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A. H. EMERY.

APPARATUS FOR TEMPERING PARTS OF GUNS OR OTHER TUBULAR BODIES.

APPLICATION FILED NOV. 26, 1892.

NO MODEL.

Fig. I.

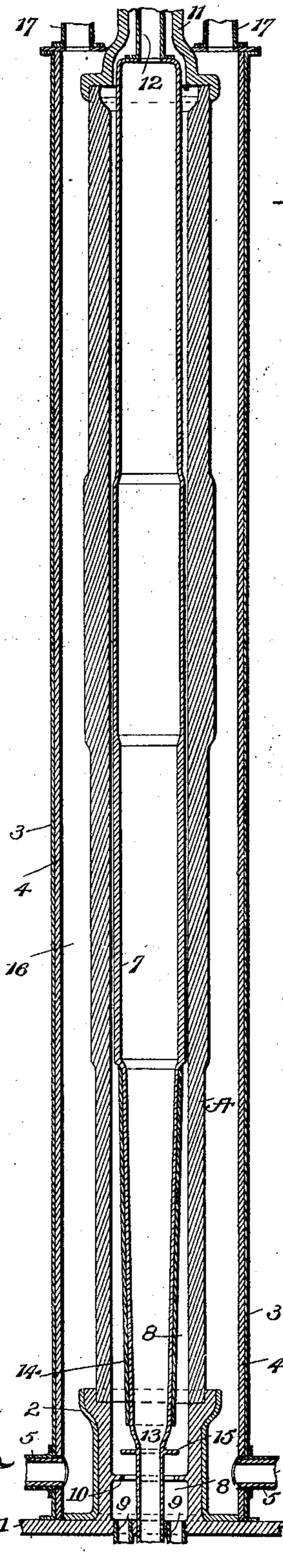


Fig. II.

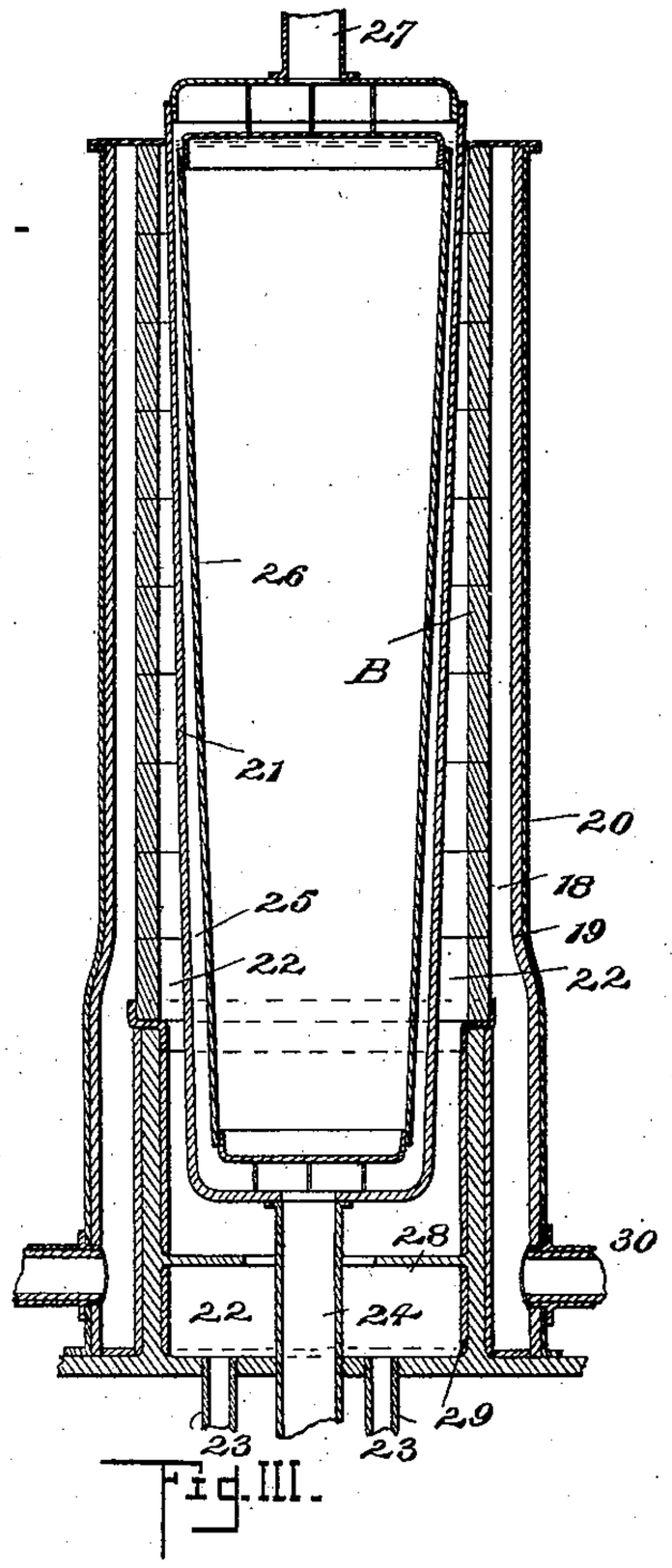
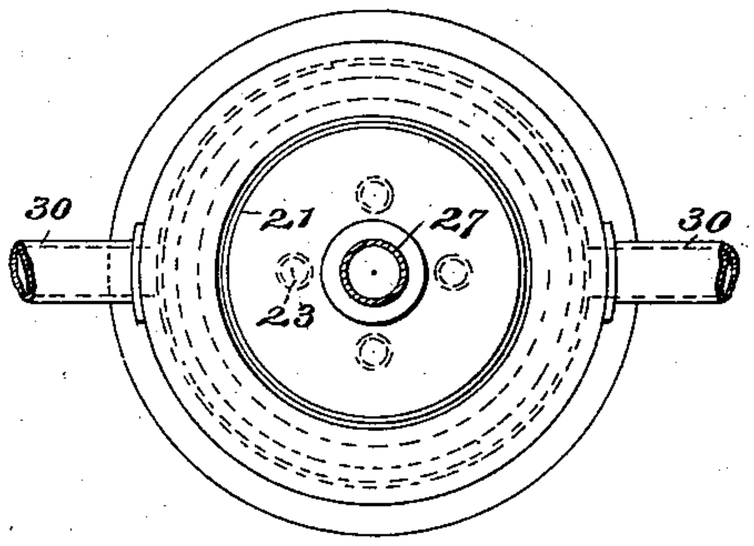


Fig. III.



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UNITED STATES PATENT OFFICE.

ALBERT H. EMERY, OF STAMFORD, CONNECTICUT.

APPARATUS FOR TEMPERING PARTS OF GUNS OR OTHER TUBULAR BODIES.

SPECIFICATION forming part of Letters Patent No. 720,337, dated February 10, 1903.

Original application filed August 30, 1882, Serial No. 70,621. Divided and this application filed November 26, 1892. Serial No. 453,210. (No model.)

To all whom it may concern:

Be it known that I, ALBERT H. EMERY, a citizen of the United States, residing at Stamford, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Apparatus for Tempering Parts of Guns or other Tubular Bodies, of which the following is a specification.

The invention hereinafter described and claimed was originally disclosed in my application, Serial No. 70,621, filed the 30th of August, 1882, of which application the present is a division.

In the manufacture of tempered-steel tubes for barrels and other parts of guns it is highly desirable to so perform the tempering operation or apply the cooling fluid in the operation of tempering that the metal will be cooled from the interior outward, so as to subject the tubular body to initial strains of compression on the interior and tension on the exterior, and with tubes of any considerable length these relative strains of compression on the interior and tension on the exterior may be in a longitudinal direction as well as tangential or circumferential. To accomplish this result in the tempering of tubular bodies, I place the body to be tempered in vertical position and introduce within it a cooling liquid or fluid, so that cooling and tempering will proceed from the interior outward, as desired, during which the exterior may be surrounded by such non-conducting materials or heated walls or gases as shall sufficiently retard the cooling of the exterior. It is preferred to effect the cooling and tempering from the interior outward by means of a stream of oil or other liquid forced under pressure through the tubular body. By providing passages of variable thickness or radial depth through which the cooling or tempering media are conducted over the interior or exterior, or both, of the body to be tempered after heating the cooling of the inside and outside and of the various parts of the tubular body to be tempered are regulated so as to produce such initial strains therein as will adapt the tubular body—such, for example, as the barrel or other part of a gun—to operate to the best advantage and develop the greatest strength in use. The same principle is applicable to the controlling of the cooling or heating of the parts at various stages in assembling the parts of a composite gun or other structure. For example, one part may be cooled while another is heated or the cooling may be retarded by heating media on the exterior or interior of the body under treatment, so as to regulate the cooling of the parts, retard the cooling of parts which would otherwise be cooled too rapidly, or control the cooling of the interior and exterior parts with relation to each other. By enveloping the exterior of the tubular body in a heating or non-conducting medium while the interior is cooled by passing a cooling medium through it the tempering of the piece will leave it with initial strains of compression on the interior and tension on the exterior, caused by the more rapid cooling of the inner parts or cooling from the interior outward. That smoke and vapor may not prevent the liquid from continuous contact with the bore, and thus cause unequal cooling of its surface, a tube is passed through the barrel or other part which stands for tempering in a vertical position, with the axis of the tube coincident with that of the barrel. The oil or other cooling liquid is then rapidly forced through the opening between the tube and barrel. This insures contact of the liquid with the interior surface of the bore throughout its whole extent and permits the cooling of each portion of the barrel with uniformity, so far as the opposite sides of each portion are concerned, whereas should one side cool more quickly than the other the strains would be unsymmetrical and the barrel crooked thereby. Cooling from the interior and cooling the barrel symmetrically will give strains of compression on the interior both longitudinally and tangentially and strains of tension on the exterior both longitudinally and tangentially, all of which are desirable for the best endurance of the piece. To insure the liquid being of the temperature desired throughout the different parts of the barrel, the tempering-tube through the interior of the barrel should be of uniform thickness and have passed through it a stream of water or other suitable liquid of such temperature as will keep its exterior of proper temperature to cool the oil between it and the gun-barrel to the extent desired. Should more rapid cool-

ing be desired in one part than another, this inner tube may be of variable thickness at different parts of its length; but it should always be symmetrical. That the oil shall be of the proper temperature in this process it should have rapid circulation through the barrel from one end to the other. Pipes bring the water or other liquid from a pump or other proper source, carrying it away as fast as heated. The more rapid the circulation through the inner tube and the thinner the walls of this tube are the more effectively is the air or other tempering fluid around it kept uniformly of the desired temperature. A solid bar may be used in place of this inner tube; but the temperature of the liquid cannot nearly so well be regulated as when the tube is used with the liquid circulating through it, as mentioned. Air or gases may be forced through the tube with great rapidity to regulate its temperature. Air or gases may also be used to circulate between the tube and the gun-barrel to temper it. If air or gases only are used between the tubes and the tubular body to be tempered, the velocity of the discharge should be high to insure proper cooling. Cooling-gases may be used, if necessary, in the inner tube instead of liquids to produce rapid reduction of temperature, or freezing mixtures could be used, if desired; but care must be used not to reduce the temperature so fast as to crack the interior of the part being tempered. In regard to the size of the inner tube placed in the gun-barrel when tempering it should be borne in mind that the smaller the space between it and the barrel the more rapidly the heat will be taken from the barrel to the cooling or tempering medium passing between the barrel and the cooling-tube. The rate of cooling the different parts of the barrel may thus be hastened or retarded at will by regulatig the distance between the cooling-tube and barrel at different parts of the bore to make the cooling more or less rapid, as desired. The rate of conducting heat away from the part being tempered may also be regulated by the inner cooling-tube having around its interior or exterior walls at such places as are desired bands of poor heat-conducting material. These bands may be used in conjunction with different thicknesses of tube, if desired, to aid in regulating the heat it should abstract from the tempering medium around it.

In the accompanying drawings, Figure I is a vertical section of an apparatus illustrating my invention applied to the tempering of a gun-barrel. Fig. II is a vertical section, on a larger scale, of an apparatus of modified form, also illustrating the invention and applied to tempering a stack of bands or rings suitable for use in constructing, lining, or strengthening composite guns. Fig. III is a top view of the apparatus shown in Fig. II.

In Fig. I a gun-barrel A to be tempered is shown standing vertically on a base-piece 1, which is surrounded by a coating 2, of non-conducting material. The gun-barrel is surrounded at a suitable distance by a shell 3, lined with fireproof material 4, which receives a preliminary heating by suitable means—as, for example, by hot gases introduced through pipes 5, lined with fireproof material 6. The heat applied in the annular flue or passage around the gun-barrel A should be sufficient to effectively heat the exterior of the barrel to be tempered. Heat may be likewise applied to the interior of the gun-barrel by hot gases or by gas-burners of suitable construction, such as described and shown in my application, Serial No. 70,621, filed August 30, 1882, of which the present is a division. When it has been sufficiently heated for tempering either from the interior or exterior, or both, the interior heating apparatus is removed and the pipe 7 inserted, around which circulates through the annular chamber 8 the cooling medium which performs the tempering. The cooling fluid is brought in through pipes 9, and impinging against the flange 10 spreads around the pipe 7 and passes upward between it and the interior surface of the gun-barrel A. The chamber or space 8 between the pipe 7 and the gun-barrel A is of variable thickness or radial depth, so that the tempering medium may abstract heat more rapidly from the thick part of the barrel than from the thinner parts. Cold air, gases, oil, or other suitable cooling medium may be circulated through the chamber 8, passing upward and out through the pipe 11, or, if preferred, passing in through the pipe 11 and out through the pipes 9. To keep this cooling medium in contact with the inner wall of the piece A to be tempered, the space between the pipe 7 and the gun-barrel A should not be very wide at any point. The amount of heat which will be extracted from the barrel A will vary with the thickness or radial width of the chamber 8 and the velocity of the fluid passing through it, as well as the temperature of the cooling medium itself. The temperature may be kept down to the proper degree by varying the thickness of the tube 7 and circulating through it a proper cooling medium, which may enter through the pipe 12 and pass out through the pipe 13. That the heat may not be too rapidly abstracted from the cooling medium itself at any point the pipe 7 may be surrounded with a coating of non-conducting material, as shown at 14. These encircling non-conducting bands can be put upon the interior or exterior of the pipe and at such places and of such thickness as the exigencies of the case shall require. 15 shows a flange on the upper part of the pipe 13, which leads out of the tube 7. The use of this flange is to spread the cooling medium so that it may have uniform flow as it passes up around the tube. The pipes 5, lined with non-conducting material 6, may bring in a heating or cooling medium to act in conjunction with that which is passing through the chamber 8 while tem-

pering—that is to say, the tempering may proceed wholly from the interior by using a heating medium in the chamber 16 around the gun-barrel A, while the cooling medium is passed through the chamber 8. It will substantially be cooled wholly from the interior if the chamber 16 is simply closed with no circulation through the pipes 5, which lead into it, and the pipes 17, which lead out of it, as the walls 4 of this chamber are already hot, having become so during the process of heating the gun-barrel A; but, if required, a cooling-gas or other medium is passed through this chamber 16 to assist in the reduction of the temperature of the gun-barrel A while being tempered. At the same time the greater part of the heat of the gun-barrel should be conducted off through the cooling medium circulated through the chamber 8, which is assisted, if need be, by the cooling medium circulated through the pipe 7.

In Fig. II, B represents a stack or series of banding-rings of steel to be tempered, which have been heated, as already described, by hot gases or flames circulating in the interior, assisted, if desired, at the same time by hot gases in the exterior chamber 18, formed between the lining 19 of the walls 20 of the exterior chamber and the rings B, which are being heated. After the heating has been performed the heating apparatus used on the interior of these rings is removed and replaced by a chamber, drum, or tube 21, preferably made of metal, and between which and the rings may be sent a current of cooling medium, which in this case may well be a current of cold air passing with high velocity into this annular chamber 22 through the pipes 23 and which is kept comparatively cool by liquid brought through the pipe 24, passing through the annular chamber 25, around the drum 26, and out through the pipe 27. The liquid may, if preferred, pass in through the pipe 27 and out through the pipe 24. That the air, gas, or other cooling medium brought in through the pipes 23 may pass through the chamber 22 with uniform velocity around it it is allowed to impinge against the flange 28 on the interior of the supporting-base 29, when it will pass with comparatively uniform velocity through each horizontal section around the chamber 21. The annular chamber tapers upward in radial width or capacity, so that as the cooling medium becomes heated by contact with the body of rings B being tempered it may be brought more intimately in contact with the said rings. For the same purpose to carry off the heat more rapidly from the cooling medium the walls of the chamber, drum, or tube 21 are thinner at the upper end than at the lower, and the space between the drum or tube 21 and its contained drum 26 may also be made narrower, which will cause the cooling medium passing through the pipes 27 and 24 to be more active at that point. Air or gas for cooling or heating may be brought through the pipes 30 into the chamber 18 and pass out at suitable openings provided therefor at the top, so that this exterior chamber surrounding the rings B may be used either to heat or assist in heating them or may be used to assist in cooling them; but in cooling the tempering should be mainly from the interior outward.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In an apparatus for cooling and tempering tubular bodies, the combination of an external casing for protecting the outside of the body to be cooled, and an internal tube arranged to make with the tubular body an annular passage for conducting cooling fluid through the tubular body in a thin film in contact with its interior, said annular passage and internal tube each having separate inlets and outlets to permit the passage of separate fluids through them to bring a tempering fluid into contact with the body to be cooled and to regulate or modify the temperature of the tempering fluid.

2. In tempering tubular bodies by introducing into the body to be treated, cooling fluids, the combination of an internal tube constructed for use within said body, with a wall of varying thickness in different parts of its length, and forming with said body when introduced therein, an annular conduit for a cooling medium to pass between them, and means for separately supplying a tempering fluid to the annular conduit, and a temperature-regulating fluid to the interior of the internal tube, substantially as set forth.

3. In an apparatus for cooling and tempering tubular bodies, the combination of an internal tube constructed to form with said body an annular conduit for a tempering medium; and separate inlet and outlet passages for said conduit and said tube, through which they are supplied separately with a tempering medium and a temperature-regulating medium.

4. In an apparatus for cooling and tempering tubular bodies, an internal tube forming with the tubular body to be tempered, an annular passage, for a tempering medium between the exterior of said internal tube, and the interior of the tubular body to be tempered, means whereby a tempering medium is caused to flow through said annular passage, so as to cool the tubular body from the interior outward, one or more bands of non-conducting material surrounding the said internal tube, for a part of its length, so as to vary the conducting effects thereof in different parts of its length, and means for supplying a temperature-regulating medium to the interior of the internal tube, independently of the tempering medium, substantially as set forth.

5. As an improvement in tempering tubular bodies so as to leave them normally under strains of exterior tension and interior

compression; the combination of an external jacket constructed to surround the tubular body, a temperature-controlling medium between said exterior jacket and said tubular body, retarding the cooling of the latter, an internal tube within the tubular body, a tempering medium between the tubular body and this tube, and a separate temperature-regulating medium within the internal tube, controlling the tempering effect of the tempering medium.

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