

F. B. DEANE.
APPARATUS FOR LIQUEFYING GAS.

No. 509,205.

Patented Nov. 21, 1893.

Fig. 1.

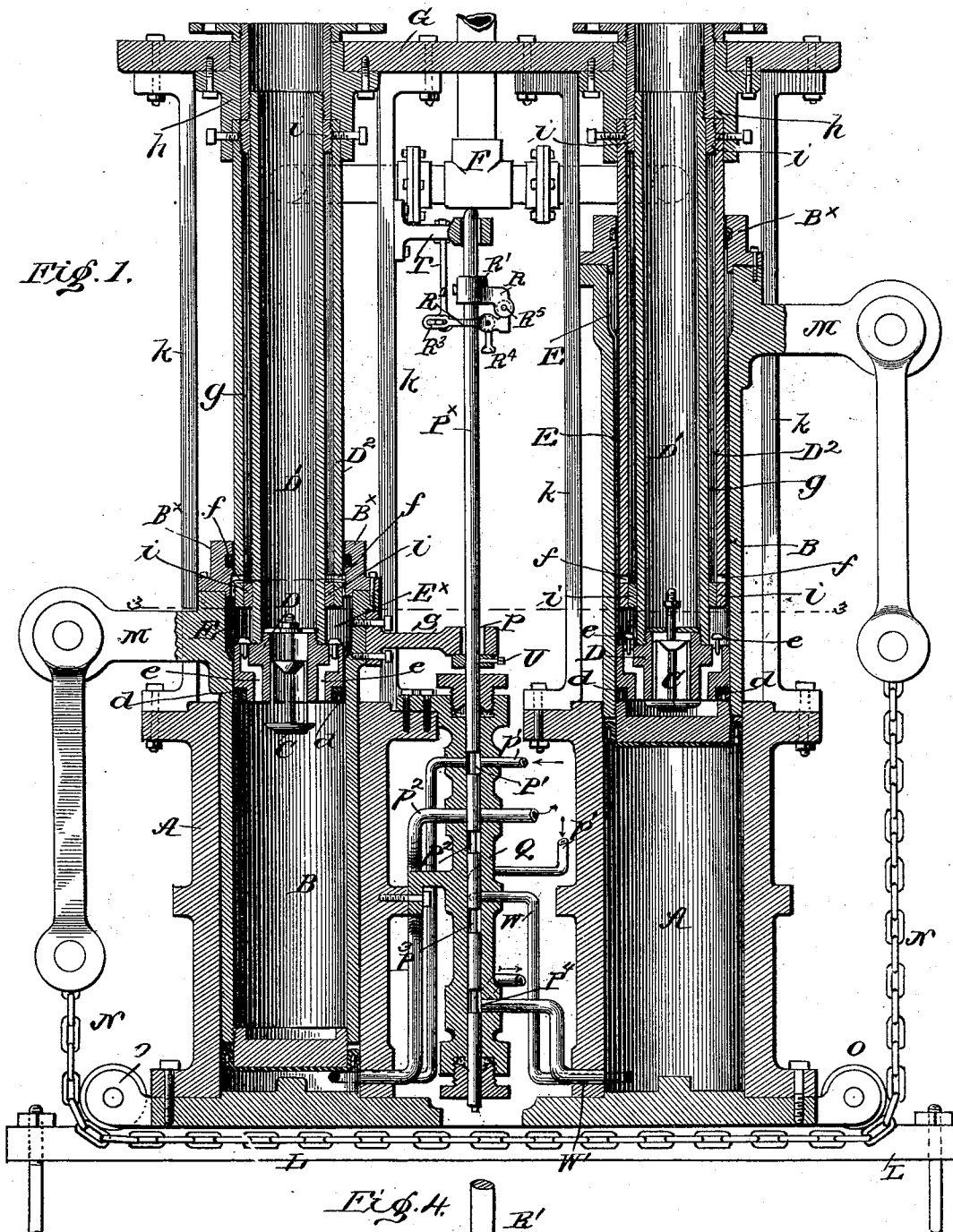
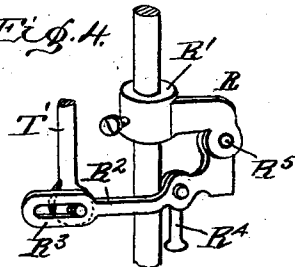


Fig. 4.



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(No Model.)

2 Sheets—Sheet 2.

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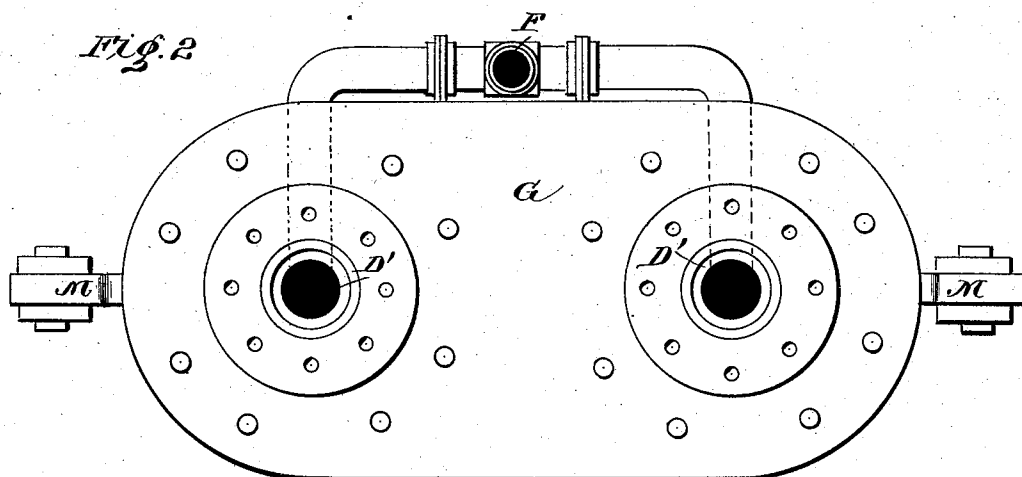
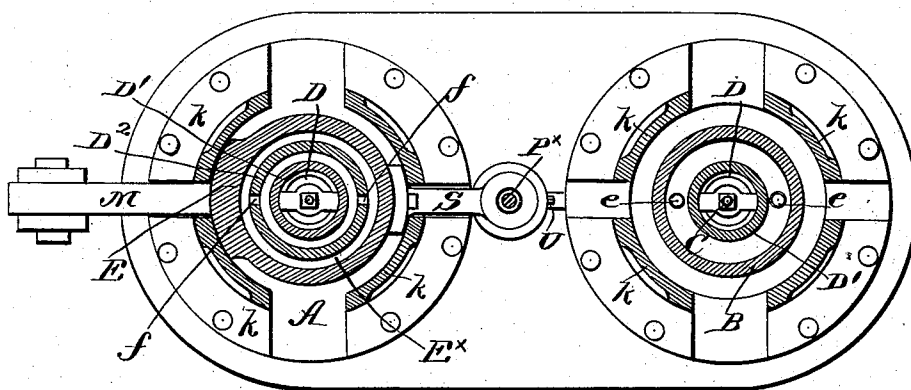


Fig. 3.



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UNITED STATES PATENT OFFICE.

FRANCIS B. DEANE, OF LYNCHBURG, VIRGINIA.

APPARATUS FOR LIQUEFYING GAS.

SPECIFICATION forming part of Letters Patent No. 509,205, dated November 21, 1893.

Application filed September 7, 1892. Serial No. 445,282. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS B. DEANE, residing at Lynchburg, in the county of Campbell and State of Virginia, have invented certain new and useful Improvements in Apparatus for Liquefying Gases, of which the following is a specification.

My invention is in the nature of a combined hydrostatic press and pump especially adapted for liquefying gas by compression, and it has for its object to provide an apparatus of this character economical and effective in its operation.

With other minor objects in view all of which will be fully set out in the specification, my invention consists in the peculiar combination and novel arrangement of parts, hereinafter described and claimed, reference being had to the accompanying drawings in which—

Figure 1 is a vertical section of my improved apparatus. Fig. 2 is a top view thereof. Fig. 3 is a horizontal section on the line 3—3 Fig. 1 and Fig. 4 is a detail view hereinafter referred to.

Referring to the accompanying drawings, B indicate hollow pistons working in the cylinders A A, which are so constructed as to serve the purpose of a ram, such as is generally used in hydrostatic presses, and such cylinders, the construction of which is most clearly shown in Fig. 1, have their upper ends enlarged as at E for a purpose presently explained.

D indicates a stationary hollow plunger, the lower end of which snugly fits, (by means of the packing ring *d*) the main bore of the piston B it being provided at its lower end with a main or inlet valve C and outlet valves *e e* of reduced area. The plunger D is constructed of two pipes of different diameters; the outer face of the smaller pipe D' being held apart from the inner face of the larger pipe D² by the space blocks or rings *i i*, such construction providing an outlet channel way *g*, the area of which can be varied to suit different purposes, by the difference between the outer and inner diameters of the pipes D' D². These pipes D' D² are united and held together to form the shaft of plunger D, by the blocks or rings *i i* before referred to, and are also attached to the head piece G, of the

press by means of socket pieces *h*, and the inner or smaller pipe of the plunger passes through the head piece G of the press and connects with any convenient and suitable reservoir for containing gas to be compressed, and provides the passage way for the induction of the gas into the pistons B. It will be noticed that when the piston B is down to its lowermost position the lower end of the plunger fits the reduced or main bore of the said piston, and the outer pipe D² which does not extend down to the said lower end of the plunger, snugly fits within the cap plate B^x of the piston.

By the construction so far described, it will be noticed, that the downward movement of the pistons on the fixed plunger, provides for the induction of the gases to be treated, through the hollow pipe D' into the hollow piston B and behind the valve C. The difference in areas, of inlet valve C and the outlet valves *e e* provides, in connection with the stroke of pistons B, for the compression of the gas introduced in the ratio of force developed by the movement of the pistons. As the pistons B move upward the gas held therein under pressure is forced through the small outlet valves *e e*, into the chamber E^x formed between the plunger and piston; which chamber is provided for by the enlarged prolongation B^x of pistons B beyond the foot of the fixed plunger D, as before referred to. The return stroke of the piston B closes the valves *e e* and still further compresses the gas in the chamber E^x and forces it through the ports *f f* in a liquefied form into the space *g* between the pipes D' D² from whence it passes into an outlet pipe F which delivers it to a suitable tank or storing receptacle. The head G of the press is connected with and bound to the cylinders A, by means of the pieces *k k*, the latter being fastened respectively to head piece G and the cylinders A.

My improved apparatus is made double acting by the following means: The twin cylinders A A are placed side by side upon a foundation plate L, and the pistons B B respectively of each cylinder are each provided with arms M, and are connected, the one with the other, by means of the chain N, which passes under friction rollers O O attached to the base of the cylinders A, and beneath the foun-

dation plate L, thus providing for the upward
 and downward throw of the pistons B and the
 double action of the press and pump. The
 alternating motion of the press and pump is
 5 directed and governed by the valve P and its
 gear connections, which consist of the body
 of valve Q, the plunger rod P^x , the valve arm
 S and stop piece U. The body Q of the valve
 is attached to one of the cylinders A A, and
 10 the plunger of valve P is made to fit the bore
 of such body Q so as to move up and down
 readily. It will be seen by reference to Fig.
 1 that the valve rod P^x has recesses $P^1 P^2 P^3$
 15 P^4 which form passageways when brought into
 register with the feed and exhaust ports $p^1 p^2$,
 the body of such valve rod or stem forming a
 cut off for such ports when the recesses are
 moved out of register. These recesses are ar-
 20 ranged to be alternately brought into register
 with the feed and exhaust of each piston and
 cylinder, *i. e.* when the several ports are in
 the position shown in Fig. 1 the recess P^1
 is in register with the feed pipe p^1 which dis-
 25 charges into the bottom of the left hand cyl-
 nder A, while the recess P^2 is out of register
 with the exhaust pipe p^2 connected with the
 aforesaid cylinder, and at the same time the
 recess P^3 will be out of register with the feed
 30 pipe W of the right hand cylinder while the
 recess P^4 will be in register with the exhaust
 pipe W' of said cylinder. It will thus be
 seen that as the valve is shifted, the cylin-
 ders A A will be alternately charged and
 35 emptied by such shifting action of said valve.
 The several recesses in the plunger rod P^x are
 so distanced and placed in connection with the
 feed and exhaust pipes as to give the alter-
 nate ingress and egress and stoppage to the
 40 liquid in its passage to the cylinders A A and
 to bring about an alternate motion of the
 pistons B in the cylinders. The alternating
 motion of the plunger rod P^x is produced by
 the arm S, which is attached to the piston B,
 and which on its upward stroke, engages a
 45 lift mechanism R secured to the upper end
 of the rod P^x , and on its down movement
 contacts with a stop collar U secured to the
 said shaft P^x at a point near the top of the
 cylinders A. The upper lifting mechanism
 50 R, comprises a sleeve R^1 adjustably secured
 to the shaft P^x , a lever arm R^2 , one end of
 which has a movable pivotal bearing R^3 , on
 the lower end of a depending arm T^1 , secured
 to the brace member T which forms the up-
 55 per guide for the shaft P^x , while the opposite
 end of such arm is pivotally connected to the
 sleeve R^1 as at R^5 .

R^4 indicates a contact member pivotally
 connected to the lever arm R^2 as most clearly
 60 shown in Fig. 4.

As described, it will be manifest that as
 the arm S travels on its up stroke it will en-
 65 gage the contact member R^4 and lift it, which
 in turn lifts the sleeve R^1 and valve rod P^x ;
 the stroke of the rod P^x , however, through
 the medium of the lever arm connections be-
 ing augmented beyond the stroke of the

pump cylinder to the extent of the difference
 between the long and short members of the
 said lever. This lengthening of the upward
 70 stroke of the valve rod beyond the correspond-
 ing stroke of the cylinder is necessitated, be-
 cause, the change in direction of the move-
 ment of the cylinders B and B' by means of
 the alternating valve P is effected on the up-
 75 ward stroke of cylinder B and must take
 place as near the end of the stroke as can be
 obtained so as to provide against dead space
 in the cylinders.

The change in register of ports upon down-
 80 ward stroke of cylinder B is effected by con-
 tact of arm S with stop U, and is brought
 about by the gravitation of cylinder B to its
 normal position in cylinder A, aided by its
 connection with its twin cylinder B' which is
 85 traveling in the opposite direction. Upon
 the down stroke the arm S engages the stop
 piece U and forces the plunger valve rod
 back to its alternate position, and by change
 of the ports, reverses the direction of move-
 90 ment of the respective pistons B. Both the
 sleeve R and the stop piece U are movable
 upon the plunger valve rod P^x at the will of
 the operator, to allow for lengthening or
 95 shortening the stroke of the press and pump
 as may be desired to any point within the
 full stroke of the pistons B.

From the foregoing description taken in
 connection with the drawings the advantages
 of my improved apparatus, as also the com-
 100 plete operation will be readily understood. It
 will be seen that in operation as one piston
 proceeds on its down stroke, it fills with gas
 drawn through the hollow plunger and the
 valve C by induction, while the other piston
 105 on its up stroke partially compresses the gas
 held within it, and as the inlet valve C closes,
 such compressed gas is forced into the cham-
 ber E^x through the outlets e , and such cham-
 110 ber being of a much less area the gas is still
 further compressed, and reduced to a liquid
 form, and as such piston again descends, to
 draw in a fresh supply of gas the liquefied gas
 within the chamber E^x is forced through the
 openings f into the chamber g and out through
 115 the exit pipe F.

Having thus described my invention, what
 I claim, and desire to secure by Letters Pat-
 ent, is—

1. In an apparatus for the purpose de-
 120 scribed, in combination, a cylinder, a hollow
 piston and a plunger fitting the same movable
 relatively as described, a valved inlet port
 opening into the piston, valved outlets opening
 through the plunger head into the upper part
 125 of the piston, an annular compression cham-
 ber of smaller capacity than the piston com-
 municating with such piston and a discharge
 outlet in such compression chamber, all ar-
 130 ranged substantially as shown whereby the
 gas is drawn into the piston by induction and
 forced into the annular chamber and liquefied
 by compression, as and for the purposes de-
 scribed.

2. An apparatus for the purpose described, comprising twin cylinders, hollow pistons operating therein, having annular enlarged upper ends, fixed hollow plungers fitting the main bore of such pistons and having at their lower end a valved inlet, and valved outlets, of less diameter than the inlet, annular chambers surrounding such plungers and communicating with the pistons, said pistons having intermediate connections, a source of driving fluid for operating the pistons, and shifting valve mechanism adapted to be operated by the alternate movement of the pistons to regulate the flow of the driving fluid, all as and for the purpose described.

3. The combination, in an apparatus as described, with a cylinder, a hollow piston B having an upper enlarged portion B^x, and means for propelling such piston substantially as shown, of the plunger D formed of the pipes D' D² of different diameters, spaced apart and connected at their upper and lower ends whereby to form an annular chamber *g*, a port *f* connecting such chamber with the piston B at a point above the lower end or head of the plunger, such head having a feed or inlet valve opening into the piston below its enlarged portion, and outlet valves opening from the lower to the upper part of such piston all arranged as and for the purpose described.

4. An apparatus for the purpose described, comprising a cylinder, a hollow piston, a stationary hollow plunger fitting in such piston, and having a valved main or feed opening, and smaller valved discharge openings in such end, an annular chamber E^x intermediate the plunger and piston, the said plunger having an annular chamber *g* communicating

with the chamber E^x said chamber *g* having a discharge F, and means for operating the piston substantially as and for the purpose described.

5. In an apparatus for the purpose described, in combination, a pair of cylinders, a pair of hydraulically operated pistons operating therein, intermediate valve mechanism, alternately operated by the movement of the pistons whereby such pistons are moved in unison but in alternate directions, a hollow plunger having an annular chamber provided with a discharge, and with a port opening into the hollow piston, said plunger having a feed valve operated to open on the down stroke of the pistons, and outlet valves of a less diameter operated to open on the up stroke of the said pistons all arranged substantially as shown and for the purposes described.

6. In an apparatus of the kind described, the combination with the cylinders A, the pistons B, and the plungers D, constructed and arranged substantially as described, said pistons connected whereby to move in unison and in reverse directions, of the feed valve Q, having inlet and outlet ports communicating with the cylinders, the vertically reciprocating valve P having alternately arranged feed recesses, adapted to be moved into register with the ports in the valve Q, the arm S, on one of the pistons, and the sleeve R and stop U on the valve P all arranged substantially as shown and described.

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Witnesses:

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JAS. B. GREGORY.