. The load-carrying patch 22 is then applied over the inner surface of the plug rubber and the inner ends of the tensile strands. Alternatively the tensile strands 29 may be removed entirely with the small holes which they formed through the casing being closed at their inner ends by the patch 22.

FIGS. 12 to 14 show a third modified form of apparatus and method for curing the plug rubber 4 in the break of the casing 1. The outer mold member consists of a flat plate 35 similar to that shown in FIG. 4 and having a heating element therein and a central opening or hole 10 extending therethrough. The
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3. Tensile strand 9 is the same as that shown in FIGS. 4, 5 and 7 and has its outer loop 13 disposed around the anchor pin 11. Inwardly of the patch rubber and the inner surface of the casing, the tensile strand 9 passes through the center of a load-carrying patch. The patch may be similar to the patch 22 being provided with overlapping plies of reinforced fabric 23 and having a rubber coating 24. Since the patch tapers in thickness from its center to its edges a desirable pressure member in the form of a torus-shaped flexible bag 36 is positioned against the inner surface of the patch with the tensile strand 9 extending through the center of the torus. The rigid backing plate 37 engages the inside of the bag and supports the anchor pin 12 for the inner loop 13 of the tensile strand. Again a valve stem 34 is provided for introducing air pressure into the bag to tension the strand. The same U-shaped clips 20 may be used around the tensile strand to prevent leakage through the outer mold plate.

The patch generally indicated at 38 may have the tensile strand 9 engaged therethrough prior to application of the patch and the tensile strand to the casing, or the tensile strand may be forced through the patch at the same time that it is passed through the plug rubber and the break in the casing. Desirably the several cords 14 of the tensile strand 9 are passed carefully through the piles 23 and 24 of the patch 38 as is shown in FIG. 14 so as to pass between the several reinforcing strands 39 of the piles without damaging the latter or reducing the strength of the patch. While various forms of inner patches 22 and 38 may be used in the patching method of the invention, patches having relatively flexible edges, and a modulus of elasticity that increases toward the center of the patch is preferred. Such patches are disclosed and claimed more particularly in my copending application, Ser. No. 479,136, filed Aug. 12, 1965 for Patch For Tires.

Each form of the patching method eliminates the need for expensive and heavy C-clamps for holding the inner and outer clamp or mold plates together, and the need for different-sized plugs to repair breaks of different sizes is eliminated. In addition, the modified method shown in FIGS. 12 to 14 attaches an inner, load-carrying, patch at the same time that the hole in the casing is plugged.

4. While the drawings show repairs made in the sidewall portion of a casing, the apparatus and method shown are equally applicable to breaks that occur in the thicker tread portion of the casing. Where the patch is applied to a thicker part of the tire, the tension strands 9 and 39 will naturally be longer.

1 claim:

1. Apparatus for patching breaks in tire casings comprising: inner and outer mold members having opposed surfaces adapted to be clamped in opposed relation on opposite sides of a casing in overlapping relation to a break in the casing, an expandable member adapted to bear against one of said mold members, said mold members and expandable member having holes formed therethrough and adapted to be aligned when the members are in overlapping relation, and retaining parts adapted to anchor the ends of tensile strands to the opposite outer sides of said expandable member and the opposite mold member.

2. Apparatus as defined in claim 1 in which said holes are formed centrally of said members, and said retaining parts are pins adapted to be passed through loops in the ends of a tensile strand and bridge the adjacent holes.

3. Apparatus as defined in claim 1 in which said holes are arranged in spaced pairs through each of said members.

4. Apparatus as defined in claim 2 in which said expandable member is a rigid, axially extensible, torus-shaped cylinder adapted to seat against the opposite face of one of said mold members from the surface of the casing.

5. Apparatus as defined in claim 2 in which said expandable member is a flexible-walled and torus-shaped bag having an inlet for fluid pressure, and one of said mold members is a flat plate adapted to engage the opposite side of the bag from the surface of the casing.

6. Apparatus as defined in claim 3 in which said expandable member is a rigid, axially expandable cylinder, said holes being formed through a flange projecting from the periphery of the outer part of the expandable cylinder.