C. G. C. SIMPSON.

Pump for Feeding Steam-Boilers.

No. 214,203. Patented April 8, 1879.

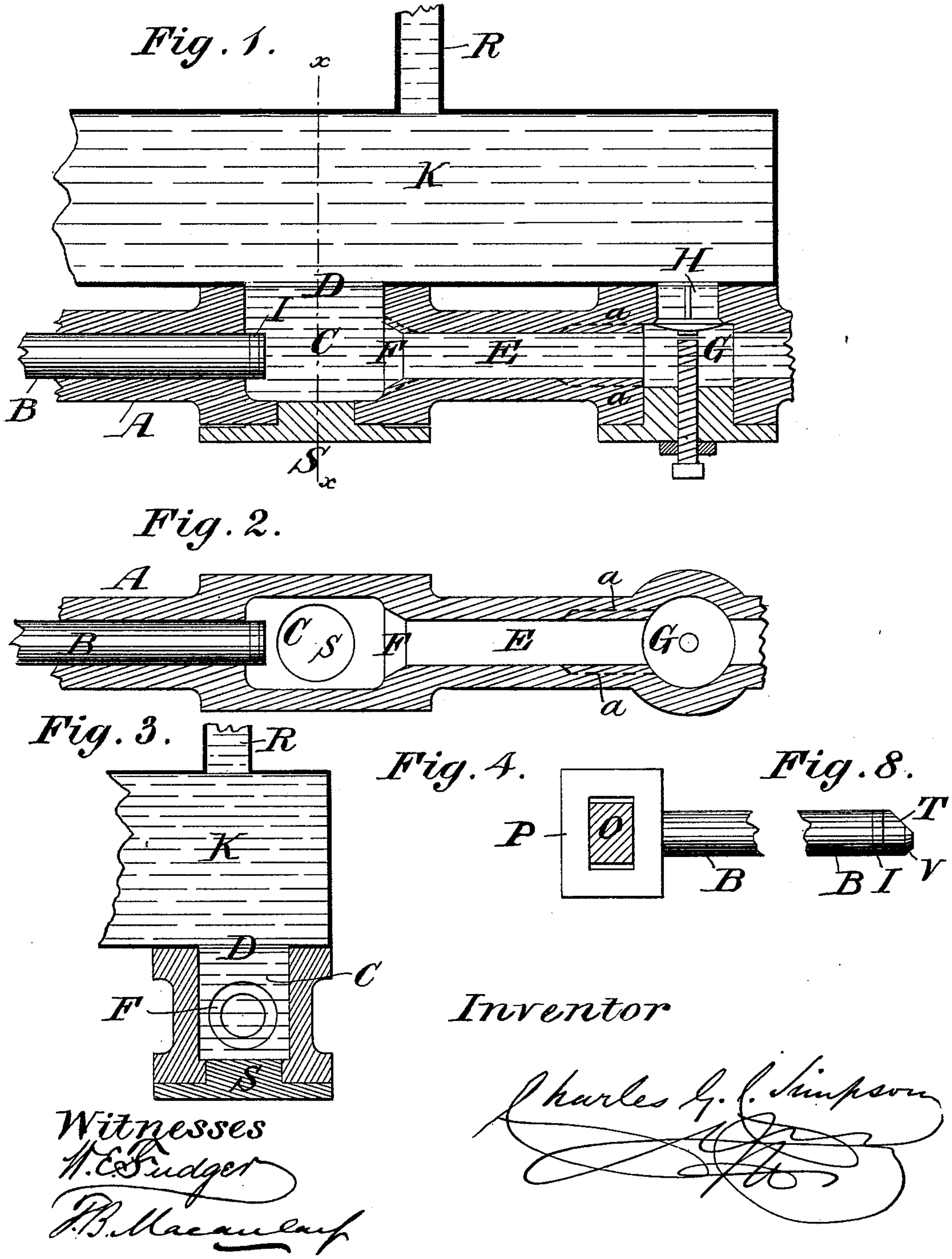

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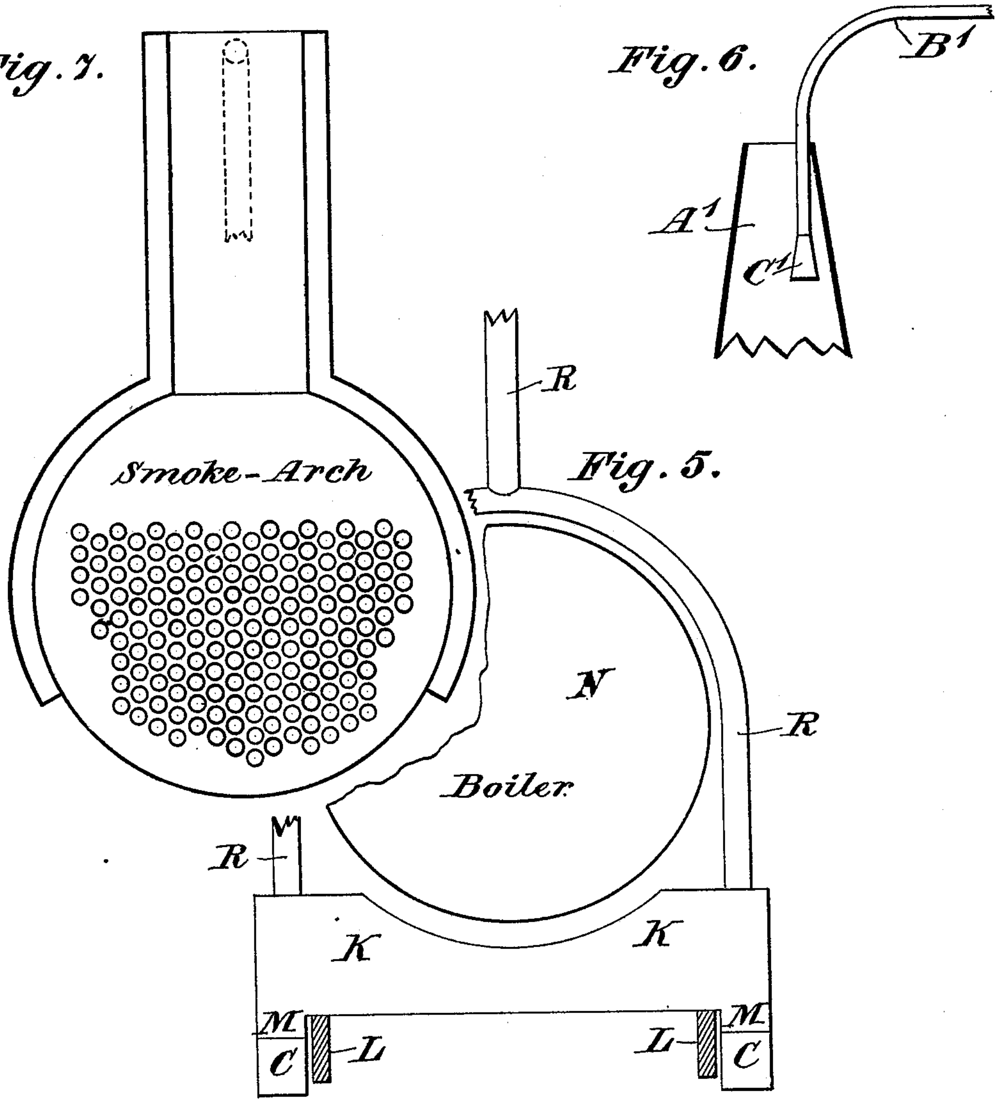
Fig. 7.

Fig. 6.

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## IMPROVEMENT IN PUMPS FOR FEEDING STEAM-BOILERS.

Specification forming part of Letters Patent No. **214,203**, dated April 8, 1879; application filed January 15, 1879.

*To all whom it may concern:*

Be it known that I, CHARLES GRAHAM CHAPPEL SIMPSON, of the city and district of Montreal, Province of Quebec, Canada, have invented certain new and useful Improvements in Pumps for Feeding Steam-Boilers; and I do hereby declare that the following is a full, clear, and exact description of the same.

This invention has reference to improvements in feed-pumps of steam-boilers for the purpose of overcoming the difficulty experienced in such engines as the railway-locomotive, where, from the high rate of speed or number of strokes made by the feed-pumps in a minute, it is found to be impracticable to properly supply the boiler with feed-water, if the said feed-water is at or near the boiling-point.

In most of said engines, if the water in the tender is heated to 140° Fahrenheit or over, the pumps fail to work, or rather cannot be relied upon to give the required supply to the boiler; and the instruments called "injectors" also become uncertain in their action at the said temperature. If, therefore, an engine-driver allows the water in his tender to be heated to above this point, he is unable to proceed farther at the required speed, if his water is low in the boiler, until by some means his water is again cooled down.

It will be borne in mind that although I have mentioned the temperature at which the pumps and injector will refuse to work as 140° Fahrenheit, I do so only approximately, as the temperature will vary somewhat in different engines, depending on the construction and arrangement of the pumps and injector.

Now, as the arrival of the train at its various stopping-places is of more importance to the interests of the railway than the mere saving of a percentage of fuel, the consequence is that the engine-driver takes very good care to keep well below the temperature at which the pumps or injector will "stick" or refuse to work. Whereas, if a pump could be provided that would feed water at any temperature, much of the heat now allowed to freely escape would be easily imparted to the feed-water, and thus a considerable saving in fuel would be effected.

The said saving (according to authority of the writings of J. W. King, United States Navy, and to those of John Bourne, the English author of many works on the steam-engine) amounts to about four and a half per cent. of the amount of fuel consumed for every 50° temperature added to the feed-water. If, then, the feed-water can be put into the boiler at 212° instead of 100°, which is now about the average heat of the feed, a considerable saving in fuel will accrue.

The present invention provides a pump that will feed the boiler at 212° temperature and over; for, in fact, if the temperature be raised above 212° the water will be under pressure, which will cause my invention to work with greater certainty.

It may not be convenient to put the feed-water under pressure in an engine situated as the locomotive is; neither is it necessary, unless the economy above referred to is wished to be carried beyond that which will be obtained by having the feed-water at 212° of heat.

Many suitable means by which the feed-water may be heated are well understood and perfectly known in the trade of engine-building and feed-water heater construction. Therefore it is not necessary that I should particularly describe them with the present invention, although a brief outline may be given of what I contemplate to employ in connection with my invention to assist those who wish to put it in use.

In the drawings hereunto annexed similar letters of reference indicate like parts.

Figure 1 is a longitudinal vertical central sectional elevation of a pump embodying my invention. Fig. 2 is a horizontal central section of the same. Fig. 3 is a transverse section on line $x$ $x$, Fig. 1, looking toward the entrance of barrel. Fig. 4 is a detail, showing a manner of attaching the plunger to cross-head. Fig. 5 shows general arrangement of tank K and pumps in cross-section at chamber C. Fig. 6 shows the means for using part of the exhaust-steam to heat water. Fig. 7 shows a general arrangement of heater to be used after the water has passed from the pumps and before it enters the boiler.

The barrel of the pump is divided into parts, as follows:

Letter A is a neck, bored out true, and fitting the plunger B snugly, yet not so tightly as to give any considerable amount of friction. This neck termines in an ordinary stuffing-box, to which my invention does not extend. The neck A, fitted as above, forms a guide to cause the plunger B to move in a line with the direction of the neck A.

C is an opening or chamber formed in the barrel of the pump, and having, preferably, an opening, D, equal to its full area, on the upper side. E is a cylinder, forming the barrel proper of the pump. It is bored out true, and in perfect line with the bore of the neck A, and of equal diameter therewith.

The barrel E is provided with a bell-mouth, F, the size and inclination of which may be varied without materially changing the object of my invention.

G is a chamber formed in connection with the barrel E, in which is situated a valve, H, and a passage extends from the said chamber G to the ordinary delivery-valve, which forms no part of my present invention.

Under certain circumstances, as will be hereinafter explained, the chamber G and valve H may be omitted, in which case the ordinary discharge-valve will be situated, with regard to the end of the barrel E, in the ordinary manner in which these valves have been situated at or near the end of the barrel E of the pump; and for this purpose the lower end of the barrel E may be counterbored to a larger diameter, as shown by dotted lines at *a a*, Figs. 1 and 2.

On the plunger B a rectangular groove is cut, and an elastic band, I, is forced over the end of the plunger, and forms the packing to render said plunger water-tight within the barrel E. As an equivalent of this packing a recess may be cut in the body of the cylinder forming the barrel E immediately behind the bell-mouth F, and metallic rings will be got in place by cutting the barrel in two parts at the points where the packing occurs, inserting said packing, and uniting the two parts of the barrel by flanges, or by screw-socketing the one part into the other. This metallic packing will be set up by set-screws passing from the outside inward and radial to the center of the cylinder E. The rings will necessarily be bell-mouthed, similarly as the barrel E is bell-mouthed; but I do not favor the employment of these metallic packing-rings, as, should a ring break and fall into such a position as to have a portion within its recess and a portion within the barrel E, the probabilities are that a general casualty or break-down would be caused to the pump, and might extend to the engine generally. In fact, while the plunger B is not reduced by friction, and fills the cylinder or barrel E and neck A pretty perfectly, no packing I may be required under ordinary circumstances.

K is a tank, into which the chamber C and valve H (if used) open.

As my invention is particularly designed for the locomotive-engine, I will describe this tank as applied to such engine.

Now, in the outside connected engines, between that part of the framing situated between the guide-bars of the steam-cylinders, an unoccupied space generally exists, in which the tank K will be situated, and may be formed to extend between the pumps on each side of the engines, so that one tank, K, may serve for both pumps. This plan I prefer, for reasons hereinafter given. Nevertheless, each pump may be provided with its own tank K, if desired.

As shown in Fig. 3, the tank K extends transversely to the outside of the chamber C and valve H, (if present,) and in length may be made of any size that there is convenient room for. It has an opening corresponding with the opening D, and ought to agree with the opening of the valve H.

If the chamber C and valve H of the pump are situated with regard to the framing L, as shown in Fig. 5, then the tank K will be provided with legs M, reaching down and connecting to the chamber C; and, should the boiler N be so low down as to require it, a section may be cut out of the tank. To this tank the ordinary feed-pipes from the tender are connected, instead of being connected directly to the pumps.

Although I have described the tank K, it may nevertheless be dispensed with by making the chamber C of sufficient size; but, as in the locomotive, the parts are already very much crowded, and a small change in the position of any part may cause a very undesirable alteration to be made in the engine, I should prefer to keep the chamber C about the size shown, and use the tank K, said tank being practically an extension of said chamber.

The end of the plunger B may be attached to the cross-head in the ordinary manner; but I prefer to attach it in the manner shown in Fig. 4, so that should there be any spring in the guide-bars or lost motion between the said guide-bars and the cross-head slides, which would tend to strain the plunger B out of line, the same may be compensated for by the sliding of the block O in the link P.

I will now describe, to a certain extent, the working of the pump, and afterward remark upon the employment of waste-heat to be applied to the water.

I shall hereinafter enter into certain dimensions for clearness; but the invention is not bounded by any dimension that will be mentioned.

We will first suppose that the plunger B is at the extreme end of its stroke, (which we will call twenty-four inches,) and that the distance from the end of the plunger to the bottom of the bell-mouth F is eight inches, and from the bottom of the bell-mouth F to the end of the barrel E is sixteen inches, which, with the chamber C, makes up twenty-four inches—the length of the stroke. It will be seen, therefore, if these proportions are followed out, that one-third of the stroke and one-third of the return-stroke are made consecutively within the chamber C; consequently when the end of the plunger B leaves the bell-mouth F the water in the chamber C has only to fall in behind it to solidly close up the space. Now, as the top of the tank K will be about on a level with the bottom of the tender, the tank K is an inclosed tank, but provided with pipes R, reaching up a sufficient height to prevent the water from overflowing, the said pipes R being open to the atmosphere.

The said pipes R may be situated on the chamber C, if the said chamber C is made large, as hereinbefore mentioned; and I wish particularly here to call attention, that in this specification the tank K is considered to be nothing more or less than an enlargement of the chamber C, and therefore does not constitute a separate element of the invention. The water closes in behind the plunger with all the velocity due to the head of water contained in the tank K and pipes R, plus the atmospheric pressure. Therefore there will be no trouble in having a solid body of water in front of the plunger B for it to act upon and drive before it into the barrel E; but as the time that the end of the plunger is within the chamber C is one-third of the time of making the return-stroke and stroke, a considerable amount of water will flow into the barrel E during the period of the finish of the return-stroke and commencement of the stroke. This will take place although the water should be at 212° Fahrenheit.

The valve H and chamber G are provided so that as soon as the return-stroke commences the valve H may, by the commencement of the withdrawal of the plunger B from the barrel E, together with its own gravity, open and admit water to assist in filling the barrel E. Were it not for this, a partial vacuum would be formed within the barrel E, and water would not enter the said barrel until the plunger B had left the bottom of the bell-mouth F. Nevertheless, a very good working pump might be formed by omitting the chamber G and valve H; and it is a question whether the partial vacuum formed by the withdrawal of the plunger from the barrel E would not be as serviceable in filling the said barrel entirely from the chamber C as all the advantage that would be derived from the use of the valve H, for, although a powerful vapor would be given from any watery particles contained within the barrel E, yet as there would be a head of water in the tank K such vapor would be instantly absorbed in the incoming water.

If the stroke of the plunger has been performed as above described, with any given proportion of it performed within the chamber C and the remainder of the stroke performed in the barrel E, it consequently follows that the pump must be made considerably longer than those at present in use, on account of the chamber G and guiding-neck A. Now, in the engines at present in use, I doubt not that in some this extra length can be afforded without any material disarrangement of the surrounding or neighboring parts; but it is quite certainly asserted that in the greater proportion of the locomotives in use this extra length cannot be afforded. Therefore we must consider how the guiding-neck A may be obtained without materially lengthening the pump.

In engines as ordinarily constructed, from five to eight inches may be added to the length of the pump without inconvenience to any of the other parts of the engine, except a small alteration in the part by which the pump is attached to the cross-head. This space I propose to throw into the guiding-neck A so far, and add to the said neck in the following manner: I cause a certain portion of the stroke of the plunger B to be performed within the said neck, another portion of the stroke to be performed within the chamber C, and the remainder in the barrel E.

As the length of the barrel E in this case and in the previous case described is decreased the area of the cross-section of the plunger B must be increased in a similar proportion to give the pump an equal capacity with those at present in use. The action of the water in the chamber C will, in this case, where a portion of the stroke is performed in the neck A, be similar to that hereinabove described, with the exception that a longer time will be given for filling the barrel E from the chamber C.

The bell-mouth F is formed to prevent any strain that might cause a slight deviation of the plunger B to spring out of line, from mounting on the edge or entrance to the barrel E, thus causing a smash-up of the parts. It also is valuable in gathering into the barrel E the water driven forward by the plunger B.

S is a hand-hole cover. This I should prefer to make with a "ground joint," the best configuration of which I consider to be a "ball" or conical joint, so that the cover may be taken off and put on tight without the use of cement. The said hand-hole is for the purpose of enabling a new packing or elastic grommet, I, to be put on the plunger B with only a few minutes' labor, which may be done at any time during a stoppage at a station, &c. If the plunger B is caused to work a portion of its stroke within the neck A, the entrance to it should be bell-mouthed, otherwise the sharp corner at the entrance to the neck may tear the grommet I to pieces after a few strokes.

It will be seen that if the chamber G and valve H are dispensed with the ordinary inlet-valve may be said to be entirely ignored in my invention, and the chamber C is substituted wholly therefor.

In the feed-pumps attached to engines of nearly all classes they are only estimated to be one-third full at each stroke under the best circumstances, and are proportioned so that a much smaller proportion of the barrel being filled will give the necessary amount of feed. There are usually two feed-pumps attached to the boiler of a double engine, either of which is competent to supply the boiler, even under said circumstances.

In Fig. 8 the plunger B is shown with a beveled end, T, to prevent the very slight ricochetting action upon the plunger in the chamber C; but this action is so very slight that I should not consider it worthy of notice in the case of the locomotive feed-pump.

Instead of the bell-mouth F a bevel, V, may be formed on B, (see Fig. 8;) but if F is dispensed with the corner at the entrance of the barrel E must be well rounded off, to prevent it injuring the grommet I. I should much prefer, however, to make the plunger B with a flat end and use F.

Having thus fully described the construction and operation of the pump, I will now show how it will be used with heated water of at or near 212° Fahrenheit.

Referring to Fig. 6, suppose A′ to be the nozzle of the exhaust-pipe of the cylinder. Into this I introduce, a distance down, a small pipe, B′, provided with a bell-mouth, C′, so that the exhaust will in part pass into the pipe B′, which pipe will extend to and is connected with the bottom of the tank of the tender in the most direct and convenient manner that can be had. Both exhaust-pipes of the cylinders will be similarly thus provided. The pipes B′ will be provided with stop-cocks, for after the water in the tender has been brought to the boiling-point it will not answer any very useful purpose to pour in a large quantity of steam, and thereby violently agitate the water in the tank, unless it is an inclosed one to retain a pressure greater than the atmosphere; but all that is required with the construction I have described is to maintain the water at the boiling-point.

As the tank K must necessarily be situated (if the pumps are in the ordinary position) at a considerable distance from the tender, and therefore a considerable amount of heat may be lost in the transmission to the tank K, I propose to put in it an ordinary coil or system of heating-pipes. This coil will be connected with one or both of the exhaust-ports of the cylinder, and will serve as a heat-refreshener to the water in the tank K; or one of the pipes B′ may be applied to this purpose; or the pipes B′ may be dispensed with, and pipes may be connected with the exhaust-ports in the cylinder, one of which will be connected with the tender-tank and the other with the tank K. I do not think it is advisable to blow the "naked steam" into the tank K, because it would too violently agitate the water, whereas it is desirable to keep the water in K as solid as possible. The coil, after passing through the tank, may open to the atmosphere; or, if it is thought worth while to save the heated water that will collect in it, it may be carried to the tender-tank. The pipes connecting the coil in K with the exhaust-passages of the cylinder must be provided with stop-cocks or valves, controllable from the foot-plate of the engine in substantially the same way that the cylinder-cocks are.

By this means my invention may be provided with water of the full heat of 212°. The pumps may deliver this water into the boiler at the usual or any desired place; but if it is desired to carry the economy farther and deliver the water into the boiler at a much higher temperature, I should form a water-space extending around the top and sides of the smoke-arch and smoke-stack, into which the pumps will deliver the feed-water, and from which it flows by gravity down a pipe attached at the top into the boiler, as roughly shown in Fig. 7.

By the use of the jacketing shown in Fig. 7 I have calculated that from 80° to 100° of heat may be added to the water over and above that of the boiling-point. I do not confine myself to the exact amount of this estimation, as the peculiar circumstances of the engine may materially interfere with it; but to be on the safe side I will put it down as 50°. Now, if a saving, as I have before mentioned, of about four and one-half per cent. of fuel is effected for each 50°, and we have the water in the tank raised 112° above the 100° of heat that the feed-water is now usually put into the boiler at, and 50° additional heat to the feed-water by jacketing in Fig. 7, the total addition will be 162°, which, pro rata, will give an economy of fourteen and one-half per cent., or thereabout, of all the fuel consumed. Consequently, in constructing new engines for a given capacity of cylinder the boilers may be made with a reduced capacity of six-sevenths, and at the same time give an equal supply of steam to the cylinders, and on the whole a considerable lightening of the total weight and cost of the boiler may be had.

In conclusion, I would say that the reason why I prefer to make the tank K in one piece for the two pumps is, that it will have a greater capacity for the two pumps, and one coil of heater-pipes will do.

Although not shown in the drawings, the pump will be provided with ordinary flanges for attaching to the bed or frame, &c., in the usual manner.

What I claim, and wish to secure by Letters Patent, is—

1. The combination, in a boiler-feed pump, of the barrel E, chamber C, and plunger B, constructed and arranged substantially as and for the purposes set forth.

2. The combination, in a boiler-feed pump, of a guiding-neck, A, plunger B, chamber C, and barrel E, constructed and arranged substantially as set forth.

3. The combination, in a boiler-feed pump, of a guiding-neck, A, plunger B, chamber C, and barrel E, having bell-mouth F, substantially as and for the purposes set forth.

4. The combination of the barrel E, cham-

ber C, plunger B, chamber G, and valve H, substantially as described.

5. In a feed-pump for steam-boilers, the hot-water chamber C, provided with a stand-pipe, R, the barrel E, and the plunger B, combined and arranged substantially as and for the purpose specified.

6. The combination of the chamber C, provided with hot water, as described, and having pipe R attached to it or its extension K, guiding-neck A, plunger B, and barrel E, substantially as set forth.

7. A feed-pump for steam-boilers in which the pump-barrel opens into a feed-water chamber, through which a solid plunger passes before entering said barrel, substantially as and for the purpose specified.

8. A feed-pump for steam-boilers in which is combined a pump-barrel, a feed-water chamber communicating therewith, a guiding-neck, and a solid plunger which passes through said neck, through said chamber, and into said pump-barrel, substantially as and for the purpose shown.

CHARLES G. C. SIMPSON.

Witnesses:

W. E. FUDGER,

T. B. MACAULAY.