B. V. NORDBERG.

FLUID OPERATED ENGINE.

APPLICATION FILED SEPT. 18, 1903.

998,032. Patented July 18, 1911.

3 SHEETS—SHEET 1.

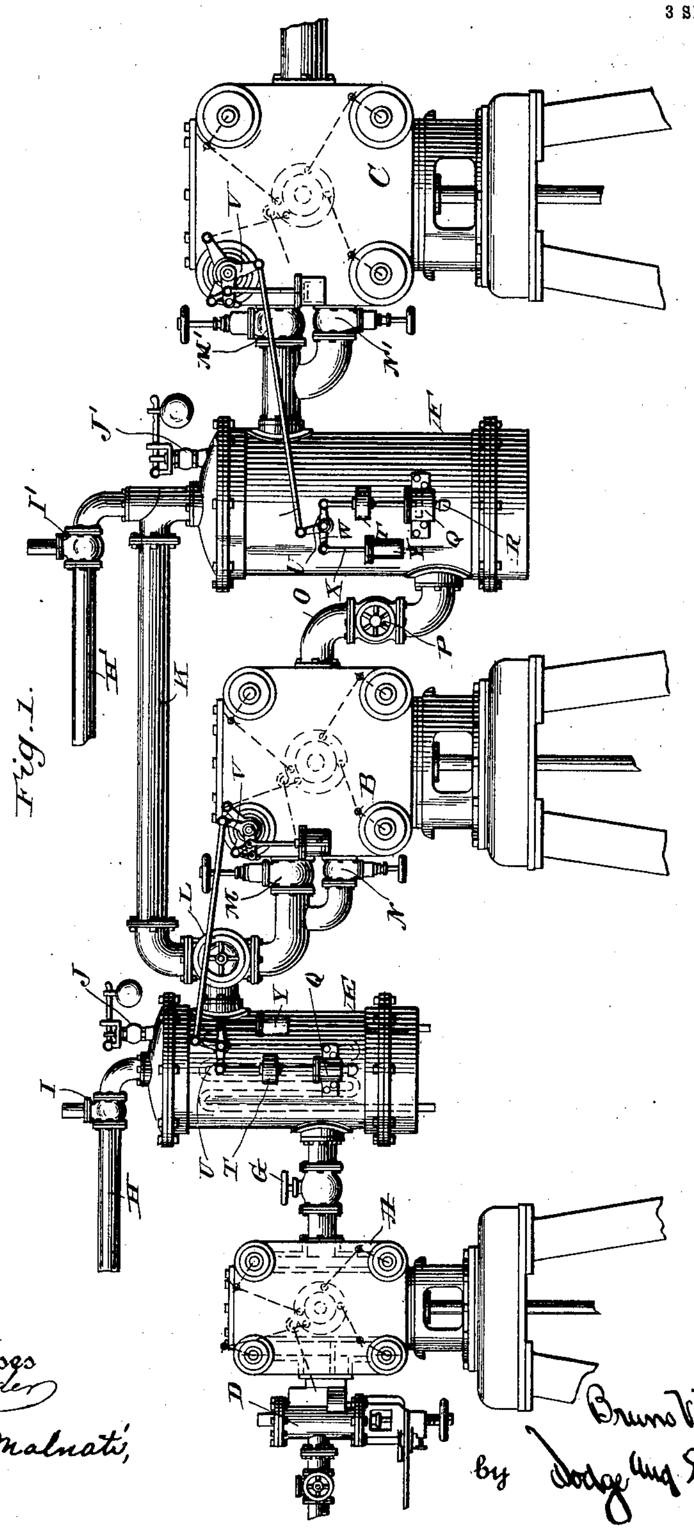

Fig. 1.

Witnesses

[signature]

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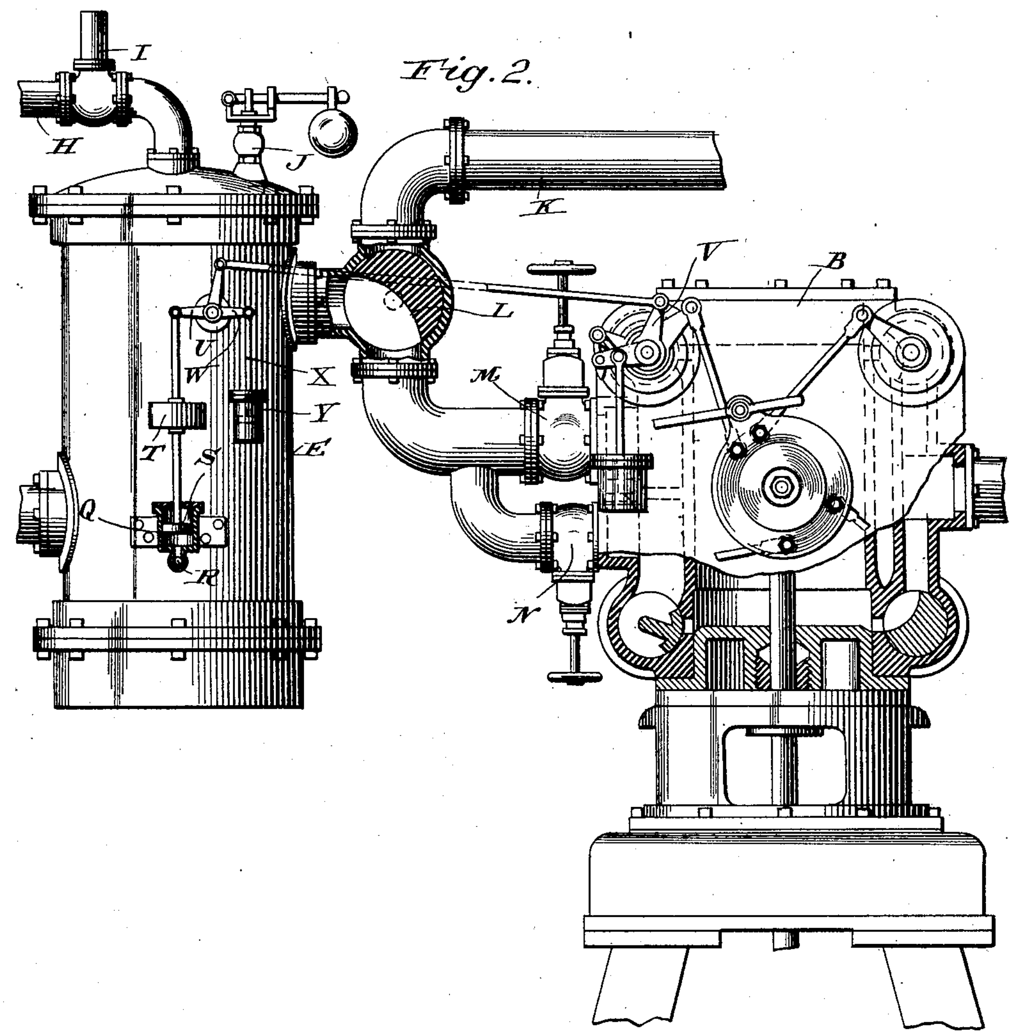
Fig. 2.



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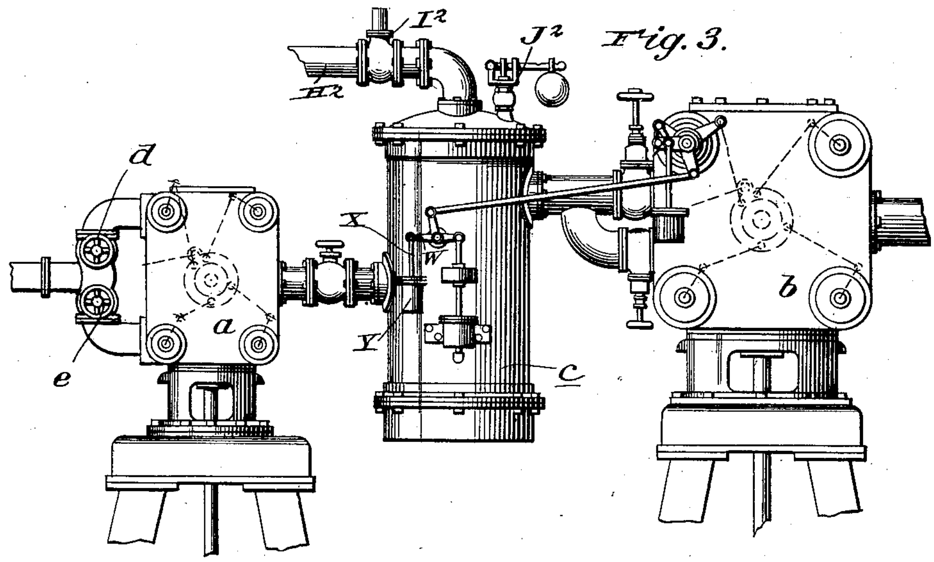
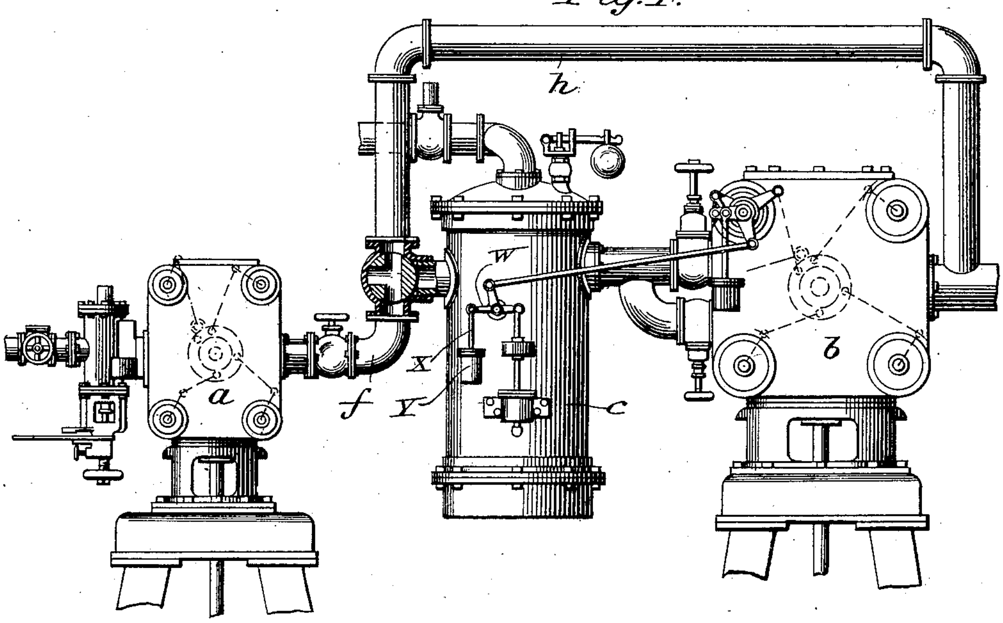


Fig. 3.

Fig. 4.



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UNITED STATES PATENT OFFICE.

BRUNO V. NORDBERG, OF MILWAUKEE, WISCONSIN.

FLUID-OPERATED ENGINE.

998,032. Specification of Letters Patent. Patented July 18, 1911.

Application filed September 18, 1903. Serial No. 173,691.

To all whom it may concern:

Be it known that I, BRUNO V. NORDBERG, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Fluid-Operated Engines, of which the following is a specification.

My present invention relates to fluid-operated engines, and more particularly to those adapted to deliver a blow, such for instance as ore-stamps, power-hammers, and the like.

The invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a side elevation of a battery of engines constructed and connected in accordance with my invention and shown as applied to a series of ore-stamps; Fig. 2, a like view, partly in section, of the intermediate engine, its receiver, and the steam-supply controlling-mechanism, the parts being shown upon a somewhat larger scale than in Fig. 1; and Figs. 3 and 4, side elevations, showing slightly modified arrangements and combinations of the engines.

The invention has for its objects, first, to combine a series of engines in such a manner that the stroke or blow delivered by each engine will at all times be the same and independent of the action of any other engine in the series; secondly, to automatically regulate the steam supply passing to each engine so that the pressure delivered thereto will remain constant; thirdly, to provide means whereby any one of the engines of the series may be cut out for the purpose of repair or the like, without in any manner affecting the others; and fourthly, to provide means for automatically regulating the length of the stroke of the various pistons.

With these and other minor objects in view I will now proceed to describe my invention in detail.

Referring first to Figs. 1 and 2, A represents the high-pressure engine or cylinder, B the intermediate engine or cylinder, and C the low-pressure engine or cylinder, the steam passing to cylinder A through a valve D, similar to the one shown and claimed in my Letters Patent No. 741,536, dated October 13, 1903. From cylinder A the steam exhausts into a receiver E, from cylinder B into a receiver F, and the exhaust from the low-pressure cylinder C may pass to the atmosphere or into a condenser, as found desirable. Each of the receivers will preferably be provided with a radiator connected to the supply of live steam so as to superheat the steam in its passage through the receiver. Such construction is not essential but is deemed advisable from an economical point of view.

A valve G is interposed between cylinder A and receiver E, to cut off the passage of steam from said cylinder to the receiver, when such becomes desirable. When the steam is cut off it is necessary to supply receiver E from some other source, and for this purpose a pipe, H, provided with a reducing valve I, connects the receiver with the live steam supply, said reducing valve being initially adjusted so as to admit steam into the receiver at the proper working pressure of the receiver and to automatically maintain such proper working pressure. A safety valve J is also provided for the receiver and is set so as to open at a point slightly above the pressure desired to be maintained within the receiver. Similar arrangement is made for the receiver F, the pipe being designated by H′, the reducing-valve by I′, and the safety-valve by J′.

A pipe K extends from a valve L, located in the outlet of receiver E, to the receiver F, said pipe serving to convey steam directly from receiver E to receiver F, when it is desired to cut out cylinder B. The position of valve L will be such as to cause the steam to pass through pipe K or into the steam-chests of cylinder B through valves M and N which control the same. Valves M and N can be adjusted to regulated the pressure exerted in the steam-chests, and consequently in the cylinder above and below the piston respectively.

Any suitable valve-mechanism for alternately admitting steam to the upper and lower ends of the cylinder and for permitting it to exhaust therefrom into the pipe O, which leads to receiver F, may be employed. Pipe O is provided with a valve P, which of course will be closed when engine or cylinder B is cut out. The steam which passes from receiver F to cylinder C will be controlled by valves M′, N′, and the action of the steam upon the piston will be controlled by the usual valve mechanism, as in the case of engines or cylinders A and B.

The operation of the system thus constructed and arranged will be evident. Steam or other expansive fluid entering through valve D, will operate engine A in the usual manner, the exhaust passing into receiver E. Valve L, under normal conditions, is adjusted to deliver steam to the valves M and N, which in turn are regulated to permit the proper volume of steam to pass to the upper and lower inlet valves of engine B. The exhaust from engine B passes through pipe O to receiver F, thence through valves M′, N′, to the inlet valves of engine C, and finally to the atmosphere or into a condenser, as found desirable. Should it become necessary to cut out engine A, valves D and G will be closed, and the steam required to operate the remaining engines of the series will pass through pipe H and reducing valve I into receiver E, from whence it will pass forward as above described. To cut out engine B, valve L is turned to cause the steam from receiver E to pass through pipe K to receiver F, valve P being at the same time closed. To cut out engine C, it is simply necessary to close valves M′, N′, and permit the excess pressure in receiver F to pass out through valve J′. Should engines A and B be cut out of the series, then engine C will derive its steam from pipe H′, reducing-valve I′ and receiver F.

As machines of the character herein described have no connecting-rod or other device for determining the exact stroke of the pistons, it is evident that the pressure upon the pistons must remain unchanged in order to maintain a constant length of stroke. This refers not only to the forward pressure on the piston but also to the back pressure, which, in a compound or triple-expansion system, is the same as the forward pressure in the next cylinder of the series. If, for instance, the back pressure be increased while the stamp piston is lifted, it will not lift as high as with normal back pressure. The same result is had whenever the forward pressure to lift the stamp falls from any cause. Again, if anything occurs to decrease the back pressure, the stroke will be lengthened and there will be danger of the piston's coming into contact with the cylinder-head and causing breakage of the parts. The boiler pressure can be kept under perfect control. The back pressure on the low-pressure stamp can also be kept under perfect control, and will be either the atmospheric pressure or the vacuum produced by the condenser. If the condenser be large enough and in good working order, it will maintain a constant vacuum under widely varying conditions of load. The pressure in the receiver of a compound stamp (Figs. 3 and 4), or in the two receivers E and F of the triple-expansion system shown in Fig. 1 is, however, subject to variations, particularly where the high and low-pressure pistons operate on independent stamps. It is impossible to feed the rock into the mortars with sufficient regularity to prevent variation in the length of the stroke, due to a greater or less quantity of rock under the stamps, and such variation means a greater or less volume of steam exhausted into the receivers or taken therefrom, depending upon the action of the high or low-pressure piston. In order, therefore, to produce a steady running stamp, it is of vital importance to have the receiver pressure under as perfect control as the boiler pressure or the vacuum. To accomplish this, I employ a cut-off valve on the steam inlet of each of the low-pressure cylinders, said valve working in conjunction with an expansion gear operated and controlled by the steam pressure in the receiver. In the construction shown (see Fig. 2), Q denotes a cylinder which is connected at its lower end to the receiver E by a pipe R. A piston S works in the cylinder, and a weight T is mounted upon the piston rod, said weight tending to counteract the steam pressure acting upon the lower face of the piston. If desired, a spring may be substituted for the weight. The piston rod is connected to a bell-crank lever U, which in turn is connected to an arm V of the cut-off valve or device, and a second arm W is connected to one end of a rod X, the other end of which carries a piston or plunger working in a cylinder Y filled with oil. This dash-pot, as it may be termed, tends to dampen the action of the regulating device.

The connections and arrangements of the parts are such that should the receiver pressure rise and as a result lift the piston S and weight T, the cut-off valve will be moved to admit a greater volume of steam into the cylinder B, thereby increasing the mean effective pressure in said cylinder for the time being. It is evident, therefore, that a rise in the receiver pressure will be followed by a greater discharge of steam into the cylinder, and conversely, a fall in the receiver pressure will position the parts so as to allow a smaller flow of steam into the cylinder, thereby causing an increase in the receiver pressure. The result of these two operations will be to maintain a constant pressure in the receiver, or, in other words, the action of the parts will be such as to neutralize any rise or fall of pressure in the receiver.

With a triple-expansion system, such as shown in Fig. 1, a regulating device will be provided for each receiver and the cylinder or engine working in conjunction therewith.

It is apparent that the effect of increasing the weight will be to increase the receiver pressure, which increases the work done in the low-pressure cylinder, while it decreases the work done in the high-pressure cylinder because the receiver pressure is equal to the back pressure in the high-pressure cylinder.

By the mechanism thus described, it is therefore possible to regulate the load of the different cylinders in series with each other, which is of importance in a stamp-mill designed to give an equal output of all the stamps.

It is manifest that the arrangement of the piping for connecting the engines and receivers may be materially varied without departing from the spirit or purpose of the present invention. For instance, in Fig. 3, two engines—a high-pressure engine *a* and a low-pressure engine *b*, connected to an intermediate receiver *c*—are shown. Under this construction separate valves, *d* and *e*, control the admission of steam to the upper and lower inlet valves of the engine *a*, and the by-pass K is omitted. With the engine *b* out of operation, engine *a* will continue to work, its exhaust passing out through the safety valve J^2. With engine *a* cut out of the series, steam will pass into receiver *c*, through pipe H^2 and reducing valve I^2.

In Fig. 4 a still further arrangement is shown, wherein the pipe *f*, passing from the high-pressure engine to the receiver, is provided with a three-way valve. A pipe *h*, leading from said valve, permits its high-pressure engine *a* to exhaust to the condenser, or directly into the atmosphere, when the low-pressure engine is not working.

Having thus described my invention, what I claim is:

1. In combination with a series of engines each having a free piston adapted to deliver a blow, means for supplying steam to the first engine in the series; a receiver located intermediate each pair of engines in the series; and means for automatically supplying steam directly to each of the receivers independently of the exhaust from the preceding engine when the pressure in the receiver falls below a predetermined point.

2. In combination with a series of engines each having a free piston adapted to deliver a blow, means for supplying steam to the first of said engines in the series; a receiver located intermediate each pair of engines in the series; means for supplying steam directly to each of the receivers independently of the exhaust from the preceding engine when the pressure in the receiver falls below a predetermined point, or the exhaust from the preceding engine is cut off therefrom; and means for permitting any one of the engines in the series to be cut out of operation without affecting the continued operation of the other engines in the series.

3. In combination with a series of engines each having a free piston adapted to deliver a blow independently of the others, means for admitting steam to the first engine of the series; a receiver located between each pair of engines in the series and adapted to receive the exhaust steam from the preceding engine and to deliver it to the next succeeding engine in the series; means operated by the pressure in each of the receivers for controlling the stroke of the piston in the engine to which it delivers its steam; and means acting in conjunction with the exhaust steam for maintaining a constant pressure in the receiver.

4. In combination with a series of engines each having a free piston adapted to deliver a blow independently of the others, a receiver mounted intermediate each pair of engines in the series and adapted and arranged to deliver the exhaust steam from the preceding engine to the next succeeding engine in the series; and means acting in conjunction with the exhaust steam to secure a constant pressure in the receivers.

5. In combination with a series of engines working upon the expansive system and each adapted to deliver a blow independently of the others, means for delivering steam to the first engine in the series; a receiver mounted intermediate each pair of engines in the series and adapted to receive the exhaust steam from the engine preceding it and to deliver the exhaust steam to the succeeding engine; means controlled by the pressure in each of the receivers, for controlling the amount of steam passing from said receiver to the engine into which it delivers; and means for supplying steam directly to each of the receivers independently of the exhaust from the engine next preceding.

6. In combination with a high-pressure engine, a low-pressure engine and an intermediate low-pressure engine; a receiver located between the high-pressure engine and the intermediate engine; a second receiver located intermediate the low-pressure engines, each of said receivers receiving the exhaust steam from the preceding engine and delivering it to the next succeeding engine; means for controlling the volume of steam delivered from said receivers to the upper and lower faces, respectively, of the pistons of the low-pressure engines; means for passing the steam directly from the first receiver to the second receiver independently of the intermediate engine: and means for supplying steam directly to each of said receivers when the pressure therein falls below a predetermined point.

7. In combination with a high-pressure engine, a low-pressure engine and an intermediate low-pressure engine; a receiver located between the high-pressure engine and the intermediate engine; a second receiver located intermediate the low-pressure engines, each of said receivers receiving the exhaust steam from the preceding engine and delivering it to the next succeeding engine; means for controlling the volume of steam delivered from said receivers to the upper and lower faces, respectively, of the

pistons of the low-pressure engines; means for passing the steam directly from the first receiver to the second receiver independently of the intermediate engine; means for supplying steam directly to each of said receivers when the pressure therein falls below a predetermined point; and means, controllable by the pressure in each of said receivers, for operating a cut-off valve working in the delivery end of each of said low-pressure engines.

8. In combination with a series of engines each having a free piston adapted to deliver a blow independently of the others, means for admitting steam to the first engine of the series; a receiver located between each pair of engines in the series and adapted to receive the exhaust steam from the preceding engine and to deliver it to the next succeeding engine in the series; means operated by the pressure in each of the receivers for controlling the stroke of the piston in the engine to which it delivers its steam; and means for securing a constant pressure in the receivers.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

BRUNO V. NORDBERG.

Witnesses:
E. C. BAYERLEIN,
GEO. W. LOWE.