

Jan. 1, 1952

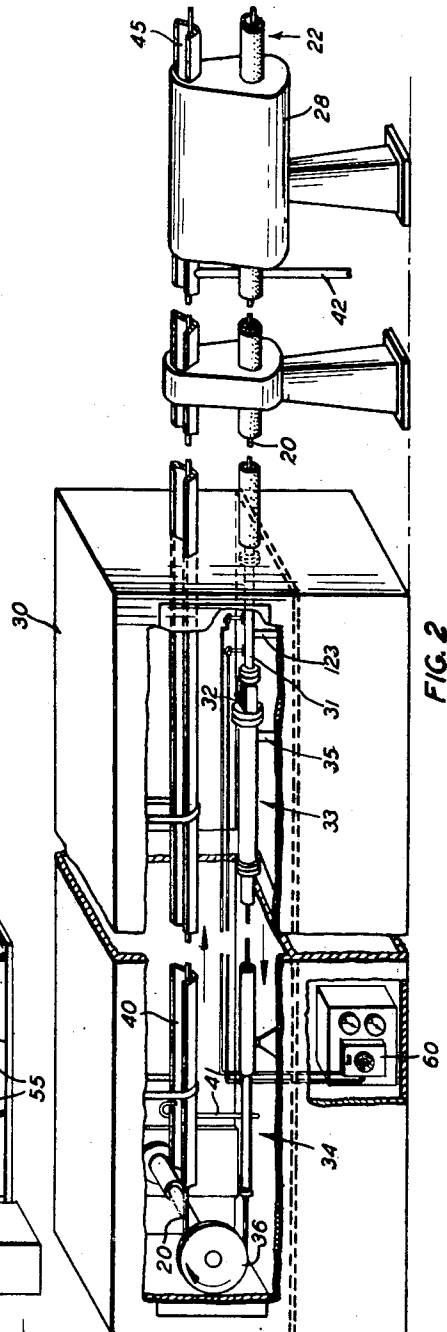
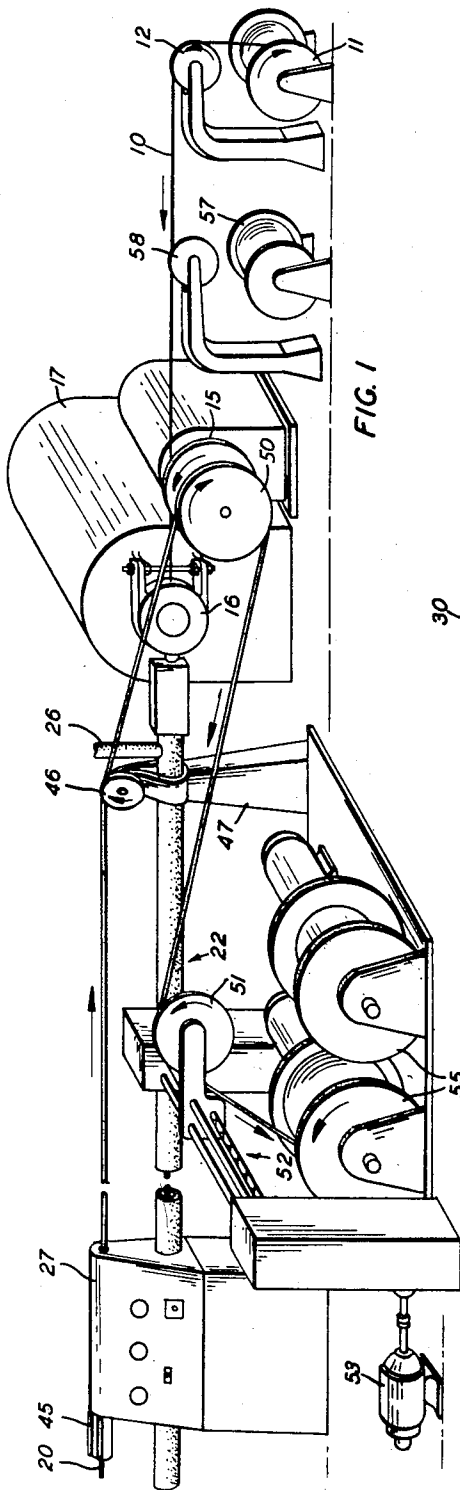
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CONTINUOUS VULCANIZING METHOD AND APPARATUS

Filed July 8, 1948

3 Sheets-Sheet 1



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CONTINUOUS VULCANIZING METHOD AND APPARATUS

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3 Sheets-Sheet 2

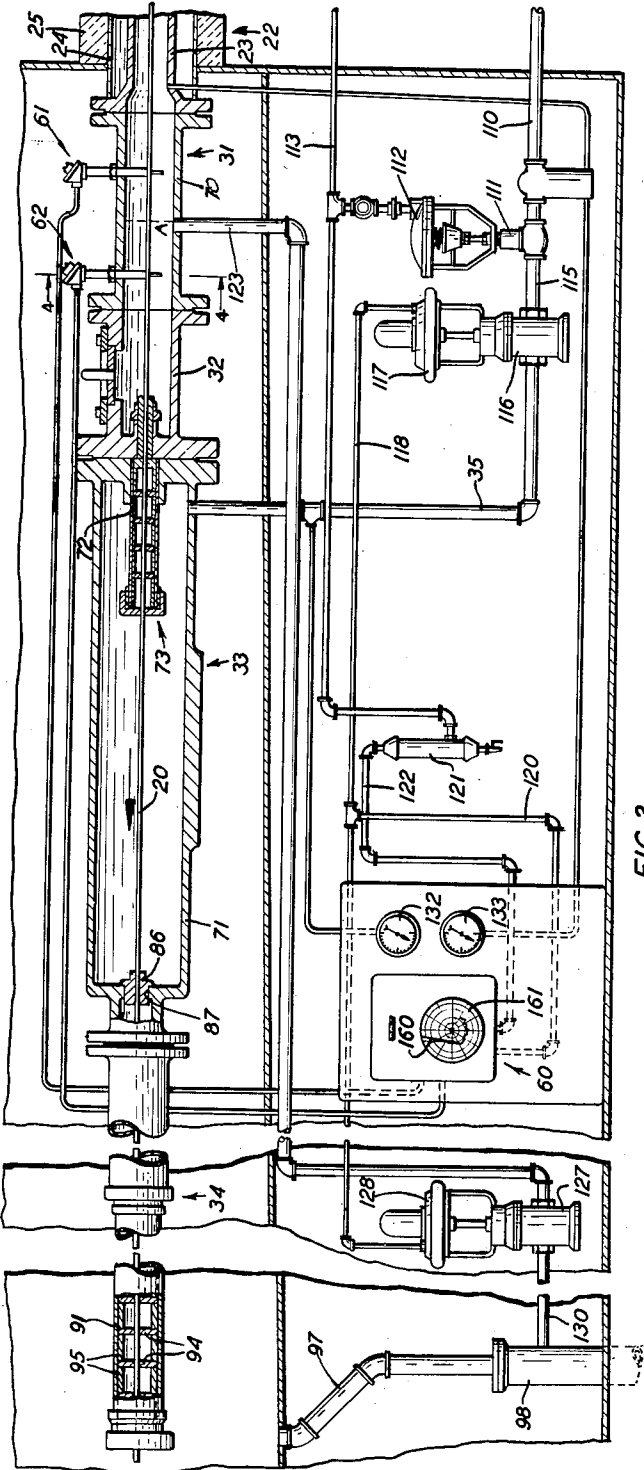


FIG. 3

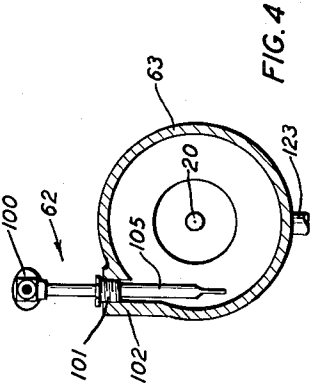


FIG. 4

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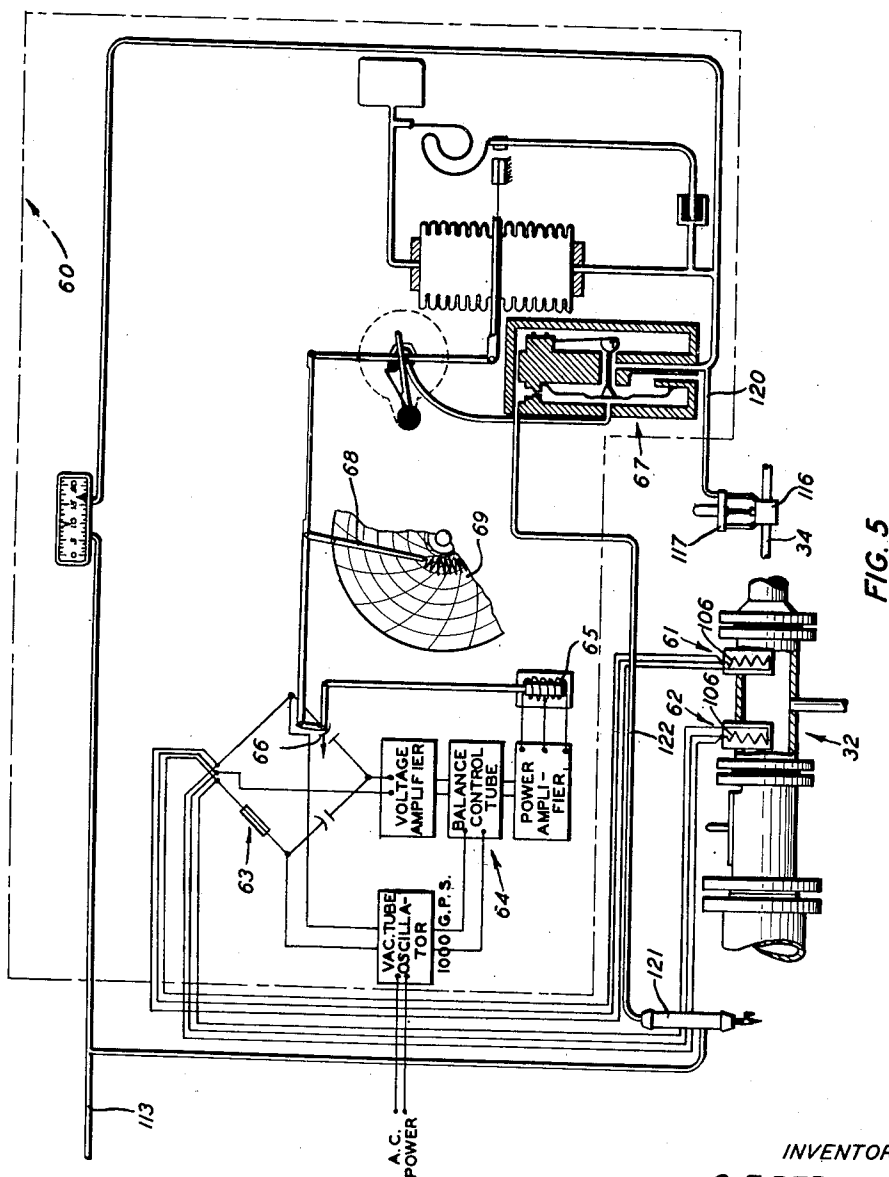
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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,581,231

CONTINUOUS VULCANIZING METHOD
AND APPARATUS

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25 Claims. (Cl. 18—6)

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This invention relates to continuous vulcanizing methods and apparatus, and more particularly to methods of and apparatus for vulcanizing coverings of vulcanizable material upon continuously advancing conductors.

In the manufacture of insulated filamentary articles, such as insulated and jacketed conductors and cables, a core having an outer covering of vulcanizable compound therearound is advanced through an elongated vulcanizing tube containing a high pressure, high temperature vulcanizing medium, such as high pressure steam, to vulcanize the covering on the core. Frequently the core may include a layer of textile material, such as a cotton serving, or a braided or knitted cotton covering. In that case, the vulcanization of the outer covering often develops high internal pressure in entrapped air and moisture within the textile layer, which must be reduced materially before the core emerges into the atmosphere in order to prevent blistering of the resulting vulcanized covering.

This is generally accomplished by passing a core and its vulcanized covering directly into a cooling tube supplied with a low temperature cooling medium, such as cold water, at high pressure for the purpose of cooling the covering until the internal pressures within the covering have been reduced to values such that there is no danger of the cover blistering when it emerges into the atmosphere. Various devices have been proposed for use at the junction point of the vulcanizing tube and the cooling tube to maintain the escape of the vulcanizing medium from the vulcanizing tube at a minimum because excessive leakage of the high temperature vulcanizing medium into the cooling tube raises the temperature of the cooling medium and thereby impairs the efficiency of the cooling medium. Also, it is desirable to minimize loss of heat from the vulcanizing medium. To hold the leakage of the vulcanizing medium to a minimum, the pressure of the cooling medium must be maintained substantially equal to the pressure of the vulcanizing medium at all times.

An object of the invention is to provide new and improved continuous vulcanizing methods and apparatus.

A further object of the invention is to provide new and improved vulcanizing methods and apparatus employing a vulcanizing tube and a cooling tube, and new and effective methods and means for regulating the pressure of the water in the cooling tube in accordance with fluctuations in the pressure of a vulcanizing medium in the vulcanizing tube.

An apparatus embodying certain features of the invention, by means of which methods embodying certain features of the invention may be practiced, comprises an elongated tube

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through which a continuously advancing core having a vulcanizable covering thereon may be passed, means for supplying a high temperature, high pressure fluid to a portion of the tube first encountered by the core to vulcanize the covering thereon, means for supplying a low temperature fluid to a portion of the tube subsequently encountered by the advancing core to cool the vulcanized covering to reduce the temperature of the vulcanized covering as it emerges from the vulcanizing fluid, and means for controlling the relative pressures of the fluids in accordance with temperature differentials existing between spaced points in the tube so as to continuously maintain the pressure of the cooling fluid and the vulcanizing fluid substantially in equilibrium at all times.

A complete understanding of the invention may be obtained from the following detailed description of an apparatus forming a specific embodiment thereof, when read in conjunction with the appended drawings, in which

Fig. 1, a perspective view of a portion of an apparatus, which may be used for vulcanizing insulating coverings on continuously advancing filamentary cores in accordance with one embodiment of the invention;

Fig. 2 is a perspective view showing a continuation of the apparatus shown in Fig. 1 extending from the left-hand end thereof;

Fig. 3 is an enlarged, fragmentary vertical sectional view of a portion of the apparatus shown in Fig. 2;

Fig. 4 is an enlarged, fragmentary, vertical sectional view taken along line 4—4 of the Fig. 3, and

Fig. 5 is a schematic diagram of an electronic controller forming a portion of the apparatus.

Referring now in detail to the drawings, and more particularly to Fig. 1, there is shown a filamentary conductor 10 being withdrawn from a rotatably mounted supply reel 11 and around a guide pulley 12 by a motor driven capstan 15, which is turning at a constant rate of speed in a counter-clockwise direction. The conductor 10 passes around the capstan 15 and then through an extruding head 16 forming part of an extruder 17, which extrudes a vulcanizable covering around the conductor to form a covered conductor indicated by the numeral 20.

Upon leaving the extruding head 16, the covered conductor 20 passes into an elongated vulcanizing tube indicated generally at 22, which consists of a steam tube 23, a tubular jacket 24 surrounding the tube 23, and an insulating jacket 25 surrounding the jacket 24. High pressure, high temperature steam is admitted to the steam tube 23 by a pipe 26 whereby the entire tube 23 is filled with high pressure steam. Steam is also

admitted to the jacket 24 surrounding the tube 23 to heat the steam tube 23.

The vulcanizing tube 22 (Fig. 1) is joined to the extruding head 16 in a suitable manner and continues therefrom through a housing enclosing a high voltage sparktester 27 (Fig. 1) and through a housing enclosing an air wiper 28 to an elongated enclosure 30. The covered conductor passes through the elongated vulcanizing tube 22 and upon emerging therefrom passes directly through a mixing tube 31, a splice box 32, a cooling tube indicated generally at 33 and a pressure reducing nozzle 34 into the atmosphere. Low temperature water, under high pressure is admitted to the cooling tube 33 by means of a pipe 35 for the purpose of cooling the vulcanized covering of the covered conductor 20 and substantially sealing the steam in the vulcanizing tube. Upon leaving the nozzle 34, the conductor 20 passes around an idler pulley 36 and travels along a V-shaped trough 40 to which a continuous stream of cold water is supplied by the pipe 41. A pipe 42 is connected to the trough 40 adjacent to the air wiper 28 to drain the water from the trough.

The conductor 20 passes from the trough 40 through the air wiper 28, which removes the moisture from the vulcanized covering, and then travels along a V-shaped trough 45 to the spark tester 27 where the vulcanized covering is subjected to a high voltage testing operation. The conductor then passes over an idler pulley 46, which guides the conductor 20 to a capstan 50 turning at a constant rate of speed in a clockwise direction. The conductor 20 passes around the capstan 50 and then over a pulley 51 mounted on a distributing apparatus, indicated generally at 52, which is driven by a motor 53. The distributing apparatus 52, including the pulley 51, distributes the conductor 20 evenly on one or the other of motor driven take-up reels 55—55.

The take-up reels 55—55 are provided for the purpose of permitting continuous reeling of the covered conductor 20. A second supply reel 57 containing a conductor identical with the conductor 10, and a second guide pulley 58 are provided for the purpose of maintaining a supply of filamentary conductor, which will permit a substantially continuous extruding and vulcanizing process.

The covering on the conductor 20, in passing through the steam tube 23 of the vulcanizing tube 22, is subjected to sufficient heat and pressure by the steam therein to vulcanize the covering. However, if a textile covering is present beneath the vulcanized covering, undesirable high internal pressures may be developed in air and moisture entrapped within the textile covering. In order to prevent these high internal pressures from blistering the vulcanized covering when the conductor emerges into the atmosphere, the conductor 20 passes directly from the steam tube, through the cooling tube 33 filled with low temperature water under pressure, which serves to cool the covering while keeping the covering under pressure, and thereby reduces the internal pressures within the coverings to values such that there is no danger of the covering blistering when the covered conductor merges into the atmosphere.

While the pressure of the water in the cooling tube 33 must be maintained at a pressure equal at least to the pressures of the entrapped air and moisture within the covering to prevent it from blistering as the conductor passes therethrough,

it is also expedient that it be maintained at a pressure substantially equal to the pressure of the steam in the vulcanizing tube at all times in order to prevent excessive escape of steam from the splice box into the cooling tube or water from the cooling tube into the splice box. Excessive leakage of steam into the cooling tube results in raising the temperature of the cooling water above its most effective operating temperature and in loss of high pressure steam, whereas excessive leakage of water into the vulcanizing tube reduces the vulcanizing efficiency of the apparatus.

Under normal operating conditions of balanced steam and water pressure, it is desirable that the junction point of the steam in the vulcanizing tube 22 and the water from the cooling tube 33 in the mixing tube 31 occur at the broken line "A" (Fig. 3). By arranging the junction in the mixing tube, the normal condensate forming thereat may be drained therefrom before it can seriously affect the vulcanization or cooling of the vulcanized covering of the advancing conductor 20. Since the steam admitted to the steam tube 23 is subject to substantial fluctuations in pressure over sustained periods of operation, it is necessary to regulate the pressure of the water in the cooling tube continuously so as to keep it substantially equal to the pressure of the steam in the vulcanizing tube at all times in order to hold the junction point at the "A" position and to obtain proper vulcanization and cooling of the covering.

To maintain this balance between the water and the steam pressures at all times, an electronic controller, indicated generally at 60 (Figs. 2 and 3), which is electrically connected to resistance bulbs 61 and 62 spacedly positioned in the mixing tube 31 so as to straddle the normal junction point position "A," is provided for the purpose of controlling the pressure of the water in the cooling tube 33, with respect to the temperature differential existing between the temperature bulbs positioned in the mixing tube.

When the junction point is at the "A" position in the mixing tube 31, a condensate is continuously forming thereat composed of relatively hot water and low temperature steam, which surrounds the bulb 62. In this case, a definite temperature differential exists between the bulbs 61 and 62, which bears a definite relationship to the pressure and temperature of the steam in the vulcanizing tube. The temperature of the water and steam condensate adjacent to the junction point depends on the temperature of the steam, which, in turn, is determined by the pressure of the steam in contact with the water in the vulcanizing tube. Sudden increases in the pressure of the steam in the vulcanizing tube will cause the junction point to move to the left toward the resistance bulb 62, whereas sudden decreases in the pressure of the steam will cause the junction point to move to the right toward the resistance bulb 61. Such movements of the junction point result in variations in the heating effect of the steam on the water adjacent to the junction point and thereby causes corresponding variations in the temperature differential existing between the resistance bulbs. The controller 60, in response to the changes occurring in the temperature differential between the bulbs 61 and 62, constantly regulates the admission of water to the cooling tube and the discharge of the condensate from the mixing tube so as to maintain the pressure of the water substantially equal to the pres-

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sure of the steam, and keep the junction point at position "A" in the mixing tube.

The temperature controller 60 is shown schematically in Fig. 5, and includes a sensitive Wheatstone bridge circuit 63 in which the resistance bulbs 61 and 62 mounted in the mixing tube are connected, and an electronic circuit indicated generally at 64 for amplifying any unbalance potential occurring across the bridge circuit. The amplified potential is utilized to actuate a solenoid 65, which rotates a variable capacitor 66 to rebalance the bridge circuit and in so doing actuates an air bleeder valve 67 of the controller to vary the output air pressure thereof. The output in pressure of the valve 67 is used for controlling an air-operated valve regulating the pressure of the water admitted to the cooling tube 32. Each temperature differential existing between the resistance bulbs 61 and 62 results in a different balance of the bridge circuit and a corresponding operating position of the air bleeder valve 67. The solenoid 65 also actuates a pen 68, which records the change occurring in the steam pressure on a chart 69.

One type of such a controller is manufactured by the Foxboro Company, Foxboro, Mass., and is described in detail in their booklet No. 644 entitled "Temperature Controller" on pages 1 and 2, identified as 16-300 and dated February, 1945; pages 1 and 2, identified as 11-449 and dated February, 1947; pages 1 and 2, identified as 16-300 and dated May, 1947; pages 1 and 2, identified as 13-150 and dated February, 1947; pages 1 and 2, identified as 11-452 and dated October, 1946; pages 1 and 2, identified as 11-460 and dated October, 1946; pages 1 and 2, identified as 11-461 and dated April, 1946; and pages 1, 2 and 3, identified as 11-462, and dated July, 1947. In view of the description contained in the above-mentioned booklet, a detailed description of the construction and operation of the controller 60 is unnecessary.

Referring now to Fig. 3 of the drawings, it will be noted that the mixing tube 31 comprises a tubular body 70, which is suitably connected so that the ends thereof communicate with the corresponding ends of the steam tube 23 and the splice box 32. The left end of the splice box 32 is connected so as to communicate with a tubular body 71 forming part of the cooling tube 33. The body 71 has an elongated baffled tube 73 centrally positioned in the right end thereof through which the conductor 20 passes in traveling from the splice box 32 into the tubular body 71 of the cooling tube.

The purpose of the baffled tube 73 is to prevent sudden increases in the pressure of the steam in the vulcanizing tube from causing the steam to surge through the splice box and into the cooling tube 33 and force a substantial amount of water therefrom through the nozzle 34, and also to prevent the water in the cooling tube from surging into the splice box and vulcanizing tube upon substantial decreases in the pressure of the steam in the vulcanizing tube. The construction and operation of the seal are described specifically and claimed in my copending application Serial No. 17,916, filed March 30, 1948. Hence, a more detailed description thereof is not necessary herein.

The cooling tube 33 consists of the tubular body 71 and an elongated tubular member 72. The tubular member 72 is connected so as to communicate with the tubular body 71 and is substantially reduced in diameter as compared to the body 71.

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The nozzle 34 is removably connected to the left end of the member 72 so as to communicate with the cooling tube 33.

A gland 86 is threadedly mounted in a central bore 87 provided in the left end of the body 71 to seal the exit end of the cooling tube except for a central aperture through which the conductor 20 passes as it travels from the cooling tube into the member 72.

The nozzle 34 secured on the exit end of the tubular member 72 of the cooling tube 33 consists of a tubular member 91 having a plurality of annular baffles 94-94 positioned therein between tubular spacers 95-95. The annular baffles 94-94 are provided with the central apertures through which the conductor 20 passes as it travels through the nozzle 34 and emerges into the atmosphere. The provision of the annular baffles 94-94 (Fig. 3) in the nozzle 34 permits the water in the cooling tube 33 to escape therefrom at a low rate of flow into the closure 30 and at the same time gradually reduces the pressure of the escaping water to that of the atmosphere. The nozzle 34 permits a continuous circulation of the cooling water from the pipe 35 through the entire length of the cooling tube, whereby the cooling water in the tube may be maintained at its most effective operating temperature. The cooling water is discharged from the end of the nozzle 34 into the closure 30 and is drained from the closure 30 by a pipe 97 leading to a large drain 98, which drain may return the water to a suitable water cooling system (not shown) so that it may be recirculated through the cooling tube 33.

The resistance bulb 62 (Figs. 3 and 4) is positioned adjacent to the left end of the mixing tube 31 so that when the junction point of the water and steam assumes position "A" in the mixing tube, the sensitive portion of the bulb is immersed in water the temperature of which has been raised substantially as a result of its contact with the steam from the vulcanizing tube. The resistance bulb 61 is positioned adjacent to the right end of the mixing tube 31 so that when the junction point assumes the "A" position in the mixing tube, the sensitive portion of the bulb 61 is surrounded by the steam adjacent to the junction point the temperature of which has been lowered by contact with the water. The resistance bulbs 61 and 62 are identical in construction, and have electrical characteristics which suit the temperature differential most likely to occur during the operation of the apparatus, hence only the resistance bulb 61 will be described in detail.

A terminal head 100 (Fig. 4) is provided on the external end of the resistance bulb 61 by means of which the bulb is electrically connected to the controller 60. The terminal head 100 is secured to a threaded body portion 101 which threadedly engages a boss 102 provided on the mixing tube. A thin shell 105 is secured to the threaded body 101 and has the opposite end thereof sealed so as to completely enclose a sensitive resistance element 106 (Fig. 5) positioned therein.

Low temperature water, under a pressure substantially higher than the maximum pressure which may be reached by the steam in the vulcanizing tube 22 is conducted from a suitable supply source by a supply pipe 110 (Fig. 3) to a valve 111 arranged to be actuated by an air diaphragm 112. The air diaphragm 112 receives air under constant pressure from an air supply pipe 113 which actuates the diaphragm 112 and sets the opening of the valve 111 so as to produce a constant water pressure in the pipe 115, which

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pressure is still above the maximum pressure of the steam in the vulcanizing tube.

The pipe 115 conducts the water from the valve 111 to a reducing valve 116 arranged to be actuated by an air diaphragm 117 which receives air under a pressure controlled by the valve 67 of the controller 60 through a pipe 118 connected to the valve 67 by a pipe 120. The valve 116 is connected to the cooling tube 33 by the pipe 35, whereby the water emerging from the pipe 115, after being subjected to a further reduction in pressure determined by the opening of the valve 116, then is conducted to the cooling tube. Air is supplied to the controller 60 from the supply pipe 113 through a filter dripwell 121 and a pipe 122.

A pipe 123 is connected to the bottom of the body 70 of the mixing tube 31 to drain the condensate which forms therein at the normal junction point of the water and steam, to a valve 127 arranged to be actuated by an air diaphragm 128. The air diaphragm 128 receives air from the supply pipe 120, in which the air is at a pressure regulated by the valve 67 of the controller 60. This regulated air pressure from the controller 60 actuates the air diaphragm 128 and sets the opening of the valve 127 so as to release the condensate from the mixing tube 31 at a rate determined by the temperature and pressure of the steam in the vulcanizing tube. The hot water emerging from the valve 127 flows into a pipe 130 connected with the drain 98.

A water pressure gauge 132 is mounted adjacent to the controller 60 for indicating the pressure of the water in the supply line 35 and the cooling tube 33. Another pressure gauge 133 is positioned adjacent to the controller 60 for indicating the pressure of steam in the steam tube 23 of the vulcanizing tube 22.

Operation

Let it be assumed that the conductor 10 has been threaded through the apparatus from the supply reel 11 to one of the take-up reels 55—55, that the vulcanizing tube 22 is filled with high pressure, high temperature steam from the pipe 26, that the cooling tube 33 is filled with low temperature water under high pressure from the pipe 35, and that the valves 116 and 127 have been so adjusted that the pressure of the water in the cooling tube is substantially equal to the pressure of the steam in the vulcanizing tube and the splice box. The steam is first admitted to the vulcanizing tube and then the water is admitted to the cooling tube 33 through the valve 116, which is controlled initially by manual controls (not shown) provided on the controller 60. The manual controls are adjusted until the output air pressure of the valve 67 of the controller which is directed to the diaphragm 117 of the control valve 116 is sufficient to effect a valve opening which regulates the pressure of the water as indicated by the gauge 132, to a value substantially equal to the pressure of the steam as indicated by the gauge 133.

In establishing the balanced pressure relationship between the water and the steam manually, the junction point thereof may occur at any point within the mixing tube 31, in which case, when the controller 60 is switched to automatic operation, the temperature differential between the bulbs 61 and 62 will cause the controller 60 to effect regulations of the valves 116 and 127 that will restore the junction point to position "A" in the mixing tube. However, for the sake of clar-

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ity, let it be assumed that when the steam and water are first admitted to the vulcanizing tube and cooling tube, respectively, and the pressures of the water and the steam are substantially balanced, the junction point of the water and the steam assumes the "A" position in the mixing tube. With the junction point so positioned, a temperature differential determined by the pressure and temperature of the steam exists between the bulbs 61 and 62. The controller 60 is switched to automatic operation, whereupon the temperature differential between the bulbs instantly produces an unbalance potential across the bridge circuit 135. This unbalance potential is amplified by the electronic circuit 64 and is utilized to effect a balanced adjustment of the bridge circuit 63 in accordance therewith, and in so doing regulates the valve 67 so that air pressure on the diaphragm 117 of the valve 116 maintains the water pressure substantially equal to the steam pressure.

At the same time, the condensate constantly forming at the junction point is drained from the mixing tube 31 through the valve 127 at a rate determined by the output air pressure of the valve 67 of the controller 60 in response to the temperature differential between the bulbs 61 and 62 which straddle the junction joint of the water and steam. The rate of formation of the condensate at the junction point depends upon the pressure and temperatures of the steam and water at the junction point, and therefore its rate of discharge from the mixing tube must be adjustable in order to meet the conditions set up by the fluctuating stem pressure at all times. When steam and water have been so regulated by the controller 60, the capstans 150 and 50 are placed in operation to draw the conductor 20 through the apparatus, in which case, the covered conductor 20 emerges from the extruding head 16 of the extruder 17 and passes through the vulcanizing tube 22 wherein the covering is subjected to heat and pressure sufficient to vulcanize the covering. The conductor and the vulcanized covering then pass through the cooling tube 33 filled with low temperature water under pressure to cool the vulcanized covering, after which the conductor 20 passes through the nozzle 34, around the sheave 36, through the air wiper 28 and the sparktesting apparatus 27 to the capstan 50, and around the capstan 50 to one of the take-up reels 55—55.

Since the apparatus operates with the pressure of the steam and the water substantially in equilibrium and with the junction point at position "A" in the mixing tube, there is a minimum leakage of the hot water from the splice box through the tube 73 as the covered conductor passes through the tube. The heating effect of the escaping hot water and of the vulcanized covering of the conductor 20 on the water in the cooling tube 33 is maintained within safe limits by the circulation of the cooling water through the cooling tube, and the water in the cooling tube is thereby maintained at its most effective operating temperature. Under these operating conditions, the high internal pressures developed within the vulcanized covering during the vulcanization thereof are reduced by the cooling water under pressure to values such that blistering of the covering on the conductor will not occur as it passes through the cooling tube 33 and emerges from the nozzle 34 into the atmosphere.

Let it be assumed that a sudden increase occurs in the pressure of the steam in the vulcanizing tube 22. This increase in the pressure of the steam starts the junction point of the water and

steam slowly moving to the left in the mixing tube toward the resistance bulb 62 which in turn increases the rate of leakage of the hot water through the tube 73 into the cooling tube 33. This increased leakage of the hot water through the tube 73, raises the temperature of the cooling water, and if this condition were allowed to prevail for a prolonged period of time, the cooling effect of the water would be substantially impaired. As a result, the vulcanized covering would not be cooled sufficiently to reduce the high internal pressures entrapped therein to safe values in passing through the cooling tube. As a result, when the covered conductor emerges into the atmosphere, blistering of the covering is likely to occur. The movement of the junction point toward the left, places the bulbs 61 and 62 no longer astride the junction point, in which case, the bulb 62 is surrounded by higher temperature condensate adjacent to the junction point, while the bulb 61 is surrounded by steam of higher temperature. The temperature of the steam at the junction point also increased with the increase in the steam pressure, and as a result, tends to increase the temperature of the condensate surrounding the bulb 62.

The movement of the junction point plus the increased temperature of the steam result in a substantial decrease in the temperature differential between the bulbs 61 and 62. The increase in temperature of the condensate surrounding the bulbs effects a corresponding change in the ohmic resistance of the resistance elements 106-106, which in turn, unbalances the bridge circuit 63 and a potential difference exists thereacross. This unbalance potential is amplified by the electronic circuit 64, and the amplified potential is utilized by the solenoid 65, to turn the rotor of the variable capacitor 66 to a position which brings the bridge circuit 63 into balance. In so doing, the solenoid also actuates the air valve 67 of the controller so as to increase its output pressure which in turn is directed to the diaphragms 117 and 123 of the valves 116 and 127, respectively, and effects a greater valve opening in each case, which results in an increased rate of flow of cooling water to the tube 33 and an increased rate of flow of the condensate from the mixing tube 31 to the drain pipe 98.

The increased opening of the valve 116 also effects an increase in the pressure of the water in the cooling tube and mixing tube and this increased water pressure, together with the increased rate of discharge of the condensate through the valve 127 checks further movement of the junction point caused by the increased steam pressure in the vulcanizing tube.

Since the resistance bulbs 61 and 62 no longer straddle the junction point of the water and the steam, the decrease in the temperature differential therebetween is sufficient to cause the controller 60 to regulate the valve 116 so as to increase the pressure of the water slightly above that of the steam. The increased water pressure, plus the increased rate of discharge of the condensate through the valve 127, causes the junction point to move back toward position "A" in the mixing tube 31. As the junction point moves to the right to its normal "A" position, the temperature differential between the bulbs 61 and 62 is constantly increasing because the bulbs are again substantially astride the junction point, in which case the bulb 62 is surrounded mainly by hot water condensate, and the bulb 61 is again surrounded mainly by low tempera-

ture steam. The controller 60, which constantly seeks to balance the bridge circuit 63 in response to this constantly increasing temperature differential between the bulbs 61 and 62, continuously effects a corresponding regulation of the valves 116 and 127, which gradually reduces the valve opening in each case, whereby the movement of the junction point becomes slower and slower as it approaches its mid-position between the bulbs.

When the junction point finally is restored to the "A" position in the mixing tube, the final temperature differential between the bulbs is slightly less in value than that which existed therebetween before the steam pressure increased due to the fact that the temperature of the steam increased in accordance with the increase in the steam pressure, and in turn, increases the temperature of the condensate. This decreased operating temperature differential of the condensate, effects a corresponding regulation of the valves 116 and 127 so as to keep the water pressure substantially equal to the steam pressure, and also increases the rate of flow of the water through the cooling tube, which serves to maintain the temperature thereof with safe operating limits. As a result, the controller 60 maintains the pressure of the water and the steam in substantial equilibrium, in which case the apparatus continues to operate under the increased steam pressure, and the cooling water effectively reduces the internal pressures within the vulcanized covering to values such that there is no danger of blistering as the conductor passes through the cooling water or emerges from the nozzle 34 into the atmosphere.

Should a sudden decrease in the pressure of the steam occur, it would result in the apparatus operating momentarily with the pressure of the water in the cooling tube substantially exceeding the pressure of the steam of the vulcanizing tube. Under such circumstances, the cooling water forces its way through the tube 73 and enters the splice box 32 and the mixing tube 31, whereupon the junction point of the water and steam starts moving slowly toward the right end of the mixing tube, that is, toward the resistance bulb 61 (Fig. 3). Since the water pressure exceeds the steam pressure, there is no leakage of hot water from the mixing tube into the cooling tube and, therefore the heating effect normally caused by such leakage is not present in the cooling tube. The absence of this heating effect on the water in the cooling tube 32 allows the entire body of water to reach a lower temperature as the water circulates through the cooling tube. While the cooling effect of the water is not impaired by the reduction in the pressure of the steam, if this condition were allowed to prevail for a prolonged period, the water would eventually penetrate a substantial distance into the vulcanizing tube and might prevent proper vulcanization of the covering of the conductor 20.

As the junction point moves toward the right end of the mixing tube 31, the bulb 62 becomes surrounded with water having a lower temperature and the bulb 61 now is surrounded by the hot water condensate, in which case, a constantly increasing temperature differential exists between the bulbs. While the temperature differential between the bulbs is constantly increasing, the actual temperature of each resistance element 106 thereof is decreasing, which effects a corresponding decrease in the ohmic resistance of each resistance element. This decrease in the

ohmic resistance of the elements 106—106 unbalances the bridge circuit 63 of the controller 60 and produces an unbalance potential thereacross.

The polarity of the unbalance potential produced by such a change in the temperature differential between the bulbs is such that when it is amplified by the electronic circuit 64 and applied to the solenoid 65, it causes the solenoid to turn the rotor of the variable capacitor 66 in a counter-clockwise direction to a position which brings the bridge circuit into balance in accordance with the temperature differential responsible for such movement.

This movement of the solenoid 65 also actuates the air valve 67 of the controller 60 so as to reduce the output pressure thereof which in turn, results in a corresponding reduced air pressure on the diaphragms 117 and 128 which actuate the valves 116 and 127, respectively. This reduced air pressure on the diaphragms of the valves effects a corresponding decrease in the opening of each valve which reduces the rate at which the cooling water is admitted to the cooling tube and consequently, the pressure of the water in the cooling tube, and the rate of discharge of the condensate from the mixing tube. When this reduction of the pressure of the water in the cooling tube occurs, further movement of the junction point is prevented, but since the junction point is not positioned equidistant between the bulbs 61 and 62, there still exists a substantially decreased temperature differential between the bulbs.

This temperature differential initially effects such a regulation of the valves 116 and 128 that the pressure of the steam slightly exceeds the water pressure, in which case, the junction point moves slowly toward position "A" in the mixing tube. As the junction point moves back to its normal or "A" position, the temperature differential constantly is increasing to its normal value, and the controller 60, in response thereto, continuously effects a regulation of the valves 116 and 127 in accordance with the increasing temperature differential. The controller 60 continues to respond to the changing temperature differential until the junction point is restored to position "A" in the mixing tube.

When the junction point again assumes the "A" position, the temperature differential between the bulbs is now slightly less than the differential that existed prior to the decrease in steam temperature, due to the drop in the temperature of the steam. However, the controller 60, in response to this new temperature differential, regulates the opening of the valve 116 so as to maintain the pressure of the water substantially equal to the new steam pressure which in turn, maintains the junction point midway between the bulbs 61 and 62. The controller 60 continues to control the pressure of the water in the cooling tube in this manner so that there is always present only a minimum leakage of hot water from the mixing tube through the tube 73 into the cooling tube 33, and in turn, regulates the flow of the water through the cooling tube at a rate sufficient to maintain the temperature of the cooling water at its most effective operating temperature.

To maintain such a control of the water pressure with respect to the steam pressure, the controller and the valves 116 and 127 are adjusted so that, for a given steam pressure and corresponding temperature differential between the

bulbs 61 and 62, the pressure of the water in the cooling tube is maintained slightly under the pressure of the steam in the vulcanizing tube so that there is always present a normal, but small, leakage of hot water into the cooling tube. It is preferable to have the leakage occur from the mixing tube to the cooling tube, rather than the reverse condition, because the amount of steam condensed under this condition is at a minimum, and hence, the steam consumption of the apparatus is accurately regulated so as to maintain a high degree of efficiency in the operation of the apparatus.

In operating continuous vulcanizing apparatus like that described hereinabove, it has been found that a steam pressure of at least 150 pounds per square inch in the vulcanizing tube will vulcanize satisfactorily the covering on the conductor advancing therethrough. Under certain operating conditions established by the size of the conductor and the rate at which it travels through the vulcanizing tube, it has been found that a vulcanizing tube approximately 200 feet long having steam therein under a pressure of 250 pounds per square inch will prove satisfactory. With such a steam pressure, the water in the supply line is maintained at a pressure of 270 pounds per square inch to allow for fluctuations in the steam pressure. The valve 116, in response to the controller 60, reduces the pressure of the water admitted to the cooling tube so that it is substantially equal to the pressure of the steam at all times. Under these conditions, it has been found that, when the cooling tube 33 is approximately sixteen feet long and the nozzle 34 is approximately three feet long, the apparatus will cool the covering and reduce the internal pressures therein so that danger of the covering blistering after it has passed through the cooling tube is prevented. When the steam is approximately at 250 pounds pressure in the vulcanizing tube 22, the temperature of the steam surrounding the bulb 61 is approximately 400° F. The temperature of the water admitted to the cooling tube 33 is approximately 38° F., in which case, the temperature of the water surrounding the bulb 62 is approximately 100° F. under normal conditions. Under these conditions, the temperature differential between the bulbs 61 and 62 is approximately 300° F. The controller 60, in response to this temperature differential, sets the valve 116 so as to maintain the pressure of the water substantially equal to the pressure of the steam. A change in the steam pressure effects a corresponding change in the temperature differential due to the resulting movement of the junction point. The controller 60, in response to any change in the temperature differential, regulates the valve 116 accordingly to effect a change in the water pressure commensurate with the change in the steam pressure, whereby equilibrium is restored between the water and steam pressure.

The vulcanizing tube 22, the mixing tube 31, the splice box 32, the cooling tube 33 and the nozzle 34 have been described as separate elements for the purpose of simplifying the specification and for emphasizing the particular function each element performs in the treatment of the insulated conductor 20. The vulcanizing tube 22 comprises a plurality of lengths of pipe secured together in tandem to form a vulcanizing tube having a predetermined length. The mixing tube 31 is a length of pipe designed to receive the resistance bulbs 61 and 62 which

straddle the normal junction point of the steam and water. The splice box 32 is interposed between the exit end of the mixing tube and the entrance end of the cooling tube to provide a closure which may be opened when the conductor 10 is threaded from the extruding head 16 through the vulcanizing tube and cooling tube. Since this assembly of these elements provides a continuous chamber in which the conductor is enclosed from the time it leaves the extruding head 16 until it emerges from the nozzle 34, the entire assembly may be considered as a single tube having a steam-filled portion of sufficient length to vulcanize the covering on the core 10 and a water filled portion of sufficient length to cool the covering before it emerges into the atmosphere.

What is claimed is:

1. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises an elongated tube through which the core passes continuously, means for maintaining a high temperature, high pressure vulcanizing fluid in a portion of the tube first encountered by the core to vulcanize the covering thereon, means for supplying a low temperature cooling fluid under pressure to a portion of the tube subsequently encountered by the core to cool the vulcanized covering, means for controlling the relative pressures of the fluids in said portions of the tube, means for measuring the temperatures of the fluids at predetermined spaced points within the tube and means responsive to temperature differentials existing between said spaced points as measured by said temperature measuring means for regulating the fluid pressure controlling means to maintain the pressures of the cooling fluid and the vulcanizing fluid substantially equal.

2. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises an elongated tube through which the covered core may pass continuously, means for maintaining a high temperature, high pressure vulcanizing fluid in a portion of the tube first encountered by the advancing core to vulcanize the covering thereon, means for supplying a low temperature cooling fluid under pressure to a portion of the tube subsequently encountered by the core to cool the vulcanized covering, a pair of temperature-sensitive elements positioned at spaced points in the tube, and an electronic controller arranged to respond to temperature differentials existing between the spaced points as measured by the temperature-sensitive elements for maintaining the pressures of the cooling fluid and the vulcanizing fluid substantially equal.

3. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises an elongated tube through which the covered core passes continuously, means for maintaining high temperature, high pressure steam in a portion of the tube first encountered by the core to vulcanize the covering thereon, means for supplying low temperature water under pressure to a portion of the tube subsequently encountered by the core in its path of travel through the tube to cool the vulcanized covering, a pair of temperature-sensitive elements positioned at spaced points in the tube, and an electronic controller arranged to respond to temperature differentials existing between the spaced points as measured

by the temperature-sensitive elements for maintaining the pressure of the cooling water substantially equal to the pressure of the steam.

4. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises means for subjecting the covering on the advancing core to a high temperature, high but fluctuating pressure vulcanizing fluid to vulcanize said covering, means for subjecting the vulcanized covering to a low temperature cooling fluid under pressure as it emerges from said vulcanizing fluid to cool the vulcanized covering on the core, means for controlling the relative pressures of the vulcanizing fluid and the cooling fluid, means for measuring the temperatures of the vulcanizing fluid and the cooling fluid at spaced points within the tube, and means responsive to the temperature differentials existing between the vulcanizing fluid and the cooling fluid at said spaced points as measured by said temperature measuring means for continuously regulating the pressure controlling means to maintain the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid.

5. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor, which comprises means for subjecting the covering on the advancing conductor to a high temperature, high but fluctuating pressure vulcanizing fluid to vulcanize said coverings, said vulcanization of the covering developing internal pressures in air and moisture entrapped therein, means for subjecting the vulcanized covering to a high pressure, low temperature cooling fluid as it emerges from said vulcanizing medium to cool the covering to reduce the internal pressures entrapped therein to values such that there is no danger of the covering blistering when the conductor emerges from the cooling medium into the atmosphere, means connecting the adjacent ends of the vulcanizing means and the cooling means, the vulcanizing fluid and the cooling fluid contacting each other with their junction point normally positioned at a predetermined point within said connecting means, and means including an electronic controller responsive to the temperature differential existing between the vulcanizing fluid and the cooling fluid at points adjacent to the normal junction point thereof for maintaining the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid at all times.

6. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises means for subjecting the covering on the advancing conductor to a high temperature, high but fluctuating pressure vulcanizing fluid to vulcanize said covering, said vulcanization of the covering developing undesirable high internal pressures in air and moisture entrapped therein, means for subjecting the vulcanized covering to a high pressure, low temperature cooling fluid as it emerges from said vulcanizing fluid to cool the covering and reduce the internal pressures entrapped therein to values such that there is no danger of the covering blistering when the conductor emerges from the cooling fluid into the atmosphere, means connecting the adjacent ends of the vulcanizing means and the cooling means, means associated with the cooling means through which the conductor passes for preventing excessive escape of the mixed fluids forming at the junction point thereof from

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the connecting fluid into the cooling means, the vulcanizing fluid and the cooling fluid contacting each other with their junction point normally positioned at a predetermined point in the connecting means, and means including an electronic controller arranged to be responsive to temperature differentials existing between the vulcanizing fluid and the cooling fluid at points adjacent to the normal junction point thereof for maintaining the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid at all times.

7. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises means for subjecting the covering on the advancing conductor to a high temperature, high but fluctuating pressure vulcanizing fluid to vulcanize said covering, said vulcanization of the covering developing undesirable high internal pressures in air and moisture entrapped therein, means for subjecting the vulcanized covering to a high pressure, low temperature cooling fluid as it emerges from said vulcanizing medium to cool the covering and reduce the internal pressures entrapped therein to values such that there is no danger of the covering blistering as the conductor passes through the cooling fluid, fluctuations in the pressure of the vulcanizing fluid causing corresponding variations in the temperature differential between fixed points in the fluids, means for selectively controlling the relative pressures of the fluids, and means including an electronic controller responsive to the temperature differentials existing between said fixed points for regulating the pressure controlling means to maintain the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid.

8. An apparatus for the continuous vulcanization of a vulcanizable compound surrounding a continuously advancing conductor, which comprises means for subjecting the covering on the advancing conductor to a high temperature, high but variable pressure vulcanizing fluid to vulcanize the covering on the conductor passing therethrough, means for subjecting the vulcanized covering to a high pressure, low temperature cooling fluid immediately after it emerges from the vulcanizing fluid to cool the vulcanized covering of the conductor, means connecting the adjacent ends of the vulcanizing means and the cooling means, the vulcanizing fluid and the cooling fluid being in contact with their junction point normally positioned at a predetermined point within the connecting means, adjustable means for conducting the mixture of the vulcanizing fluid and cooling fluid from the junction point at a predetermined rate, and means including an electronic controller arranged to be responsive to temperature differentials existing between the vulcanizing fluid and the cooling fluid at points spacedly positioned astride the normal junction point for simultaneously regulating the relative pressures of the fluids and the adjustable means controlling the discharge of the mixed fluids from the junction point so as to maintain the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid at all times.

9. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor, which comprises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying a high temperature, high

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but fluctuating pressure vulcanizing fluid to the vulcanizing tube to vulcanize the covering on the conductor, a cooling tube through which the conductor passes on leaving the vulcanizing tube, means for supplying a cooling fluid under pressure to the cooling tube adjacent its entrance end for cooling the vulcanized covering emerging from the vulcanizing tube, means connecting the adjacent ends of the vulcanizing tube and the cooling tube, the vulcanizing fluid and the cooling fluid contacting each other to form a junction point normally positioned at a predetermined point within the said connecting means, means provided in the entrance end of the cooling tube through which the conductor passes continuously to the cooling tube to prevent excessive escape of the vulcanizing fluid from the said junction point into the cooling tube, and means responsive to the temperature differential between the vulcanizing fluid and the cooling fluid at points astride the normal junction point thereof for selectively regulating the cooling fluid supply means so as to maintain the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid at all times.

10. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor, which comprises an elongated tube through which the covered conductor may be advanced, means for supplying a high temperature, high pressure vulcanizing fluid to the vulcanizing tube to vulcanize the covering on the conductor passing therethrough, an elongated cooling tube through which the conductor passes after leaving the vulcanizing tube, means for continuously supplying a low temperature cooling fluid under pressure to the cooling tube to cool the vulcanized covering on the conductor, the vulcanizing fluid and the cooling fluid being in contact with their junction point normally at a predetermined position near the exit end of the vulcanizing tube, means for measuring the temperatures of the fluids at fixed points on opposite sides of their normal junction point, fluctuations in the pressures of the fluids causing variations in the temperature differential between said fixed points, and means responsive to temperature differentials between said fixed points as measured by the temperature measuring means for continuously regulating the pressure of the cooling fluid so that only a minimum leakage of the vulcanizing fluid from the junction point into the cooling tube occurs, whereby the cooling fluid is maintained at its most effective operating temperature.

11. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying high but variable pressure, high temperature steam to the vulcanizing tube, an elongated cooling tube through which the insulated conductor passes after it emerges from the vulcanizing tube, a supply of low temperature water at a pressure above the maximum pressure of the steam admitted to the vulcanizing tube, means for continuously transmitting water from said high pressure source to the cooling tube, means provided in the water transmitting means for selectively controlling the water pressure in the cooling tube, a mixing tube connecting the vulcanizing tube and the cooling tube, the water and steam contacting each other to form a junction point nor-

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mally positioned at a predetermined point within the mixing tube, a pair of temperature-sensitive elements positioned in the mixing tube so as to straddle the normal junction point of the water and the steam, and an electronic controller responsive to the temperature differential existing between the temperature-sensitive elements for regulating the water pressure controlling means so as to maintain the water pressure and steam pressure substantially in equilibrium and thereby maintain minimum penetration of the condensate formed at the junction point into the cooling tube and vice versa.

12. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises an elongated vulcanizing tube through which the covered conductor is advanced, means for supplying high temperature, high but variable pressure steam to the vulcanizing tube for vulcanizing the covering on the conductor passing therethrough, a cooling tube through which the wire passes after it leaves the vulcanizing tube, adjustable means for continuously supplying low temperature water under pressure to the cooling tube to cool the vulcanized covering of the conductor as it passes therethrough, the steam and water being in contact with their junction point normally positioned adjacent to the exit end of the vulcanizing tube, means positioned at the entrance end of the cooling tube for preventing excessive escape of the hot fluids from the junction point into the cooling tube, means positioned at the exit end of the cooling tube to gradually reduce the pressure of the water escaping from the exit end of the cooling tube to that of the atmosphere, a pair of resistance bulbs positioned astride the normal junction point of the water and the steam, and an electronic controller including a sensitive Wheatstone bridge circuit arranged to be temporarily unbalanced by a change in the temperature differential existing between the resistance bulbs caused by a change in the pressure of the steam and to be automatically rebalanced so as to suit the changed temperature differential, said rebalancing operation of the controller effecting a corresponding regulation of the adjustable water supply means so as to maintain the pressure of the water substantially equal to the pressure of the steam at all times.

13. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying high pressure, high temperature steam to the vulcanizing tube, an elongated cooling tube through which the insulated conductor passes after it emerges from the vulcanizing tube, a supply of low temperature water at a pressure above the maximum pressure of the steam admitted to the vulcanizing tube, means for continuously transmitting water from said high pressure source to the cooling tube adjacent to the entrance end thereof, an air-operated valve provided in the water transmitting means for selectively controlling the water pressure in the cooling tube, a mixing tube connecting the adjacent ends of the vulcanizing tube and the cooling tube, the water and steam contacting each other to form a junction point normally positioned at a point equidistant the ends of the mixing tube, means positioned at the entrance end of the cooling tube for permitting continuous passage of the conductor therethrough

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while restricting the leakage of steam from the junction point into the cooling tube, a pair of resistance bulbs spacedly positioned in the mixing tube so as to straddle the normal junction point of the water and the steam to measure the temperatures of the water and steam adjacent said junction point, and an electronic controller responsive to the temperature differential existing between the resistance bulbs for selectively regulating the air-operated valve so as to maintain the water pressure substantially equal to the steam pressure, whereby any change in the steam pressure causes a movement of the junction point of the steam and water and a corresponding change in the temperature differential between the resistance bulbs and the temperature controller in response thereto effects a corresponding regulation of the air-operated valve to make the water pressure substantially equal to the steam pressure and restore the junction point to its normal position with respect to the resistance bulbs.

14. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor, which comprises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying high temperature, high but variable pressure steam to the vulcanizing tube whereby the conductor passing therethrough is subjected to heat and pressure sufficient to vulcanize the covering, said vulcanization of the covering developing undesirable high internal pressures in entrapped pockets of air and moisture in the covering, an elongated cooling tube through which the conductor passes after emerging from the vulcanizing tube, a mixing tube connecting the adjacent ends of the vulcanizing tube and the cooling tube, adjustable means for supplying low temperature water under pressure to the cooling tube to cool the covering and reduce the internal pressures therein to values such that there is no danger of the covering blistering as the covered conductor passes through the cooling tube into the atmosphere, the water and steam contacting each other to form a junction point normally positioned at a predetermined point within the mixing tube, means provided in the entrance end of the cooling tube through which the covered conductor passes as it enters the cooling tube for preventing excessive escape of the steam from the junction point into the cooling tube, means spacedly positioned in the mixing tube for measuring the temperatures of the steam and the water at points adjacent to the normal junction point thereof, and an electronic controller continuously responsive to the temperature differential existing between the temperature measuring means for regulating the water supply means so as to maintain the pressure of the water in the cooling tube substantially equal to the pressure of the steam in the vulcanizing tube at all times.

15. The process for the vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises passing the covered core continuously through an elongated treating zone, subjecting the advancing core to a high temperature, high pressure vulcanizing fluid within the portion of the treating zone first encountered by the advancing core to vulcanize the covering thereon, subjecting the advancing core to a low temperature cooling fluid within the next succeeding portion of the treating zone to cool the vulcanized covering, measuring

the temperature differential of the vulcanizing fluid and the cooling fluid between spaced points in the treating zone, and controlling the relative pressures of the fluids in accordance with the measured temperature differentials existing between said spaced points in the treating zone so as to maintain the pressure of the cooling fluid and the pressure of the vulcanizing fluid substantially equal.

16. The process for the vulcanization of a vulcanizable covering surrounding a continuously advancing core, which comprises passing the covered core through an elongated treating zone, subjecting the advancing core to a high pressure, high temperature vulcanizing fluid within the initial portion of the treating zone to vulcanize the covering thereon, subjecting the advancing core to a low temperature cooling fluid within the next subsequent portion of the treating zone to cool the vulcanized covering before the core emerges from the treating zone into the atmosphere, measuring the temperatures of the fluids at predetermined spaced points within the treating zone and controlling the relative pressures of the fluids in accordance with temperature differentials existing between the spaced points in the treating zone at which the temperatures are measured so as to continuously maintain the cooling fluid at a pressure substantially equal to the pressure of the vulcanizing fluid.

17. The process for the vulcanization of a vulcanizable covering surrounding a continuously advancing electrical conductor, which comprises passing the covered conductor continuously through a high pressure, high temperature vulcanizing fluid to vulcanize the covering surrounding the conductor, said vulcanization of the covering at the same time developing undesirable high internal pressures in the air and moisture entrapped in the covering, passing the conductor and the vulcanized covering continuously and directly from said vulcanizing fluid into and through a cooling fluid which is in contact with the vulcanizing fluid to cool the vulcanized covering, continuously measuring the temperature differential of the vulcanizing fluid and cooling fluid between predetermined points astride the normal contact point of the fluids, and controlling the relative pressures of the fluids in accordance with the measured temperature differentials existing between said spaced points so as to continuously maintain the pressures of the cooling fluid and the vulcanizing fluid substantially equal, whereby the pressure of the cooling fluid exceeds the internal pressure within said vulcanized covering and prevents blistering of the covering as the conductor passes through the cooling fluid.

18. The process for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor in which undesirable internal pressures may develop in air and moisture entrapped within the covering when the covering is vulcanized, which comprises passing the covered conductor continuously through a vulcanizing zone, subjecting the covering to a high pressure, high temperature vulcanizing fluid while passing through said vulcanizing zone to vulcanize the covering, passing the conductor and the vulcanized covering continuously from said vulcanizing zone to a cooling zone, continuously maintaining a cooling fluid under pressure in the cooling zone to cool the vulcanized covering, the vulcanizing fluid and the cooling fluid being in contact with their junction point nor-

mally positioned at a point intermediate the adjacent ends of the cooling zone and the vulcanizing zone, continuously measuring the temperature differential existing between the vulcanizing fluid and the cooling fluid at points spacedly positioned astride the normal junction point thereof, and continuously regulating the pressure of the cooling fluid in accordance with the measured temperature differential so as to maintain the cooling fluid at a pressure substantially equal to the pressure of the vulcanizing fluid at all times, whereby the high internal pressures within the covering are reduced by the cooling fluid to values such that there is no danger of the covering blistering as the vulcanized covering passes through the cooling zone.

19. The process for the vulcanization of a vulcanizable covering surrounding a continuously advancing electrical core, which comprises continuously passing the covered core through an elongated treating zone, continuously supplying high temperature, high pressure steam to a portion of the treating zone first encountered by the core as it travels therethrough to vulcanize the covering on the core, continuously supplying low temperature water under pressure to a portion of the treating zone subsequently encountered by the core for cooling the vulcanized covering, continuously measuring the temperature differential of the steam and the water between predetermined spaced points in the treating zone, and controlling the relative pressures of the steam and water in accordance with the measured temperature differentials existing in the treating zone between said spaced points so as to maintain the pressure of the cooling water substantially equal to the pressure of the steam.

20. The process for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing electrical conductor, which comprises passing the covered conductor through a vulcanizing zone, maintaining high temperature, high pressure steam in the vulcanizing zone to vulcanize the covering surrounding the conductor, passing the conductor and the vulcanized covering continuously and directly from said vulcanizing zone through a cooling zone, continuously maintaining low temperature water under pressure in the cooling zone to cool the vulcanized covering as the conductor passes therethrough, the steam and water being in contact with their junction point normally positioned at a point intermediate the adjacent ends of the vulcanizing zone and the cooling zone, continuously measuring the temperature differential existing between the steam in the vulcanizing zone and the water in the cooling zone at points spacedly positioned astride the normal junction point thereof, and continuously regulating the pressure of the cooling water in the cooling zone in accordance with the measured temperature differential existing between the steam and the water at said spaced points to maintain the pressure of the cooling water substantially equal to the pressure of the steam in the vulcanizing zone.

21. The process for the vulcanization of a vulcanizable covering surrounding a continuously advancing electrical core, which comprises continuously passing the covered core through a treating zone, continuously supplying high temperature, high pressure steam to a portion of the treating zone first encountered by the core as it travels therethrough to vulcanize the covering thereon, continuously supplying low tem-

perature water to a portion of the treating zone subsequently encountered by the advancing core for cooling the vulcanized covering, the steam and the water contacting each other to form a junction point normally positioned in a portion of the treating zone intermediate the vulcanizing and cooling portions thereof, discharging the condensate forming at the junction point from that portion of the treating zone, and continuously regulating the relative pressures of the water and steam and the rate of discharge of the condensate from the junction point in accordance with temperature differentials existing between the steam and the water at points spacedly positioned astride the said normal junction point so as to maintain the cooling water at a pressure substantially equal to the pressure of the steam at all times.

22. The process for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing electrical conductor, which comprises passing the covered conductor through a vulcanizing zone, maintaining a high temperature, high pressure vulcanizing fluid within the vulcanizing zone to vulcanize the covering on the advancing conductor, passing the conductor and the vulcanized covering continuously and directly from said vulcanizing zone through a mixing zone, passing the conductor and the vulcanized covering from the mixing zone into a cooling zone, continuously maintaining a low temperature cooling fluid under pressure in the cooling zone to cool the vulcanized covering as the conductor advances therethrough, the vulcanizing fluid and the cooling fluid contacting each other to form a junction point normally positioned at a predetermined point within the mixing zone, discharging the mixed fluids from the mixing zone, continuously measuring the temperature differential existing between the vulcanizing fluid and the cooling fluid at points spacedly positioned astride the normal junction point of the fluids in the mixing zone, and continuously regulating the discharge of the mixed fluids from the mixing zone and the relative pressures of the cooling fluid and vulcanizing fluid in accordance with the measured temperature differential so as to maintain the pressure of the cooling fluid substantially equal to the pressure of the vulcanizing fluid at all times.

23. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding conductors, which comprises means for subjecting the covering on the advancing conductor to a high temperature, high pressure vulcanizing vapor to vulcanize said covering, means for subjecting the vulcanized covering to a high pressure, low temperature cooling liquid as it emerges from said vulcanizing medium to cool the covering, said vulcanizing vapor and cooling liquid contacting each other with their junction point normally positioned intermediate the adjacent ends of the vulcanizing means and the cooling means, fluctuations in the pressures of the vapor and liquid causing longitudinal movement of the junction point thereof and corresponding variations in the temperature differential therebetween, and means including an electronic controller responsive to the temperature differentials existing between the vulcanizing vapor and the cooling liquid for maintaining the pressures thereof substantially equal.

24. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a continuously advancing conductor, which com-

prises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying high but fluctuating pressure, high temperature steam to the vulcanizing tube to vulcanize the covering on the conductor, an elongated cooling tube through which the insulated conductor passes as it emerges from the vulcanizing tube, means for continuously circulating low temperature water through the cooling tube at a predetermined pressure below the pressure of the steam to cool the vulcanized covering, said steam and water contacting each other and having their junction point normally positioned at a predetermined point with respect to the exit end of the vulcanizing tube, said pressure differential between the water and the steam causing a predetermined leakage of hot fluid from the junction point into the cooling tube, means for measuring the temperatures of the steam and the water at fixed points on opposite sides of their normal junction point, said fluctuations in the steam pressure causing longitudinal movement of the junction point and corresponding variations in the temperature differential between the steam and the water at said fixed points, and means responsive to the temperature differentials between the water and the steam at said points as measured by the temperature measuring means for selectively controlling the water circulating means to continuously maintain the water in the cooling tube at a pressure which maintains said predetermined leakage of hot fluid into the cooling tube.

25. An apparatus for the continuous vulcanization of a vulcanizable covering surrounding a conductor, which comprises an elongated vulcanizing tube through which such a covered conductor may be advanced, means for supplying high temperature steam at approximately 250 pounds pressure to the vulcanizing tube to vulcanize the covering on the conductor, an elongated cooling tube through which the covered conductor passes after it emerges from the vulcanizing tube, a supply of low temperature water maintained at a pressure of about 270 pounds per square inch, means for continuously transmitting water from said high pressure supply to the cooling tube to cool the vulcanized covering, said steam and water contacting each other with their junction point normally positioned at a predetermined point with respect to the exit end of the vulcanizing tube, means positioned at the exit end of the cooling tube through which the conductor passes for regulating the discharge of the water therefrom, adjustable means provided in the water transmitting means for selectively controlling the pressure of the water introduced into the cooling tube so that only a predetermined leakage of steam from the junction point into the cooling tube occurs, a temperature-sensitive element subject to the temperature of the steam adjacent to the normal junction point, a second temperature-sensitive element subject to the temperature of the water adjacent to the normal junction point, fluctuations in the pressures of the water or the steam causing longitudinal movement of the junction point with respect to the temperature-sensitive elements and effecting corresponding changes in the temperature differential between said temperature-sensitive elements, and an electronic controller responsive to the temperature differentials between the temperature-sensitive elements for adjusting the water pressure controlling means so as to maintain the said predetermined leakage of

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steam into the cooling tube, whereby the cooling water is maintained at its most effective operating temperature.

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