W. CORLISS.

Steam-Engines.

No. 134,361. Patented Dec. 31, 1872.

Fig. 1.

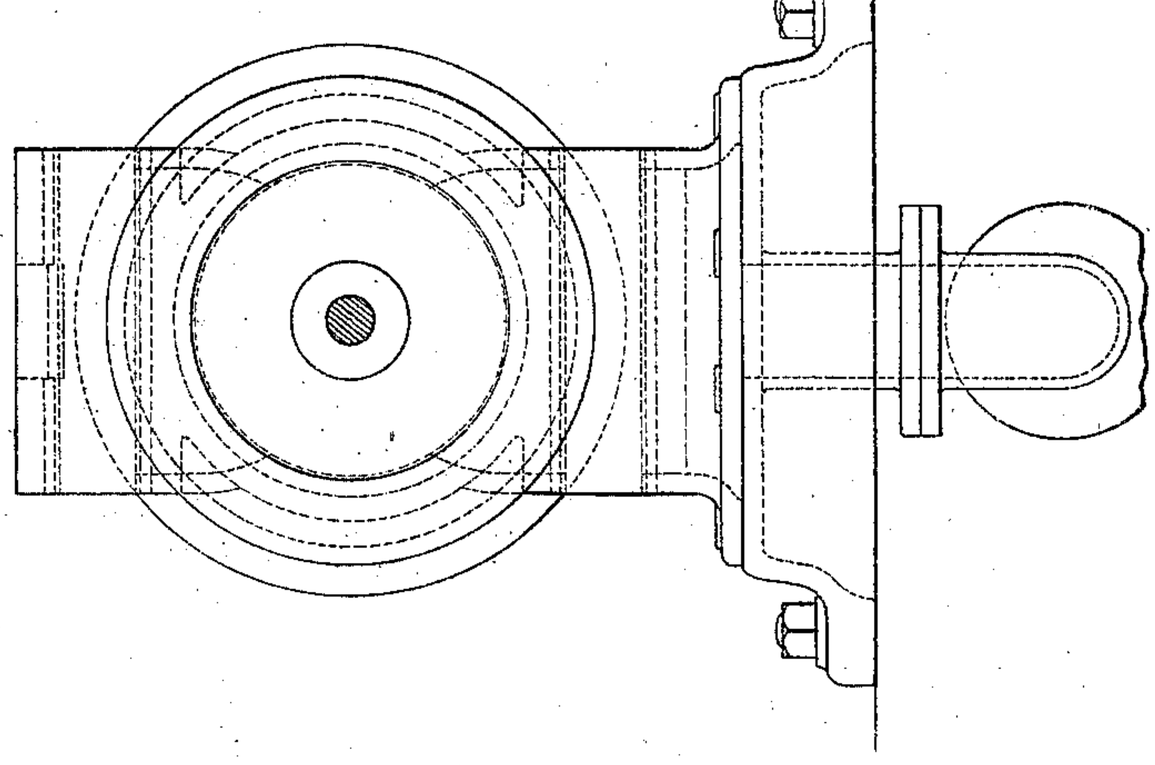


Fig. 3.

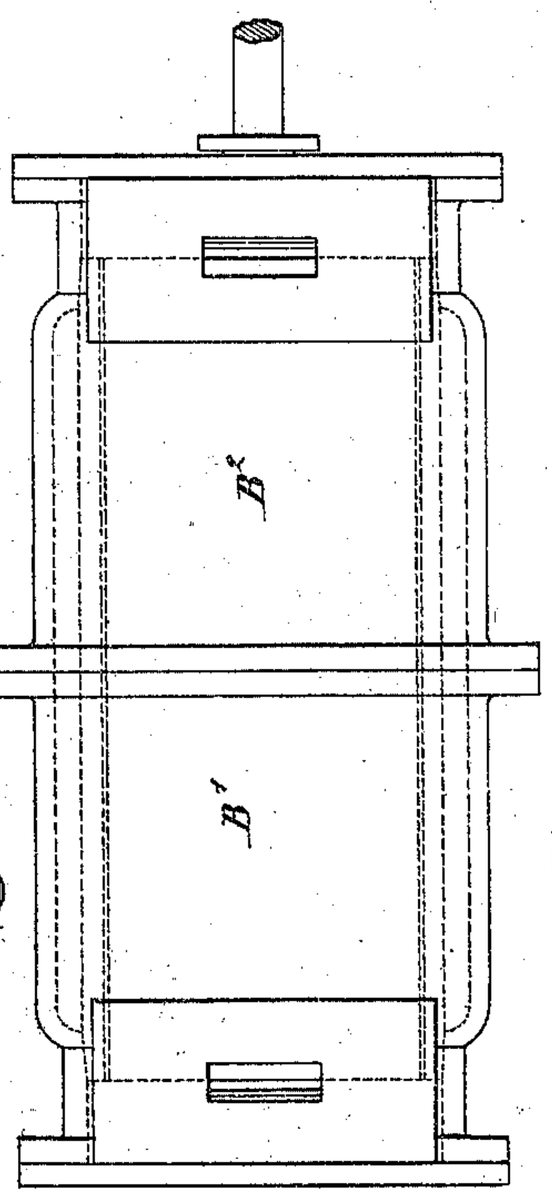
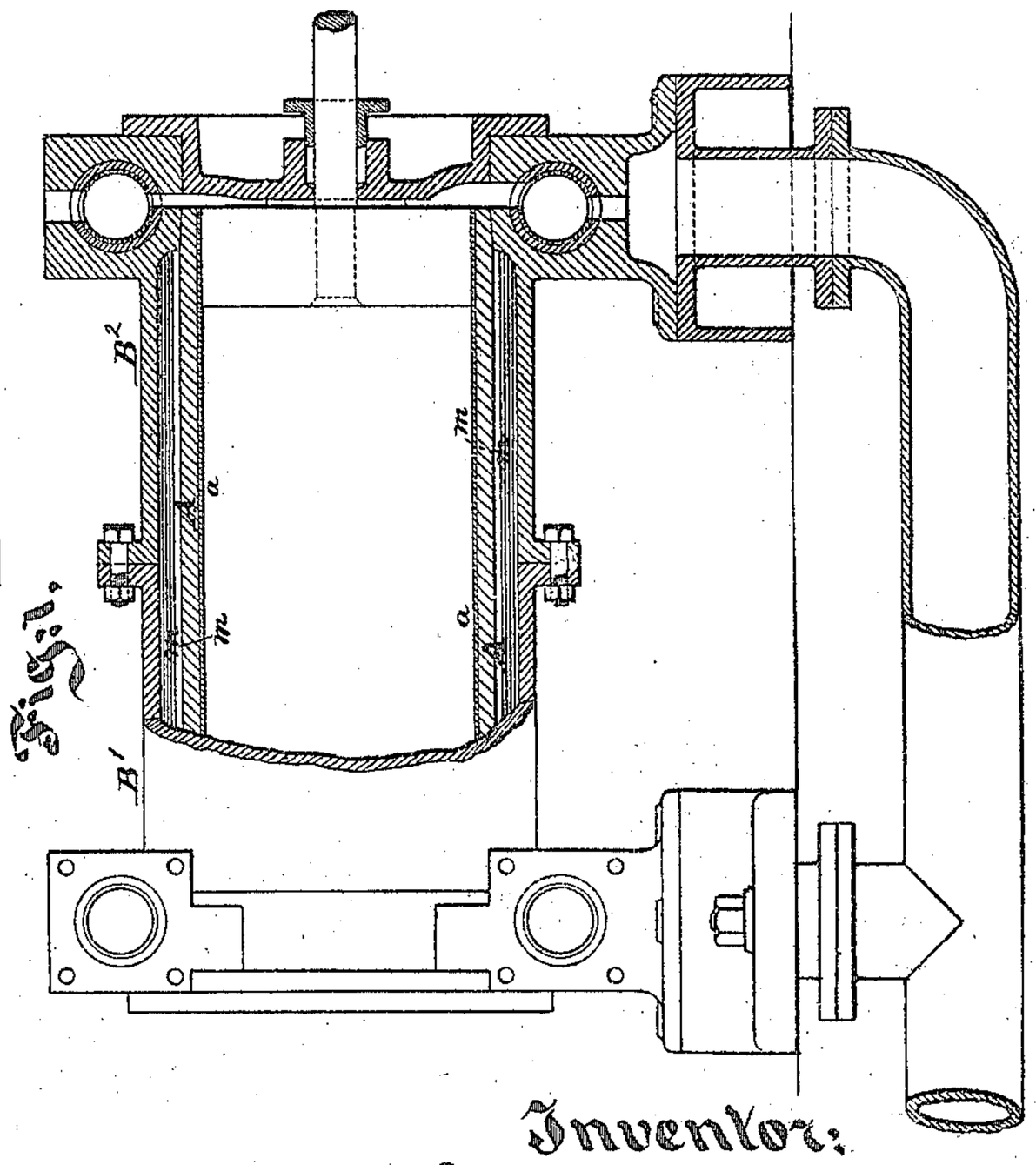


Fig. 2.



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AM. PHOTO-LITHOGRAPHIC CO. N.Y. (OSBORNE'S PROCESS.)

UNITED STATES PATENT OFFICE.

WILLIAM CORLISS, OF PROVIDENCE, RHODE ISLAND.

IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. **134,361**, dated December 31, 1872.

To all whom it may concern:

Be it known that I, WILLIAM CORLISS, of Providence, in the State of Rhode Island, have invented an Improvement in Steam-Engines, of which the following is a specification:

The invention relates to the construction and lining of cylinders of steam and other engines, for the purpose of securing greater economy in the use of steam and increased durability of the parts. It may also be of great service in similarly lining cylindrical steam valve-seats of engines.

Steam-engine cylinders are ordinarily made of cast-iron, and the term cylinder, as ordinarily used, comprehends all the parts that are cast with the cylinder, as nozzles, flanges, steam-chest, &c.

The superior excellence of very hard and perfectly true surfaces for the working-parts is conceded by all who have experience in this branch of mechanism; but we cannot, according to the present system, secure the hard wearing-surface without encountering other difficulties that have thus far been practically insurmountable.

My aim is to so construct the parts as to secure the advantage of extreme hardness, and the utmost perfection in the bore of the cylinder, and at the same time to actually lessen the labor upon the other parts of the cylinder by allowing it to be made of even softer metal than usual, and also to simplify the making of the casting. These conditions are secured by making the barrel of the cylinder in a peculiar manner, and by making it entirely separate and independent of the other parts. By this manner of construction, and the modifications I have made in the other parts, I am able, not only to guard more effectually than heretofore against the friction and wear experienced in the use of ordinary cylinders, but also to obviate, in a great measure, the loss of power due to the alternate condensation and evaporation in the cylinder. I also guard very efficiently against the escape of heat from the interior of the cylinder outward into the atmosphere, and maintain a permanently high temperature in the metal on the interior of the cylinder during the whole period while the engine is working.

The following is a description of what I consider the best means of carrying out the invention as applied to the cylinder of a horizontal stationary engine having a cylinder sixteen inches diameter and thirty-six inches stroke. The engine is what is known as the CORLISS engine, as may be inferred from the position and arrangement of the valve-chests; but my invention will apply with almost equal benefit to any other form of engine. It also applies to the valve seats or chests.

The accompanying drawing forms a part of this specification.

Figure 1 is a side elevation partly in section. Fig. 2 is an end view, and Fig. 3 is a plan view.

Similar letters of reference indicate like parts in all the figures.

A *n* is the barrel or cylindrical part of the cylinder, formed very accurately. Its inner face, *a*, is of cast-steel, and its exterior, A, of good homogeneous wrought-iron. What I esteem a preferable mode of forming this cylinder will be explained further on. The total thickness may be, say, three-fourths of an inch, the steel lining being made about one-eighth of an inch deep—that is to say, the barrel of the cylinder will be composed of an inner lamina of hardened steel of one-eighth of an inch or thereabout in thickness, re-enforced and strengthened by wrought-iron, say five-eighths of an inch thick. In case the cylinder thus formed is warped in the process of hardening its inner surface, I reduce its interior very carefully to a true cylindrical form by a process of grinding, and afterward polishing with rapidly-revolving wheels or other suitable means. The whole outer surface of the barrel of the cylinder is parallel with the interior surface, except at each end, where it tapers slightly, as indicated. The cast-iron portion of the cylinder is made in sections B^1 B^2, and is provided with suitable flanges, and adapted to be drawn tightly together over the barrel, the parts B^1 B^2 being bored out very accurately to correspond to the skillfully-tapered ends of the barrel. Between the ends the parts B^1 B^2 are chambered, as represented in Fig. 1. The space between the exterior of the barrel and the interior of the parts B^1 B^2 may vary from one-fourth of an inch upward to any desired extent. I do not consider it generally expedient to make it of greater depth than one and a half inch.

The piston may be of the ordinary thickness

and material, and any ordinary or approved packing may be used; but the extraordinary hardness and trueness of my cylinder admits of very simple packing. I propose to make my piston of steel or wrought-iron, and construct it as light as practicable, and to have it fill the bore of the cylinder very closely. I believe it practicable with this steel lining to make the piston substantially solid, using very slight metal packing. It is well known that when cylinders are smooth and true very slight packing prevents any blowing-by of the steam, and the frictional resistance to the working of the piston is inconsiderable; but when the cylinder wears out of truth the waste of steam by leakage commences, and the packing-rings must be forced out very firmly, adding greatly to the loss of power by frictional resistance to the motion of the piston and increasing very rapidly the wear upon the cylinder, enlarging at every stroke the inaccuracies on its surface. The piston-rod and all the other parts may be made in any suitable manner. The jointing-surfaces of the barrel and the parts B^1 B^2 may be touched lightly with red lead or other cementing material before they are applied together, if preferred; but I propose in most cases to simply make the metal bare and smooth and draw the surfaces forcibly into contact. Of course the parts should be nicely fitted, so that the flanges of the parts B^1 B^2 will not come together until the joints at each end of the barrel are properly made. The space between the barrel and the parts B^1 B^2 may be left simply filled with air, and a very great amount of the escape of heat from the cylinder may be thereby prevented, and the exterior of the cylinder will keep comparatively cool; but I esteem it important not only thus to imprison a stratum of air between the inner metal and the outer metal, but also to prevent its free circulation. I wish to maintain the barrel at the temperature of the hottest steam that enters the cylinder, and to allow the exterior metal to be somewhat cooler without objection. Although any quantity of felt or other covering, lagging, &c., may be employed around the exterior parts to maintain its temperature at a high point without objection, without some interposed medium the air imprisoned in the space would circulate freely between the inner and outer metal, taking up the heat from the metal A and conveying it to the outer metal B^1 B^2, thus tending constantly to equalize their temperatures. I prevent this by introducing a number of concentric sheets of coarse paper, *m m*. I find that paper is an excellent non-conductor, and is capable of withstanding all the influences to which it is subjected in such a position.

Many engineers regard it very important that the working-cylinder be surrounded by a reservoir of steam. My impression is that for ordinary use the air-chamber described is best, but when exceedingly high pressure is used, and a high rate of expansion is desired, a bette sult may be obtained by introducing steam instead of air in the annular space inclosing the barrel, as described.

I consider the construction of cylinder herein described peculiarly adapted to carrying out either of these systems, for it simplifies the formation of the chamber or jacket, which has heretofore been an expensive and complicated appendage.

The manufacture of the barrel of the cylinder in a suitable manner is a matter of considerable importance; and although the process is very simple the work requires to be carefully done and involves the necessity of some special machinery. I first make a hollow cylinder by taking a thick plate of wrought-iron, bending it to a cylindrical form and welding it together, then rolling it in the direction of its circumference, by rolls adapted to the purpose, until it is perfectly round and of uniform thickness. I propose to do this rolling by a system of rolls analogous to the mills used in rolling locomotive-tires, using two or more rolls, one of which passes through and rotates within the cylinder. By this process the thick cylindrical body is gradually reduced, enlarging the diameter just in proportion as its thickness is diminished. Having attained to within a few inches of the ultimate size it is allowed to cool, and after perfecting its cylindrical form, if necessary, it is ready to receive its cast-steel lining, which is introduced in the following manner: The wrought-iron barrel is placed in a suitable furnace and heated to the proper degree—a bright-red heat. It is then taken out, placed upon a plate of iron, and a suitable core introduced in its center, leaving a space all around the thickness of the steel coating; into this space as a mold the molten cast-steel is poured; the union of the two metals is perfect; and the barrel is then heated and rerolled until it is of the proper dimensions. The thickness of the two metals being properly proportioned, we have finally a barrel of thick wrought-iron completely lined with a thin coating of steel. The process of hardening and finishing needs considerable care. I first see that the barrel is perfectly round and of uniform thickness, and it may sometimes be necessary at this juncture to turn off both the inside and outside surfaces so that the tendency to warp will be uniform on all sides, then heating and applying any suitable hardening solution in such manner as to insure the uniform contraction of the different sections of the cylinder in the direction of its axis. The comparatively small amount of steel and the great strength and stiffness of the iron casement, together with its perfectly-cylindrical form, will prevent any serious warping in the hardening process. All inaccuracies now remaining on the interior surface must be reduced by grinding. The iron part can, of course, be worked without difficulty.

I propose, as another means of producing the barrel A *a*, to make the entire thickness of sound wrought-iron, carefully bored and

turned, and then to case-harden its interior to the proper thickness.

By making the barrel of the cylinder separate from the other parts its form is very simple, and as there is scarcely any work to be done upon it excepting to perfect its inner surface, it may be made of any desired material, such as would be wholly impracticable were the cylinder made in the ordinary manner; and while I regard the wrought-iron steel-lined barrel the best, I am aware that other alloys could be used to good advantage in combination with this arrangement—as, for instance, a cast-iron barrel made of extremely hard metal would do good service, and there would be no particular difficulty in its construction.

The wrought-iron steel-lined barrel is also specially adapted for use as a bushing for cylinders of ordinary construction, for the reason that after it is made and hardened its exterior is easily reduced by turning it off to any desired diameter, and its strength will be sufficient when very thin; therefore an ordinary cylinder may be rebored and bushed with this compound without materially diminishing its original diameter.

I propose to make a business of manufacturing these bushings and introducing them in ordinary cylinders and valve-seats that require reboring.

I do not claim a bushing mounted within a cylinder with a space between it and the cylinder, irrespective of the material and the hardness of the bushing; but

I claim as my invention—

1. The metallic cylinder A *a* for steam engines, formed in one piece or unit, with a soft exterior and a hard interior, so that the interior will resist abrasion and the exterior may be worked with tools, while there is no possibility of separation of the hard and soft layers, as herein set forth.

2. A bushing having its interior surface of hard material and its exterior of softer and easily-workable material, in combination with proper external inclosing metal made separately therefrom, and arranged to serve in connection with the piston of a steam engine, as herein specified.

3. The lining cylinder A *a*, composed of wrought-iron on the outside and hardened steel on the inside, and adapted to be used as a bushing for cylinders and valve-seats of engines, as herein specified.

4. In connection with an insulated space between a bushing, A *a*, and the exterior strengthening parts B^1 B^2, the several laminæ of paper or analogous non-conducting solid material *m* arranged in the space between the bushing and the exterior strengthening metal, as specified.

5. A bushing or lining piece of hard material on the interior surface of a steam cylinder bearing against an exterior strengthening part or series of parts at and near the ends, and fitted thereto with tapering joints, so as to tighten the contact therewith by the pressing of the parts endwise one upon the other, as set forth.

In testimony whereof I have hereunto set my name in presence of two subscribing witnesses.

WILLIAM CORLISS.

Witnesses:
WM. C. DEY,
ARNOLD HÖRMANN.