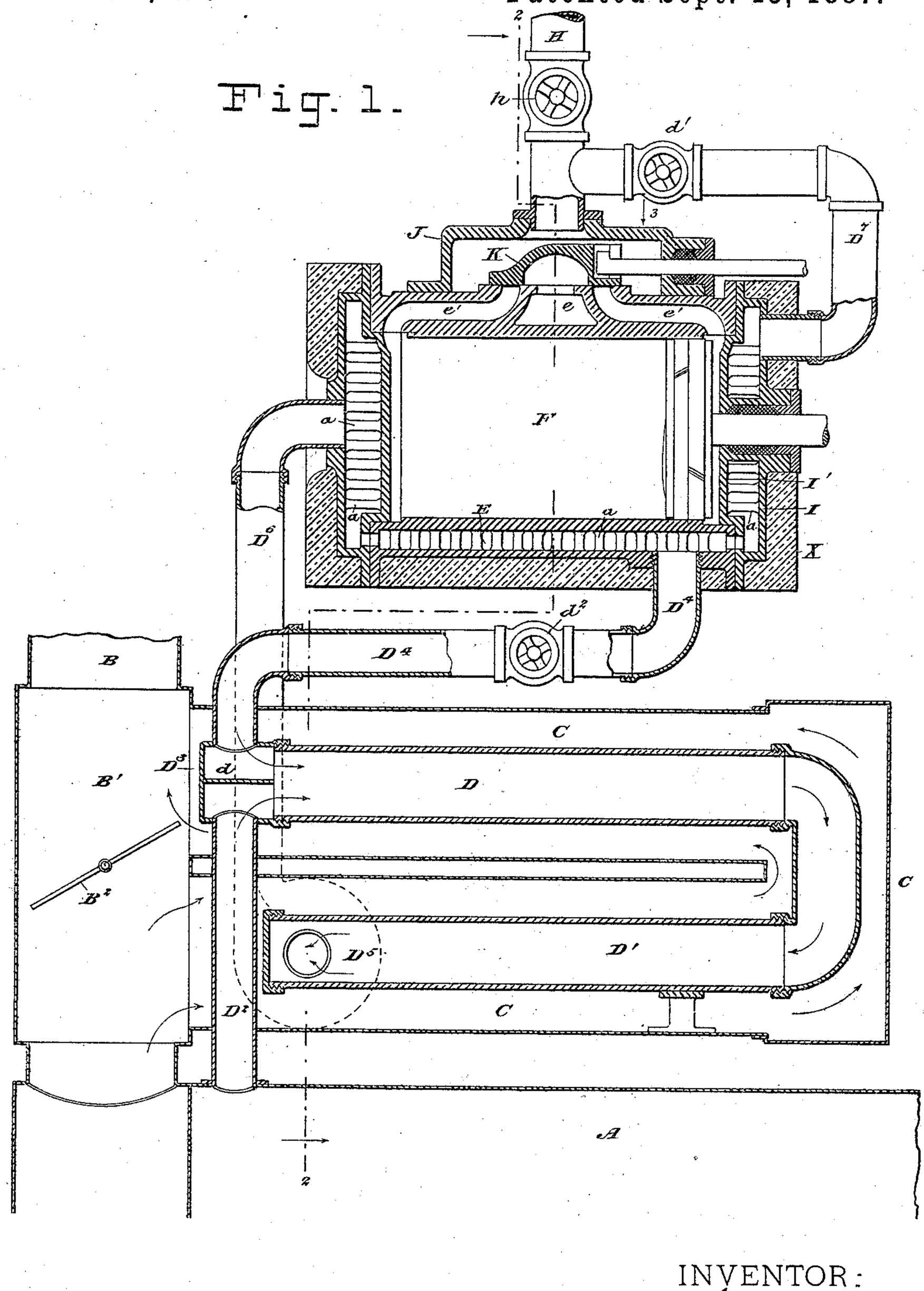
(No Model.) 2 Sheets—Sheet 1.

R. CREUZBAUR.

JACKET FOR STEAM CYLINDERS.

No. 369,922. Patented Sept. 13, 1887.

Fig. 1.



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(No Model.)

2 Sheets—Sheet 2.

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Fig. 2.

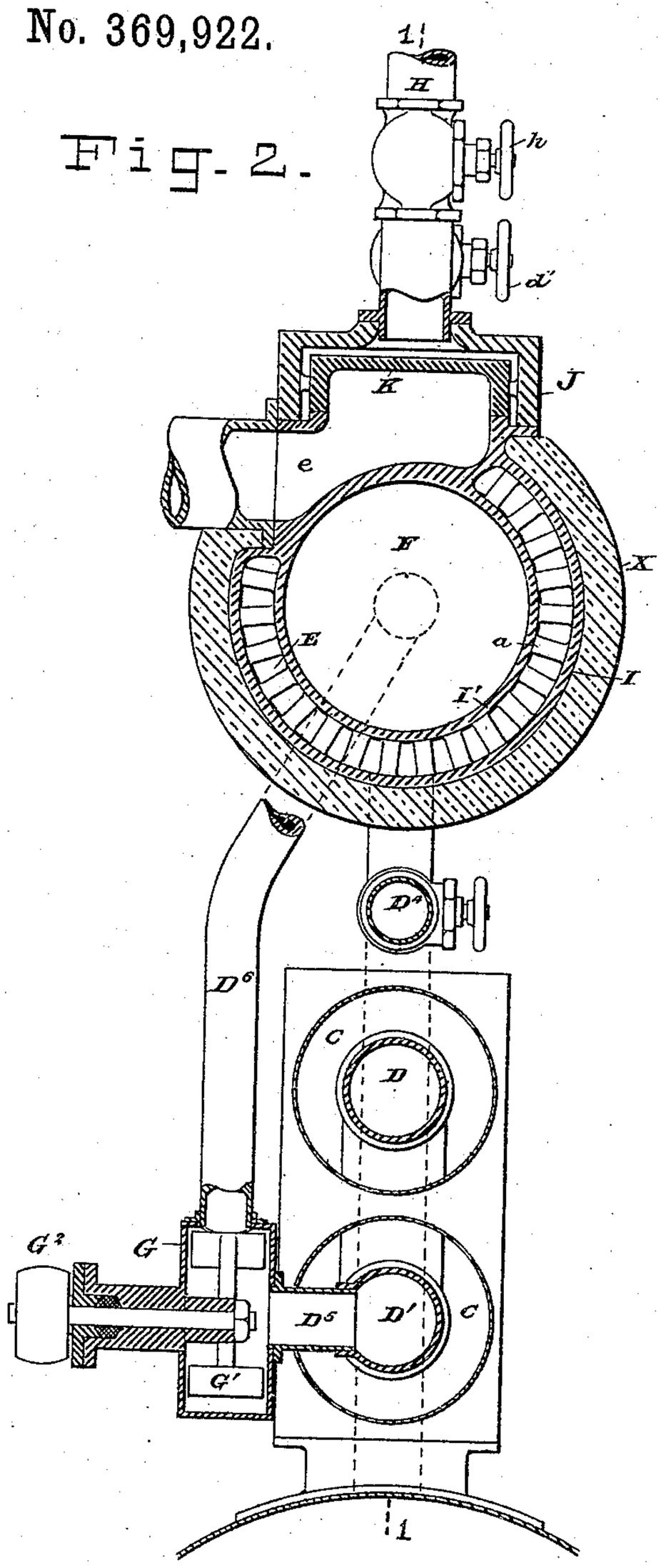
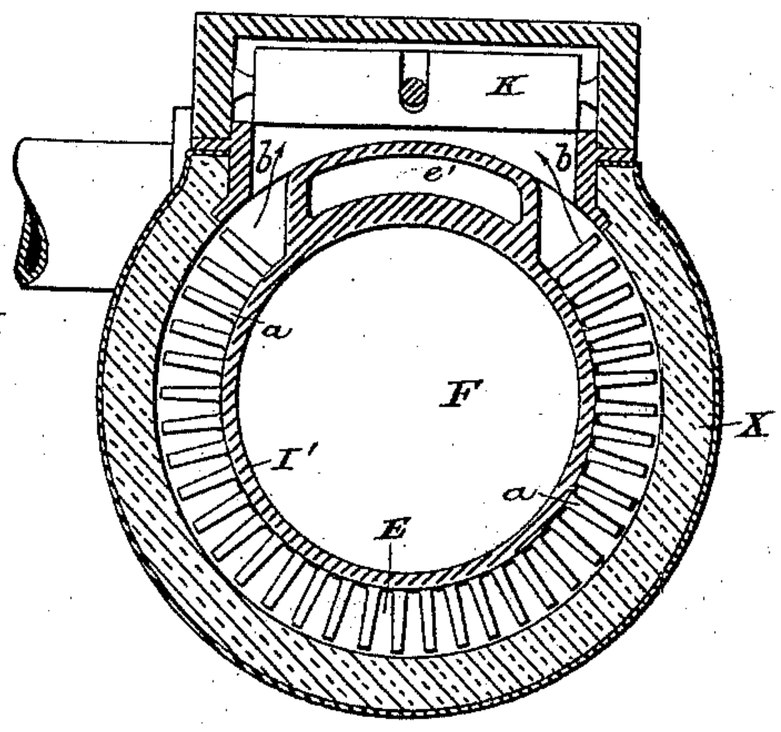


Fig. 3.



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UNITED STATES PATENT OFFICE.

ROBERT CREUZBAUR, OF BROOKLYN, NEW YORK.

JACKET FOR STEAM-CYLINDERS.

SPECIFICATION forming part of Letters Patent No. 369,922, dated September 13, 1887.

Application filed November 18, 1886. Serial No. 219,241. (No model.)

To all whom it may concern:

Be it known that I, ROBERT CREUZBAUR, a citizen of the United States, and a resident of Brooklyn, Kings county, New York, have invented certain Improvements in Jackets for Steam-Cylinders, of which the following is a specification.

My invention relates to certain improvements in the construction of the jackets of steam-cylinders—as engine-cylinders, for example; and it consists, broadly, in studding the exterior surface of the cylinder with isolated metallic pegs, which I will call "heat-pegs," said pegs being, by preference, formed integrally with the cylinder and projecting into the path of a heated or fire-fed current, either of steam or water, passing through said jacket. In some cases the heat-pegs will extend across the space or passage in the jacket and connect with the metallic outer wall of same, and in other cases they will extend nearly but not quite across. In either case the outer wall of the jacket should be lagged with some material having feeble heat-conducting capacity. The heat-pegs afford a very extended heat-receiving surface, and they conduct the heat to the cylinder, from the inside face or wall of which it will be taken up and absorbed by the saturated steam within the cylinder much more rapidly than it can be conveyed to it by superheated steam or fire-gases passing through the jacket. This is due to the great conductive capacity of saturated steam, the conductive capacity of superheated steam or dry gases being only about one-fiftieth of that of water in motion or collapsing cloudy steam.

I am fully aware that in house-heating furnaces it is a common practice to form projecting studs or pegs on the exterior face of the fire-box wall, said pegs projecting into the path of a current of air to be heated from the furnace; and I am also aware that the explosion-chambers of gas-engines have also been so provided with a view to increasing the radiation of heat therefrom, as they are liable to become overheated. In both of the above cases the object is to increase radiation of heat from the fire-box or the explosion-chamber, and in both cases, also, the current intercepted by the pegs is of cold air, and the jacket is open at both ends to the outer air. My object is entirely different. I seek to re-enforce the heat within the cylinder, and prevent the condensation of the steam therein by sending through the jacket a current of hot liquid or fluid, as the case may be, and the jacket is not open at both ends to the outer air.

I am also aware that jackets for steam-cylinders have been devised consisting of connected cells forming a continuous channel, or a tortuous or spiral passage around the cylinder, through which it is designed to pass steam or other heated fluids. Such constructions are impracticable, in that they are very difficult and costly to construct, to such an extent, indeed, as to forbid their adoption. Furthermore, they are objectionable as to efficiency, because the cell or part of the coil first traversed by the heated medium would be heated to a greater extent than those parts on the opposite side of the cylinder or farthest from the inlet, and those last traversed would hardly be heated at all, or, indeed, might be cooled; also, because of the long circuitous route traveled by the steam through these objections to its free passage and of such forced deviation from its natural course. Such a construction, in order to avoid defeating its object entirely, would compel the use of mechanical means to effect the necessary rapid circulation through the jacket and the proper renewal of the fluid cooled in its tortuous passage. With my method the usual open jacket is used, but provided with isolated pegs around which the steam is free to flow in every direction simultaneously, on all sides of the cylinder and without deviation, quickly to the parts where the most condensation takes place. The construction of such an open jacket may be effected without any material complication by the usual jacket-core with radial holes formed by loose pins in the core-box. A jacket thus formed has the maximum of efficiency with the minimum of material, and admits of an extremely thin inner cylinder-wall with a corresponding increase in the transmission of heat. Such a construction does not in the least impair the rigidity of the cylinder. On the contrary, its rigidity is far greater than that of a single-walled cylinder-shell of equal inside area embodying all the material contained in the inner and outer shells and heat-pegs of my jacket. Such rigidity coupled with a thin inner shell is

not attainable without forming the isolated pegs integrally with both shells. Where superheated steam is the medium used, I may maintain a circulatory current thereof through the jacket and superheater, or from the boiler through the superheater, thence through the jacket, and thence to the steam-chest of the engine; or water may flow from a boiler through a superheater or coil, thence through the jacket, and thence back to the boiler. The construction of a jacket with the heat-pegs extending entirely across the passage or space in same, and connected, preferably integrally, to both the cylinder and the metal shell forming the outer wall of the jacket, is, I believe, new with me in an open jacket, as described, where the heating medium is free to flow rapidly in any direction and is not confined to a tortuous channel. When the pegs extend entirely across in this manner, the outer shell of the jacket is lagged or covered with some non-conducting material, and the heat absorbed by said shell will also be carried by the pegs to the inside of the wall of the cylinder. The importance of this provision of a jacket with heat-pegs for obtaining high expansion will appear from the following:

It is well known that the greatest obstacle to high steam-expansion in an engine is the difficulty of returning to the steam during its expansive working a sufficient amount of heat, transformed into work, to preserve its normal temperature as saturated steam when expanded to its utmost bulk, doing work. The only way this has been done sucessfully heretofore was by traversing the cylinder-jacket by furnace-gases, as in the locomotive "Great Britain." This was discontinued on account of practical difficulties. The next best effect was obtained by the use of superheated steam; but the results obtained by heating the cylinder externally by fire-gases cannot be attained by superheated steam alone, for two reasons: First, if the steam when directly applied is sufficiently superheated to prevent condensation in the cylinder, requiring an average addition of temperature of from 75° to 100° Fahrenheit, the vital parts of the engine suffer and the lubrication becomes difficult; second, when the superheated steam is caused to pass through the steam-jacket on its way to the valve with the purpose of reducing its temperature to that of saturated steam nearly, and to transmit its cast-off heat into the cylinder, it is found that the cylinder has not nearly sufficient heat-absorbing capacity to so accomplish the object, to wit: Assuming a non-condensing engine receiving steam at one hundred pounds pressure, exhausting at twenty pounds absolute, and using twenty-two pounds of steam per hour, per indicated horse-power, then a pound of steam at twenty pounds pressure contains, as per tables, eleven hundred and fifty-one units of heat, of which fifty-four were consumed in displacing the atmosphere, leaving net one thousand and ninety-seven units. At one hundred pounds pressure saturated steam contains in like manner eleven hundred and seventy units. The net difference of seventy-three units is available in performing work during the expansion. For one-horse power the total work performed per pound of steam requires (two thousand five hundred and sixty-five units divided by twenty-two pounds) one hundred and seventeen units. Deducting the above available seventy-three units leaves forty-four units per pound to be supplied by the steam in the jacket, requiring an increase of temperature of forty-four divided by the specific heat of steam, 0.475, giving ninety-three degrees, in all four hundred and twenty-one degrees of temperature. The average temperature in the jacket would be $(328+421)\div 2=374°$, and the average heat in the cylinder $(328+227)\div 2=277°$, giving the average difference between the jacket and the cylinder 97°. The steam in the jacket being thus superheated, its transmitting capacity is about that of dry air—to wit, between two and three units per square foot per hour per degree of difference of temperature; in all, at the utmost, $97\times 3=291$ units per square foot, and the heat required being $44\times 22=968$ units, it requires therefore $968\div 291=3.32$ square feet of transmitting-surface per one-horse power, which is far more than can be practically obtained without such heat-conveying pegs. These pegs about treble the otherwise available skin-surfaces receiving heat from the steam in the jackets. The gain in so applying heat directly to the steam while doing work in the cylinders as compared to the alternate method of supplying that heat necessary to produce the required work by using more steam consists in this—that all the heat so supplied to the cylinder through a jacket is utilized without waste, whereas of the heat contained in the additional steam otherwise required only 6.4 per cent. are utilized, the heating of the feed-water being already provided for, the 6.4 per cent. representing the difference in the heat contained in saturated steam at one hundred pounds pressure and saturated steam at twenty pounds, which is the pressure of the exhaust-steam.

As before intimated, there are different modes of carrying out my invention or accomplishing the object I seek to attain. For example, the jacket may be a close vessel and strong enough to stand the steam-pressure employed, and the boiler-steam, after being highly superheated, may be made to pass on its way to the working-cylinder through the jacket of the engine, receiving lubrication when it enters the steam-chest; or steam from the boiler may be made to pass through a superheater, thence through the jacket, and thence back to the superheater without entering the working-cylinder, the latter receiving steam direct from the boiler. The circulation of the steam through the jacket and superheater may be accomplished through the difference of gravity of the hotter and cooler steam. This will require an arrangement of the boiler on a lower level than the cylin-

der. Otherwise this circulation of the steam may be effected by a pump or preferably by a rotating fan; or water heated to the required temperature may be made to circulate through the jacket by gravity or by means of a pump, if necessary; or saturated steam may be circulated through said jacket from a special boiler, being at a higher pressure than that admitted to the working-cylinder. These last two methods are especially applicable when the cylinder-surface is small or the piston-speed great, the water and saturated steam having far greater heat-transmitting capacity than superheated steam or furnace gases; or a special low-pressure boiler may be employed to supply the jacket, the steam therefrom being first highly superheated, but at a comparatively low tension before it is passed through the jacket; or fire-gases may be passed through the jacket on their way from the boiler-furnace to the chimney, or from any other fire or furnace.

In the drawings hereto annexed I have shown my invention as applied where superheated steam is passed through the jacket, Figures 1 and 2 illustrating a construction and arrangement whereby the superheated steam may be made to follow a circulatory path through the superheater and jacket, or at will be made to pass from the jacket to the working-cylinder by way of the usual valve-controlled inlet-ports. Fig. 1 is a sectional elevation of an engine provided with my improved jacket, a superheater, and a boiler for supplying steam, the plane of the section being longitudinal and taken on line 1 1 in Fig. 2. Fig. 2 is a transverse sectional elevation taken in the plane substantially as indicated by line 2 2 in Fig. 1. Fig. 3 is a cross section of a cylinder provided with a jacket constructed according to my invention, but of a modified form.

Referring first to Figs. 1 and 2, A represents a portion of a steam-boiler, which may be of any kind, and B the chimney or uptake from the boiler-furnace.

C is the superheater-flue, which, as herein shown, comprises a U-shaped pipe of sheet metal, opening at its ends into the enlargement B′ of the chimney, which is here provided with a deflector-damper, B^2, whereby the fire-gases may be turned into the lower branch of the superheater-flue and caused to circulate through the same, escaping into the chimney from the upper branch.

D D′ are the upper and lower branches of a U-shaped steam-pipe arranged in the U-shaped pipe of the superheater-flue.

D^2 is a steam-pipe leading from the steam-space of boiler A up through the lower branch of the superheater-pipe, and connecting with a chamber, D^3, provided with a partition, *d*, said chamber being also connected to the upper branch, D, of the steam-pipe in the superheater-flue.

D^4 is a steam-pipe leading from the upper part of chamber D^3 to the jacket E of the working-cylinder F of the engine. From the lower branch, D′, of the steam-pipe in the superheater a steam-pipe, D^5, leads to a fan-casing, G, in which is a fan, G′, provided with a driving-pulley, G^2. From the fan-casing a steam-pipe, D^6, extends to and connects with the cylinder-jacket E at the end opposite to that where pipe D^4 connects therewith.

D^7 is a steam-pipe connected with jacket E at its one end and with the steam-supply pipe H of the engine at its other end. In pipe H is a valve, *h*, in pipe D^7 is a valve, *d*′, and in pipe D^4 is a valve, d^2. This construction provides for two modes of working the superheated steam, and before describing the construction of the jacket in detail I will describe the operation.

Cocks *h* and d^2 being opened and cock *d*′ being closed, the steam from boiler A (or any boiler) supplies the engine through pipe H. Steam from boiler A flows through pipe D^2 to chamber D^3, thence through the superheater by way of pipes D and D′, thence by way of pipes D^5 D^6 to the jacket E, being impelled by fan G′, thence through the jacket to the outlet into pipe D^4, thence through pipe D^4 to chamber D^3 above the partition *d*, and thence through the pipes D, D′, D^5, and D^6 to the jacket again. The boiler A in this case merely makes up for waste after having once filled the jacket, pipes, &c., with steam. The fan G′ insures constant circulation of steam through the jacket; but where the boiler and superheater are arranged at a lower level than the engine the difference of gravity of the superheated steam on its way to the jacket through pipe D^6 and the steam after it has lost a portion of its heat in the jacket and is on its way back to the superheater through pipe D^4 will usually suffice to maintain a current. Cocks *h* and d^2 being closed and cock *d*′ opened, the steam from boiler A will flow by way of pipe D^2 to the superheater, through the pipes D D′ to the pipe D^5, through the pipes D^5 and D^6 to the jacket E, through the jacket to pipe D^7, through pipe D^7 to the pipe H below the closed valve *h*, and thence to the cylinder F through the steam-chest J. Valve d^2 being closed, the steam from the jacket cannot flow back to the superheater by way of pipe D^4. The fan G′ stands idle when the steam is employed in this manner.

I is the outer shell of the steam-jacket, and I′ represents the metal wall of the cylinder in general. Cast integrally with the said shell and the cylinder-walls are the heat-pegs *a* *a*, which extend across the space in the jacket from side to side, as clearly shown. There may be any desired number of these pegs, and they may be of any size or form in cross-section desired, so long as they preserve their isolated character and do not interfere with the perfect freedom of the fluid to flow around them and in every direction. In order to prevent radiation from the outer shell, I, it should be covered with some suitable non-conducting

material, X. The form and depth of the jacket E will be governed by the general contour and size of the cylinder.

I may take the steam from the jacket directly into the steam-chest or valve-chamber without passing it through a pipe, D', connecting the jacket with the regular steam-supply pipe. Such a construction is shown in Fig. 3, which is a cross-section of an engine-cylinder arranged in this way. In this construction *b b* are passages connecting the jacket E with the interior of the steam-chest J. Thus the jacket forms virtually a part of the steam-supply pipe and pipe H is not required. The plane of the section in Fig. 3 is taken at the front end of the steam-chest, the superheated steam being admitted in this case at the outer end of the cylinder. The arrow 3 in Fig. 1 indicates the plane referred to.

In Fig. 3 I have also shown a modification of the heat-pegs and jacket. In this construction the pegs are formed integrally with the cylinder-wall I' and extend out nearly across the space in the jacket. The outer shell, I, is omitted, and the lagging X, properly strengthened and re-enforced, forms alone the outer wall of the jacket.

In the engine shown in Figs. 1 and 2, K is an ordinary slide-valve, *e* is the exhaust-port, and *e' e'* are the live steam and exhaust ports.

I do not herein claim the special form of superheater shown in Fig. 1, as it forms no essential part of my invention. Any form of superheater may be employed for superheating the steam on its way to the jacket from the boiler, provided it shall be adapted to accomplish the desired result.

I may pass the fire-gases from a furnace directly through the jacket E in place of steam. In my pending application, Serial No. 138,987, I show heat-pegs traversing a jacket around a heating-chamber in an engine operating by the alternate expansion and contraction of a constant mass of fluid, the fire-gases from the furnace under said chamber flowing through said jacket on their way to the chimney. In such case the object is to heat said chamber and its contents, the former being open to the working-cylinder. The working-cylinder is, in such case, cooled or refrigerated either by direct radiation from its walls or by the use of a refrigerating-jacket. This application of the heat-pegs I do not claim herein, my present application being limited to their use in connection with the working cylinder of a steam-engine.

In my pending applications, Serial Nos. 193,001 and 207,309, I have shown the jackets of the cylinders provided with heat-pegs, substantially as represented herein; but I do not broadly claim such a construction of the jacket in said applications.

Having thus described my invention, I claim—

1. A working-cylinder of a steam-engine provided with a jacket covering its exterior surface wholly or in part, and with heat-pegs projecting from its exterior surface into the space in said jacket, with free passage for the heating medium around each of such pegs, as set forth.

2. The combination, with the working-cylinder of a steam-engine provided with a jacket covering its exterior surface wholly or in part and with isolated heat-pegs projecting from its exterior surface into the space in said jacket, of means for generating a heated medium—as steam or water, for example—connected with said jacket, whereby a current of said heated medium is made to traverse said jacket without being freed by such pegs in any determined direction, substantially as set forth.

3. The combination, with a steam-engine cylinder provided with a jacket covering its exterior surface wholly or in part and with isolated heat-pegs projecting from its exterior surface into the space in said jacket, of a boiler connected with said jacket, whereby a current of heated medium from the boiler is made to flow through said jacket, substantially as set forth.

4. The combination, with a steam-engine cylinder provided with a jacket covering its exterior surface wholly or in part and with heat-pegs projecting from its exterior surface into the space in said jacket, of a superheater connected with said jacket and a steam-boiler connected with said superheater, whereby a current of superheated steam is made to circulate through said jacket, substantially as set forth.

5. The combination, with a steam-engine cylinder provided with a jacket covering its exterior surface wholly or in part, said jacket communicating with the cylinder through the ports controlled by the steam-distribution valve, and said cylinder provided also with heat-pegs projecting from its exterior surface into the space in said jacket, of a steam-boiler and a superheater connected with said jacket, whereby superheated steam is made to pass through said jacket on its way to said engine-cylinder, substantially as set forth.

6. A steam-engine cylinder provided with a jacket formed by an outer metallic shell and having isolated metallic heat-pegs extending across the space in said jacket, said pegs being connected at their one ends to said cylinder and at their other ends to said outer shell.

7. A steam-engine cylinder provided with a jacket formed by an outer metallic shell, I, and having isolated heat-pegs *a*, formed integrally with said shell and said cylinder and extending across the space in said jacket.

8. A steam-engine cylinder provided with a jacket formed by an outer metallic shell, I, with a non-conducting exterior covering, X, to prevent radiation, and having isolated heat-pegs *a*, formed integrally with said shell and said cylinder and extending across the space in said jacket.

9. The combination of a steam-boiler, a superheater connected with said boiler by a steam-pipe, and a steam-engine cylinder pro-

vided with a jacket formed by an outer metallic shell protected by a non-conducting covering, and having isolated heat-pegs extending across the space in said jacket, said heat-pegs being formed integrally with said cylinder and outer shell, and said jacket being connected by a steam-pipe with said superheater, whereby a current of heated steam is made to pass through said jacket and around said isolated pegs.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ROBERT CREUZBAUR.

Witnesses:
HENRY CONNETT,
J. D. CAPLINGER.