(No Model.) 2 Sheets—Sheet 1.

E. T. GREENFIELD.

ART OF LINING METAL TUBES WITH FIBROUS MATERIAL

No. 570,165. Patented Oct. 27, 1896.

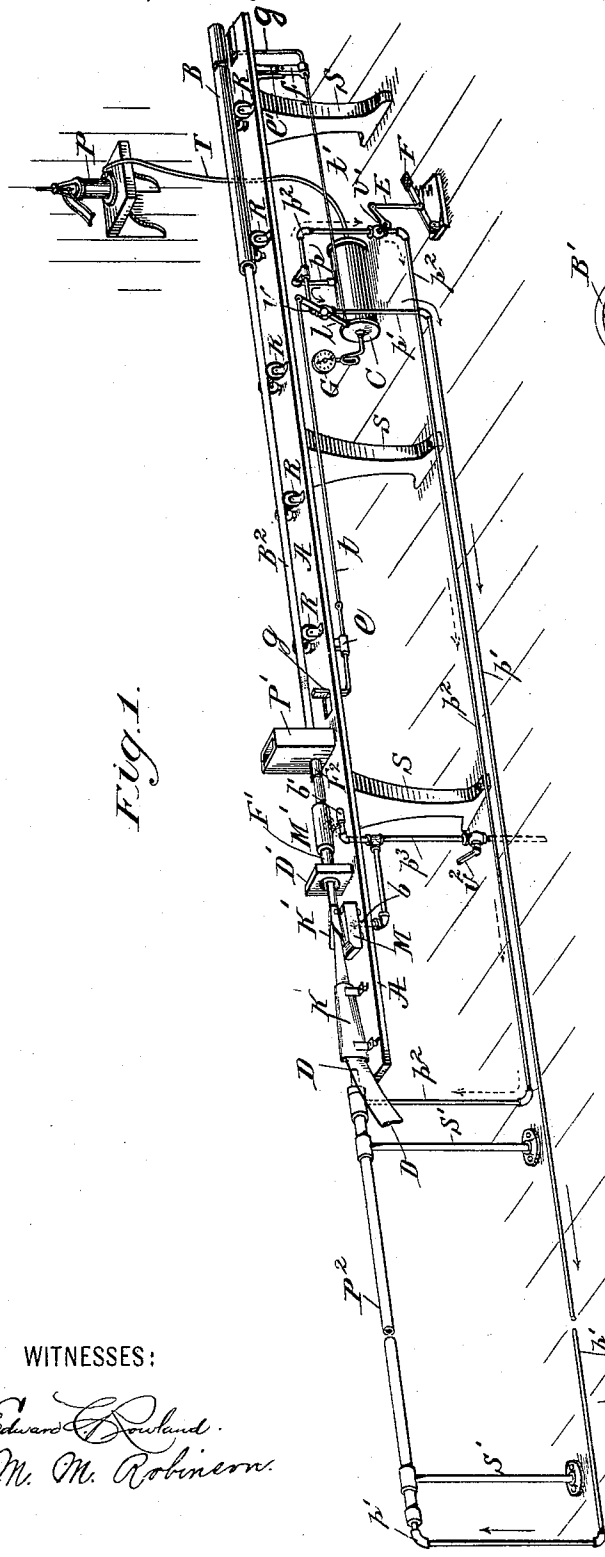

FIG. 1.

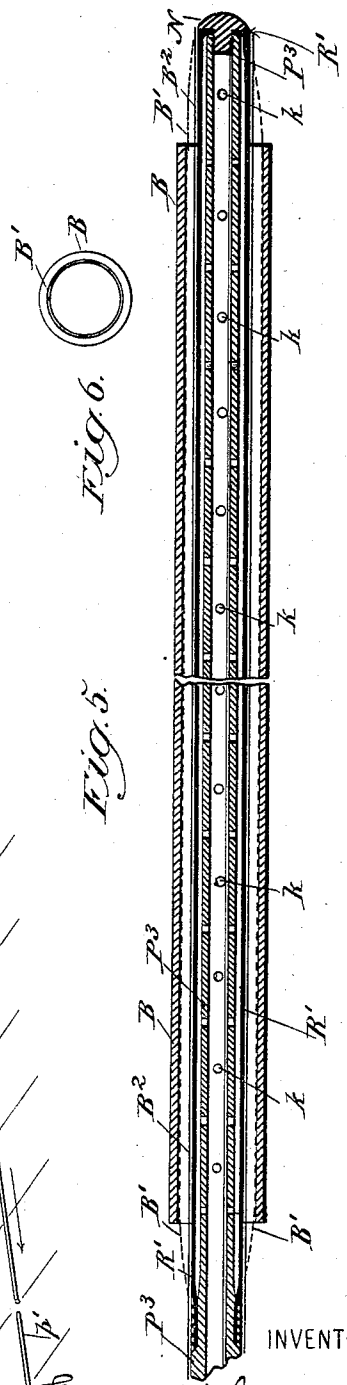

FIG. 5.

FIG. 6.

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(No Model.) 2 Sheets—Sheet 2.

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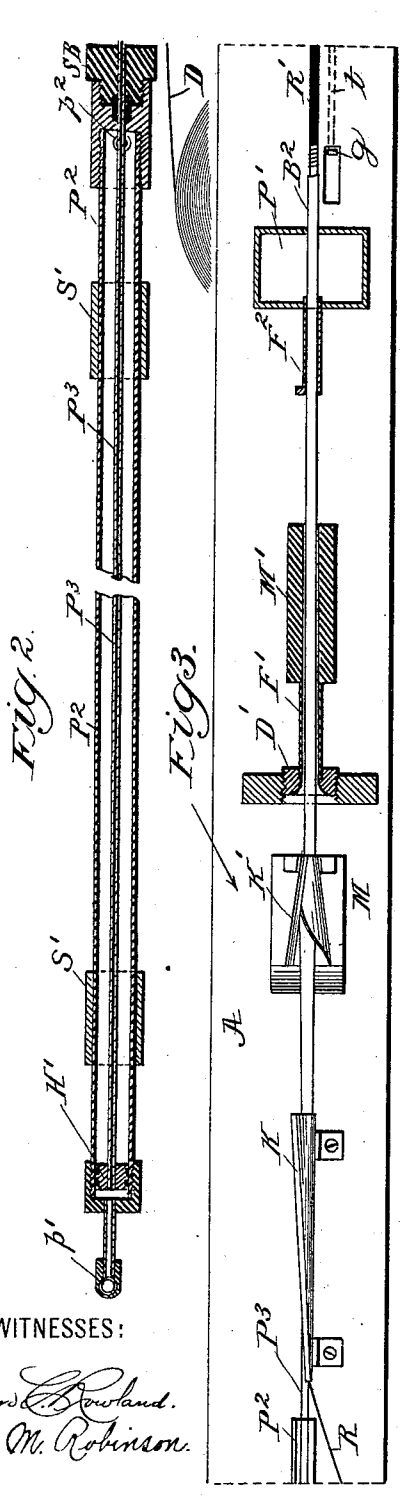

Fig. 2.

Fig. 3.

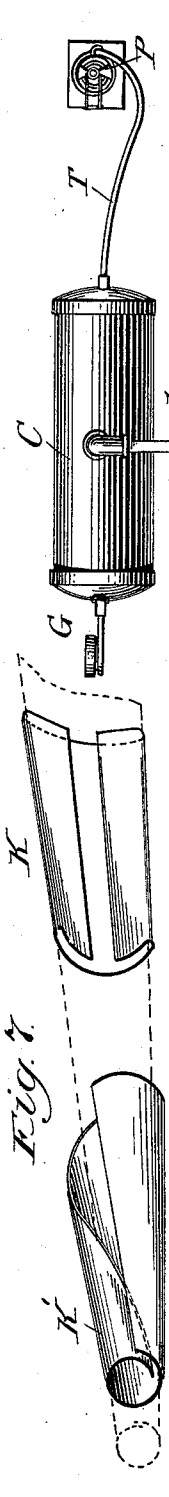

Fig. 7.

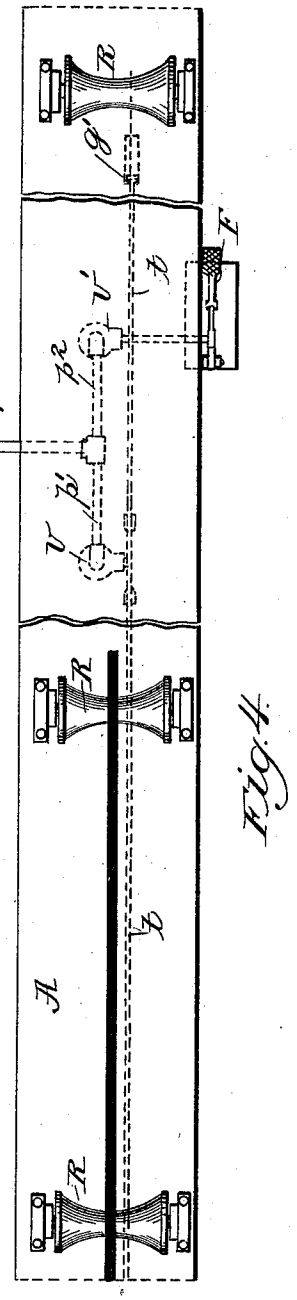

Fig. 4.

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ART OF LINING METAL TUBES WITH FIBROUS MATERIAL.

SPECIFICATION forming part of Letters Patent No. 570,165, dated October 27, 1896.

Application filed March 2, 1896. Serial No. 581,582. (No model.)

To all whom it may concern:

Be it known that I, EDWIN T. GREENFIELD, a citizen of the United States, residing at New York, in the county of New York and State of New York, have made a new and useful Invention in the Art of Lining Metal Tubes with Fibrous Material, such as Paper, of which the following is a specification.

My invention is directed particularly to the lining of metal tubes for conduit purposes, and its objects are, first, to effect the lining of said tubes with much greater speed than has heretofore been possible; second, to avoid the tearing or rupturing of the paper or analogous lining as it is drawn into the metal tube; third, to effect the formation of a paper tube by simply drawing it through a die in the direction of the length of the strip from which it is formed; fourth, to thoroughly expand and thereby unite the paper lining to the inner wall of the tube to be lined after it is once drawn therein; fifth, to accomplish any and all of the results necessarily attributable to the methods of operation and mechanism for effecting such operation, as hereinafter described, and particularly pointed out in the claims at the end of this specification.

Prior to my invention it was old in the art to line metallic tubes with paper or equivalent fibrous material by first constructing a tube of such paper or fibrous material and then coating the tube with an adhesive agent, and finally forcing said tube into the metallic tube and allowing the two to be firmly united together by such adhesive agent. It was also old to line a metallic tube by drawing a paper strip or strips within said tube and simultaneously coating said strip or strips with paste or other adhesive agent, and then drawing a former or expanding mandrel therethrough so as to cause the two tubes to be firmly united together. A metallic tube has also heretofore been lined by drawing a fibrous lining within the tube and afterward drawing an expansible lead lining within the fibrous lining, and then forcing a piston therethrough under hydraulic pressure so as to cause the lead lining to expand the fibrous lining and force it against the inner wall of the tube. These methods of lining tubes, while productive of good results, were not capable of being effected with such speed or efficiency as is possible with my present improvement, and it was with the object of effecting further improvements in the art that the present invention was devised.

My invention will be fully understood by referring to the accompanying drawings, in which—

Figure 1 represents a perspective view of the entire apparatus in course of operation in effecting the lining of a metallic tube with paper or equivalent fibrous material. Figs. 2, 3, and 4 are part sectional and part plan views of the apparatus shown in Fig. 1, said views being upon an enlarged scale. Fig. 5 is a longitudinal sectional view of a metallic tube with my improved expanding apparatus in position within said tube, illustrating also the manner of expanding the paper or fibrous lining after it is in proper position for effecting such expansion. Fig. 6 is a cross-sectional view illustrating a metallic tube provided with my improved paper or analogous fibrous lining. Fig. 7 is a perspective view of the two forming-dies which give to the lining the necessary tubular conformation as it is drawn from a roll of such material, such conformation of the paper being illustrated in said figure of the drawings in dotted lines.

Referring now to the drawings in detail, and first to Fig. 1, A represents a table secured to the floor by standards S S S. On the upper surface of this table are grooved rollers R R R R, located in alinement for supporting a metallic tube B, which it is designed to line with paper.

P is an air-pump secured in convenient proximity to the table A and operatively connected by a pipe or tube T with an air-compression chamber or cylinder C, provided, as shown, with a pressure-gage G. This air-chamber C is connected by a pipe p to a pair of pipes p' and p^2, the former running to and being connected with one end of a metallic tube P^2, secured by standards S′ S′ to the floor, and the other to the remaining end of said pipe, as clearly shown in Figs. 1 and 2 of the drawings.

v v' are valves, the former being located in the pipe p' and the latter in the pipe p^2. The valve v is controlled in its operation by an arm

l, connected by rods t t' to automatic stops g g', the former extending from a sustaining-standard e through an opening in the table A into the path of the tube B as it is advanced, and the latter extending upward through a similar opening in said table and adapted to be brought into the path of said tube B in its return movement through the agency of a pivoted arm f, secured by a standard e' on the under side of the table A, as will be fully described in connection with the description of the mode of operation of the entire apparatus. The valve v', located in the pipe p', is controlled by a spring-actuated foot-lever F and link and bell-crank lever E. This valve v' is of the well-known three-way type and is so arranged that in its normal condition there is free communication from the open air through it and the pipe p^2 to the inner end of the metal pipe or cylinder P^2.

P^3 is a tubular piston-rod located within the metallic tube P^2 and provided with a packed piston-head H' at one end and passing through a stuffing-box SB, connected to the end of the tube P^2, which is located next to the table A. That portion of the hollow piston-rod P^3 located within the tube P^2 is preferably about ten feet in length and the outer or exposed portion of this piston-rod, which extends beyond the stuffing-box SB, is of about the same length, but its exterior diameter is somewhat diminished, as clearly shown in Fig. 5, and it is provided with a large number of perforations k k k k. It is also surrounded with a close-fitting sleeve R', of pliable or soft rubber, secured to it at one end by wire-winding and at the other by a screw-plug N, the arrangement being such that when the close-fitting rubber sleeve is in the position shown in Fig. 5, the total diameter of the exposed portion of the piston-rod and the rubber sleeve is substantially the same as that of the inclosed portion of said rod. The outer or exposed portion of this piston-rod extends, when in position, through a pair of forming-dies K K', located in alinement with each other and secured to the top of the table A. It also extends through a cone-shaped compressing-die D', provided with a sleeve F', connecting said cone-shaped die to a heating-die M', and thence through a guiding-sleeve F^2 into a paste-chamber P', filled with paste or any analogous adhesive agent, the extreme end of said tubes resting above the rollers R R R R at a point near the approaching end of the tube B to be lined, as clearly shown in Fig. 1 of the drawings.

Beneath the forming-die K' and secured to the table is a metallic heating-chamber M, provided with a gas-burner b, b' being a similar gas-burner located beneath the heating-die M', said gas-burners being connected by a pipe p^3, running to a supply of gas and controlled by a cock v^2.

D represents a strip of paper entering the first forming-die K from a roll of paper. The width of this strip of paper D is preferably sufficient to give to the completed paper tube before it enters the metallic tube B a slight lap at its edges, so that when said tube is expanded this lap will substantially disappear and cause the edges to abut, thus giving to the lining a complete tubular form.

The operation of the apparatus is as follows: The air-chamber C is filled with air under pressure from the pump P to the desired compressibility and is kept thus filled by the operator as the process of lining proceeds. The operator now places his foot upon the spring-actuated foot-lever F, thereby turning the valve v' to the desired position, thus allowing air to enter, as shown by the dotted arrows, from the air-chamber C by pipe p and pipe p^2 in the rear of the piston-head H', connected to the piston-rod P^3, thus forcing it into the position shown in Fig. 2. The operator now draws by hand a strip of paper D through the forming-dies K K', the conical die D', sleeve F', heating-die M', sleeve F^2, and paste-chamber P', which has been filled with paste or other adhesive agent. As the strip of paper is thus drawn forward it is subjected to a heating influence from the gas-burners b and b' under the curvilinear forming-die K' and the solid tubular metallic heating-die M', and is therefore effectually ironed into tubular form under the united effect of the dies and the heat. As it leaves the latter heating-die, therefore, it remains in its tubular form around the tubular mandrel or the outer or exposed end of the piston-rod P^3, the paper tube being thus drawn continuously forward by hand until it covers the entire exposed portion, embracing the perforated and pliable rubber portions thereof, as shown by the letter B^2 in Fig. 5. This tube B^2 remains in its completed form by reason of the ironing effect of the forming and heating dies and should be by preference of such internal diameter that when located inside of the tube to be lined and with its axis coinciding with the axis of said tube it will in no instance touch the inner wall thereof, thus rendering it practically impossible to tear the lining-tube when drawn forward. At this stage of the proceedings the tube B to be lined is laid upon the grooved rollers R R and forced forward by hand, thus causing the pasted completed tube which surrounds the outer portion of the piston-rod to be forced therethrough until the approaching end of said tube B comes into contact with the automatic stop g, forcing it forward, thereby causing the rod t to actuate the valve v through the agency of the lever l, at the same time causing the rod t' to elevate the automatic stop g' into the path of the tube B when it shall be returned in the next movement of the apparatus which now takes place, in view of the fact that the valve v is now turned into such position that air enters from the air-chamber C by pipes p and p' into the metallic tube P^2 in the rear of the piston-head H', said air flowing first through

the hollow piston-rod P^3 and the perforations k k at the outer end of said piston-rod, thereby causing the surrounding rubber tube or sleeve R′ to expand under pressure and to expand with it the surrounding paste-coated paper tube B′, thus causing the latter tube to firmly adhere against the inner wall of the metal tube B. After the expansion of the rubber tube has effectually caused the paper-lining tube to unite itself to the inner wall of the metallic tube the pressure becomes sufficient against the rear end of the piston-head H′ to cause said piston-head and its hollow piston-rod P^3 and all of the parts attached thereto, including the metallic tube B, to advance to the right under the pressure from the air-chamber C. This advancement continues until the extreme outer end of the tube B causes the automatic stop g', which, it will be remembered, is now in its upper position, to actuate the rod t', and hence the lever l and valve v, thus cutting off the supply of air from behind the piston-head H′ and at the same time turning such valve to such a point that the escape-valve will allow the air behind the piston-head H′ to be released. The operator now severs the paper lining from the exposed unused portion of such lining at the left-hand end of the lined tube B by carefully passing a knife around it so as not to cut the rubber expanding-tube R′, and the lined tube as thus severed is drawn from around the expanding-tube and is ready for treatment with asphalt or any other good insulating material, if desired. To restore the apparatus to its normal condition, the operator places his foot upon the foot-lever F and in so doing actuates the valve v', thereby admitting air under pressure through the tube p^3 against the inner face of the piston-head H′, which, it will be remembered, is now in its extreme right-hand position. Consequently the piston-rod P^3 is carried to the left, and with it all of the parts attached thereto, thereby returning the expanding-tube to its extreme left-hand position inside of the section of paper tube which had been drawn through the dies during the time that the mechanism had been traveling to the right under air-pressure, as already described.

Although I have described my invention as applicable to the lining of metallic tubes for conduit purposes, I wish it understood that several of the features thereof may be utilized for other purposes in the arts; as, for instance, the feature of drawing and forming a paper tube continuously from a strip of paper by simultaneously subjecting it to forming-dies under the influence of heat as it is drawn forward has an especial use in the art of tube-making, and some of my claims hereinafter made are designed to cover, broadly, this feature.

It is also obvious that many of the details of construction of the apparatus may be departed from without avoiding the scope of my claims hereinafter made. I also desire it to be understood that I do not limit myself to the use of air under pressure as a means of operating the mechanism hereinbefore described, as steam, a gas, or liquid under pressure might be so used, if desired.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. One or more forming-dies for giving to a strip of pliable or fibrous material, such as paper, a tubular form; means for heating said forming die or dies, in combination with means for drawing the strip always in the same direction, substantially as described.

2. One or more forming-dies for giving to a strip of pliable or fibrous material, such as paper, a tubular form; means for heating said forming die or dies, in combination with a compression-die and an additional heating-die and means for drawing the paper continuously forward, substantially as described.

3. Mechanism for forming a tube from a strip of pliable or fibrous material, such as paper, consisting of means for giving to the strip a tubular conformation and simultaneously heating and causing said tube to retain its tubular form, in combination with a source of heat and means for drawing the strip and the completed tube continuously in the same direction, substantially as described.

4. Mechanism for forming a tube from a strip of pliable or fibrous material, such as paper, consisting of one or more forming-dies for giving tubular conformation to the strip in the direction of its length; means for supporting the paper in its tubular form as it is drawn forward, and additional means in the nature of an ironing-die which surrounds the formed tube and its supporting means, in combination with means for heating the dies and additional means for drawing the tube and its support continuously forward, substantially as described.

5. Mechanism for lining a tube from a strip of pliable or fibrous material, such as paper, consisting of means for giving to a strip of such material a tubular form of substantially the same length as the tube to be lined but of an exterior diameter somewhat less than the interior diameter of said tube; means for carrying and supporting said completed tube within the tube to be lined and without touching the interior wall thereof as it is drawn in, in combination with means for coating the outer surface of said lining-tube with an adhesive agent, and additional means for expanding it against the inner wall of the outer tube after it is fully drawn therein, substantially as described.

6. Mechanism for lining a tube from a strip of pliable or fibrous material, such as paper, consisting of means for giving to a strip thereof a tubular form with overlapping edges and of a completed length substantially that of the tube to be lined; supporting means around which said tube is formed and adapted to carry it, the completed tube, within the tube

to be lined in such manner that it does not touch the inner wall of the latter, and means for expanding the lining outwardly against the inner wall of the outer tube, substantially as described.

7. Mechanism for forming a tube from a strip of pliable or fibrous material, such as paper, consisting of an air-chamber for holding air under pressure; connections between the air-chamber and a piston operatively connected with a mandrel adapted to move backward and forward with the piston; means for giving to the strip of pliable or fibrous material a tubular form around the mandrel, and additional means for controlling the supply of air to the opposite sides of the piston-head in such manner that as the piston is forced in one direction the strip of paper is given a tubular form around the forming-mandrels and as it is forced in the other direction the mandrel is restored to its normal or starting position, substantially as described.

8. Means for expanding a tubular lining against the walls of a tube to be lined, consisting of an expansible tube adapted to be located within the tubular lining and expanded by air under pressure and then to be withdrawn after the lining is firmly set in place, substantially as described.

9. Means for lining a tube with pliable or fibrous material such as paper, consisting of a hollow perforated tube surrounded with an expansible tube, the hollow tube having connection with a source of air or liquid pressure, substantially as described.

10. Mechanism for lining tubes with pliable or fibrous material such as paper, consisting of means for forming the tube-lining of the pliable material, and additional means consisting of an expansible tube for causing a previously-formed tube-lining to adhere to the inner walls of the tube to be lined, substantially as described.

11. Mechanism for lining tubes from a strip of pliable or fibrous material such as paper, consisting of means for furnishing air or gas under pressure; a piston-rod operatively connected with said air supply, one or more forming-dies and a heating-die surrounding the outer or exposed portion of the piston-rod; means for heating both of said dies, means for coating the lining-tube with an adhesive agent, and additional means for supporting the tube to be lined in alinement with the tubular lining; in combination with an expansible device carried by the exposed end of the piston for expanding the lining-tube against the inner wall of the tube to be lined and automatically-controlled mechanism for giving to said expanding device movement in opposite directions, substantially as described.

12. The described method of lining a tube with fibrous material such as paper, consisting in first forming by ironing with heat a completed tube of the fibrous material of lesser diameter than the inner diameter of the tube which is to be lined, then inserting or drawing said completed tube within the tube to be lined and finally expanding it outwardly by pneumatic pressure against the inner wall thereof.

13. The described method of lining a tube with pliable or fibrous material, such as paper, consisting in first forming a completed tube of a strip of the material and simultaneously ironing it by heat and pressure in such manner as to cause it to retain its tubular form, then drawing this completed tube inside of the tube to be lined and without touching the inner wall thereof and finally expanding it against the inner surface thereof.

In testimony whereof I have hereunto subscribed my name this 28th day of February, 1896.

EDWIN T. GREENFIELD.

Witnesses:
C. J. KINTNER,
M. M. ROBINSON.