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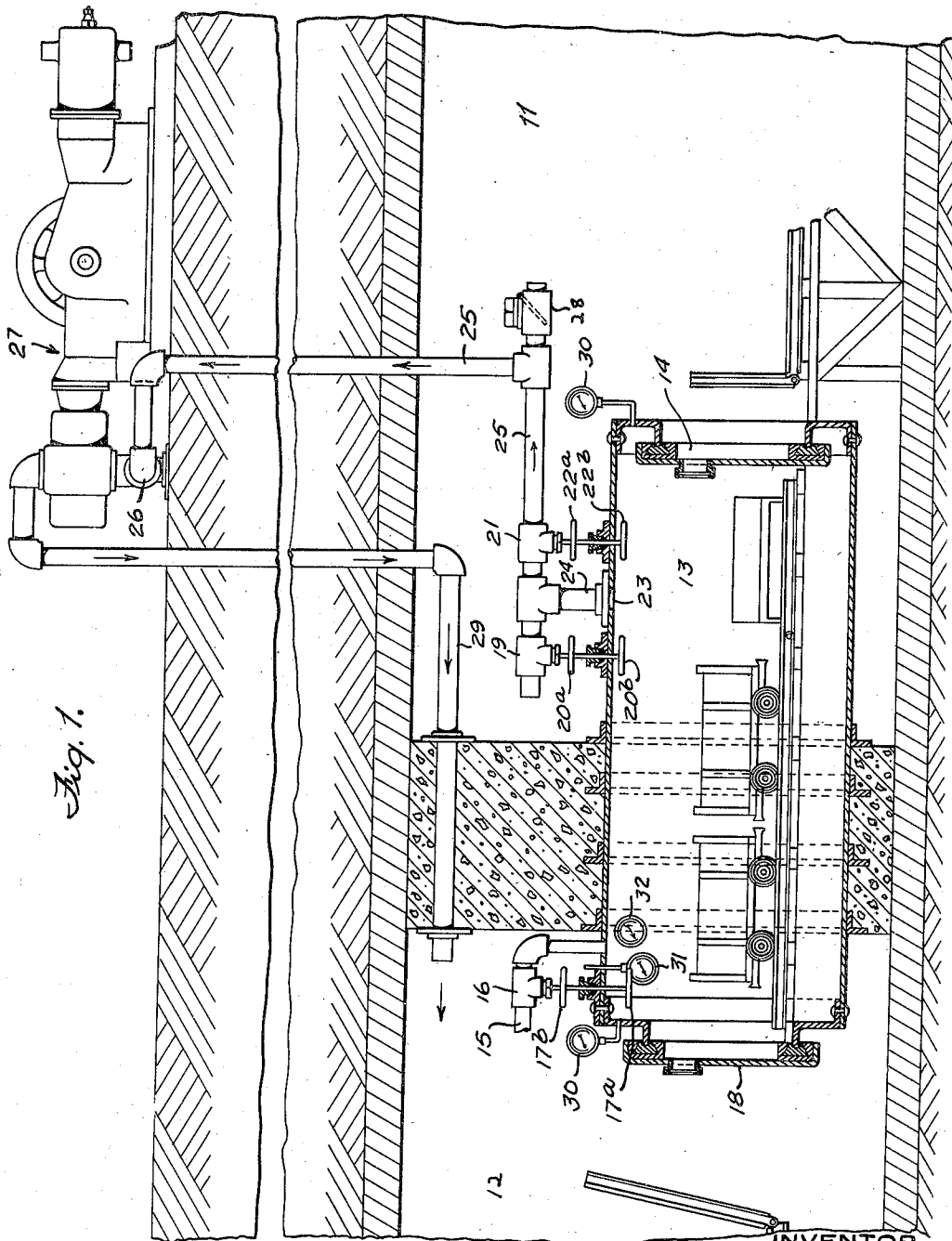
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APPARATUS FOR CONSERVING PRESSURE USED IN AIR LOCKS

Filed June 5, 1937

2 Sheets-Sheet 1



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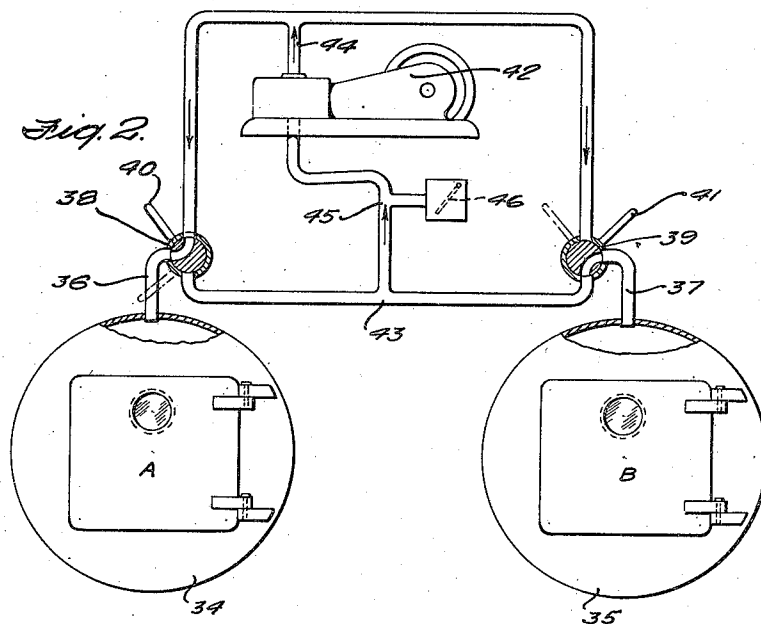
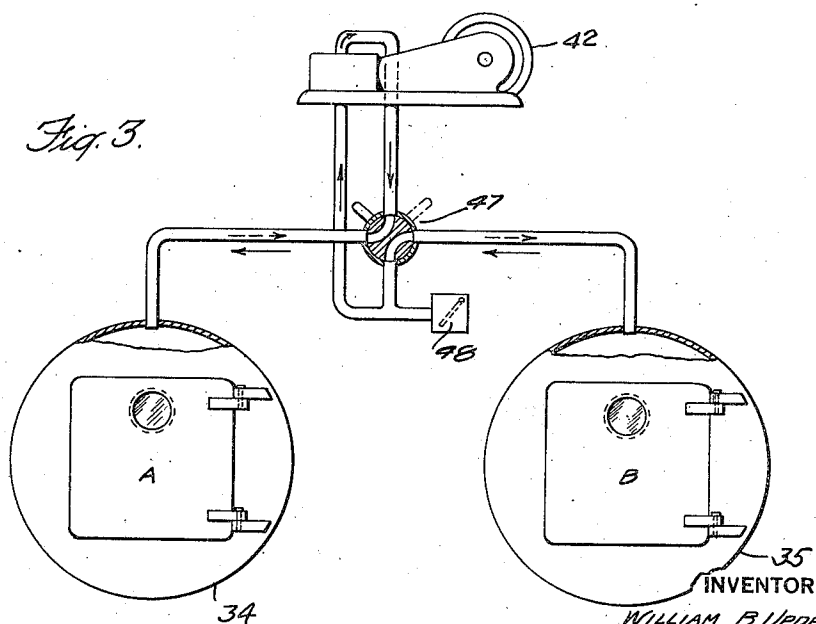
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APPARATUS FOR CONSERVING PRESSURE USED IN AIR LOCKS

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2 Sheets-Sheet 2



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APPARATUS FOR CONSERVING PRESSURE
USED IN AIR LOCKS

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8 Claims. (Cl. 61—83)

This invention relates to apparatus for conserving pressure used in air locks in connection with operations conducted under pressure, such as the building of tunnels, sinking of deep foundations, or other works where air pressure is necessary to prevent the entrance of water into the working chamber. In all such works it is necessary to provide air locks through which men and material are passed into or out of the working chamber. Whenever anything is passed out of the working chamber through the air lock, it has heretofore been necessary to reduce or relieve the pressure in the lock by venting it to an atmosphere of lower pressure, and the energy of the compressed air in the lock has therefore been entirely wasted.

It is an object of my invention to provide for the conservation of this energy, in part at least, thereby cutting down on the power required to keep the system in operation and to maintain the necessary pressure in the working chamber.

This is accomplished by utilizing the air under pressure which is released from the lock, either directly or indirectly, as a source of energy to aid in the work of compressing the air necessary to maintain the required pressure in the system. In one form of my invention the air released from the lock is led directly to the intake side of the main air compressor or to a booster, thereby enabling the compression unit employed to operate in part at least upon air which is already partly compressed.

It is another object of my invention to apply this saving of pressure to the type of system which, because of the size of the operation, may have a plurality of locks, particularly material locks, through the same bulkhead, and to provide for producing partial compression in one lock by transferring into it the compressed air discharged upon decompression of another lock.

It is also an object of my invention to provide improvements in the system and controls therefor to enable the foregoing results to be efficiently attained.

In the drawings which represent certain preferred embodiments of my invention and which form a part of the specification,

Figure 1 is a diagrammatic, vertical, longitudinal section illustrating a portion of a tunnel with a bulkhead therein confining a work chamber which is to be maintained under pressure and with an air lock in the bulkhead and showing a diagrammatic representation of an air compressor and its connections to the working chamber and air lock.

Figure 2 is a diagrammatic representation of my invention with modifications which make it applicable to a system of two locks in one bulkhead.

Figure 3 is a diagrammatic representation showing another application to a two lock system.

The method heretofore pursued for moving men and/or materials through the bulkhead is substantially as follows:

To make the transfer from the atmospheric pressure of the shaft or tunnel entrance 11 to the elevated pressure of the compression chamber 12 both doors to the air lock 13 are first closed and the pressure in the lock is reduced to atmospheric or to the pressure of the chamber 11. The outer door 14 may then be opened and the men or materials introduced into the lock. The door 14 is then closed, and air under pressure is introduced into the lock through pipe 15, controlled by valve 16, which may be operated from within or without the lock by means of hand controls 17a and 17b. When the pressure in the lock 13 equals the pressure in the chamber 12, the airtight door 18 may be opened and the men or materials passed into the chamber 12.

To remove men or materials from the compression chamber the process is reversed. Doors 14 and 18 are closed, pressure in the lock is equalized with pressure in the compression chamber 12, the door 18 is opened, the men or materials to be decompressed are placed in the lock, the door 18 is closed, pressure is released through outlet 23, pipe 24, and valve 19 operable by means of hand controls 20a or 20b from outside or inside the lock 13 until the pressure in the lock equals the pressure in the shaft or tunnel entrance 11. The door 14 may then be opened and the decompressed men or materials removed.

A procedure of substantially this nature is necessary for each introduction or removal of men or materials into or from the compression chamber, and it is easily seen that each decompression which occurs results in an irrevocable loss of the pressure in the air lock. This loss is wasteful and expensive, and the loss reflects itself in the increased work which the compressor must accomplish to maintain the pressure in the working chamber. It is to the substantial elimination of this waste and expense that my invention is directed.

My new apparatus may be applied to substantially the apparatus above described or to any similar pressure apparatus, involving air locks and a pressure differential in moving men or materials through the locks.

The apparatus shown in Fig. 1 comprises a valve 21 operable by means of hand controls 22a or 22b without or within the air lock which governs the flow of air through the outlet 23 and pipe 24.

The pipe 25 leading from the valve 21 is connected to the intake port 26 of the compressor indicated generally at 27. At any suitable point on this pipe, preferably within the space 11 or elsewhere, open to the atmosphere, is situated an inwardly opening check valve 28.

Pressure gauges 30 are situated on the outer side of either end of the air lock to indicate or record the pressure within the lock, and gauges 31 and 32 respectively indicate the pressure in the compression chamber and in the lock to those inside the lock. Thus the pressure within the air lock may be read or recorded on either side of the bulkhead and within the lock.

The operation of the air lock on removing men or materials from the working chamber is as follows:

Doors 14 and 18 are shut; valve 16 is opened to equalize pressure in compression chamber 12 and air lock 13; door 18 is opened, men or materials placed in lock; door 18 is closed; valve 16 is closed; valve 21 is opened from within or without the air lock, whichever is convenient; the pressure in the lock forces the air from the lock into the pipe 25 leading to the intake port 26 of the compressor 27 until the pressure in the air lock 13 equals the pressure in the space 11, at which time the check valve 28 opens and the evacuation of the air lock 13 ceases; the door 14 is opened and the men or materials removed.

It will be noted that in each case the equalization of pressure between the lock 13 and the chamber 12 is accomplished by putting these two chambers in communication with each other. This pressure equalization may be accomplished in other ways, as for instance, by connecting the pipe 29 with the chamber 13, but however it is done, work is necessary to raise the pressure in the lock 13 to that of the chamber 12, and this work done is necessarily wasted when the pressure is released at valve 19 in the subsequent exhaustion of the lock 13 by now used methods.

However, if the apparatus of my invention is utilized in decompression, the air lock is connected to the intake of the compressor and the air under pressure transferred thereto, and the work and necessary energy to do the work of maintaining the pressure in the compression chamber 12 is thus reduced, as the necessity of bringing the air which fills the air lock after each opening thereof, from atmospheric pressure to maximum required pressure is, in part, obviated.

This results in a saving of power used to drive the compressor and a consequent saving of cost of operating the system.

It can be seen that if my invention is applied to a two stage compressor the air lock to be decompressed may first be put into communication with the second or high pressure stage of the compressor until the pressure in the air lock is substantially reduced, and then a switch made to the low pressure stage of the compressor by means of valves or other known means.

It would also be feasible and, in large operations, possibly more economical, to install a small compressor or booster at the low pressure side of the lock 13, to the intake port of which the pipe 25 could be connected, the outlet side of the compressor being connected to the compression chamber 12, and the small compressor would then

effect the saving heretofore described by supplementing the work of the main compressor.

In Fig. 2 is shown an optional embodiment of my invention showing the use of a small compressor or booster applied to a system of two locks. This embodiment is particularly applicable to large operations where substantial quantities of material are being passed through the bulkhead and results in a considerable saving in the total work done in compression by utilizing the pressure in one lock partially to compress the air in the other and thus lessen the work done by the booster.

The locks 34 and 35 have air pipes 36 and 37 connected to three way valves 38 and 39 operable by means of hand levers 40 and 41 or in other convenient manner. By proper setting of valves 38 and 39 air connection between the lock to be decompressed may be established, through pipe 43, with the lock in which the pressure is to be raised. The pipe 43 is also in communication with the inlet side of the booster 42 through pipe 45. Situated on the low pressure side of the bulkhead and connected to the pipe 45 is a check valve 46 which operates to admit air when the pressure in the pipe 45 equals or falls below the pressure on the low pressure side of the bulkhead.

The locks 34 and 35 are also adapted to be put in communication with the outlet side of the booster through pipe 44, by setting valves 38 and 39.

This double lock system may preferably be used by alternating the locks, and when so used, the operation is as follows:

Valves 38 and 39 are adjusted to put the locks in communication through pipe 43, until the pressure in the two locks is equalized. Lock 35 is then connected to the pipe 44 by proper setting of the valve 39 and lock 34 is left in communication with pipe 43. The booster now acts to decompress lock 34 and compress lock 35. When the pressure in 34 equals that on the low pressure side of the bulkhead, the check valve 46 will act to prevent any further evacuation and the door on the low pressure side of the bulkhead may be opened. At substantially the same time the air in the lock 35 will have been compressed to a point where the door on the high pressure side of the bulkhead may be opened. Materials may now be introduced into or removed from the locks simultaneously from both sides of the bulkhead. When this is completed, the doors respectively on the inside and outside of the bulkhead may be closed and the valves so adjusted as to put the locks in communication with each other through pipe 43.

The pressure in the lock 35 now forces part of the air therein into the lock 34, thus raising the pressure in lock 34 by means of pressure released in lock 35. When the pressure in the two locks is equalized, the valves are again adjusted to continue compression and decompression.

The saving in power is thus shown to result from two distinct applications of pressure formerly wasted by venting, i. e., part of the pressure in one lock is used to compress the air in another lock, and after pressure equalization has been reached, the remainder of compressed air in the lock being decompressed is utilized to lessen the load on the booster.

Fig. 3 shows another embodiment as applied to a system having a plurality of locks in which the equalization of the pressure in the locks is accomplished through the booster. A single four way valve 47 is shown, capable of putting one lock in

contact with the intake of the booster and the other with the outlet thereof. A check valve 48 is provided in connection with the intake line to the compressor which will operate if the air leaving one lock is not sufficient for the needs of the other.

The specific types of valves or connections used in these two last mentioned embodiments of this invention are not shown, nor need they be, since the various detailed means for achieving the objects of the invention will be obvious. The use of three or four way valves as described is optional, the type of valve or connection being subordinate to the purpose accomplished.

Where relatively high pressures are used and decompression is accomplished in stages by use of a series of two or more systems of air locks through bulkheads situated at relatively large distances from each other in the tunnel, my invention is peculiarly applicable both to man and material locks. Decompression would thus be carried on from maximum pressure to an intermediate pressure at the first bulkhead and from intermediate to atmospheric at the second.

The present apparatus may be used in connection with locks for the passage of men or materials or both. It is especially applicable to use in connection with locks for passing materials as these are usually of large volume and the air pressure is released from them at a rapid rate as compared with the rate at which the air is released from man locks.

While I have illustrated and described in detail certain preferred forms of my invention, it is to be understood that changes may be made therein and the invention embodied in other structures. I do not, therefore, desire to limit myself to the specific construction illustrated, but intend to cover my invention broadly in whatever form its principle may be utilized.

I claim:

1. In an apparatus for conducting operations under pressure, a compression chamber, an air lock for passage of men or materials into or out of said compression chamber, a compressor, duct means for conducting air under pressure discharged from the lock to the intake of the compressor, and duct means for conducting compressed air from the outlet of the compressor to the compression chamber whereby the energy of the compressed air evacuated from the air lock assists in maintaining the pressure in the compression chamber.

2. In a pressure excavation apparatus, a bulkhead, a compression chamber, an air lock through the bulkhead, a compressor, means for connecting the air lock with the intake of the compressor, valve means connected with the low pressure side of the bulkhead and with the compressor to prevent evacuation of the air lock below the pres-

sure of the low pressure side of the bulkhead, and means for utilizing the energy of the compressed air evacuated from the air lock to assist in maintaining pressure in the compression chamber.

3. In an apparatus for conducting operations under pressure, a compression chamber, a compressor, a plurality of air locks for passage of men or material into or out of said compression chamber, air connections between the air locks, air connection between the air locks and the intake of the compressor, air connections between the air locks and the outlet of the compressor, and means for opening and shutting these connections so that pressure in one lock may be utilized to raise pressure in another lock.

4. An apparatus as claimed in claim 3 in which a check valve is in connection with the air connection to the inlet side of the compressor adapted to operate to prevent the evacuation of any lock below a stated terminal pressure.

5. An apparatus as claimed in claim 3 in which three way valves are located on the various air connections, adapted to put the locks in communication with each other or with either intake or outlet sides of the compressor.

6. An apparatus as claimed in claim 3 in which the connection between locks is made through the compressor, and valve means for opening and closing the connection between the locks and the connection between any lock and either side of the compressor.

7. In apparatus for conducting operations under pressure a compression chamber, a compressor, duct connections between said compressor and said compression chamber, a plurality of locks communicating with said compression chamber, valve controlled duct connections between the locks to permit exhaustion of a lock under high pressure to a lock under lower pressure until the pressure between the two is substantially equalized, valve controlled duct connections between each lock and the inlet of the compressor to permit a lock to be exhausted to a pressure below said equalization pressure, and valve controlled duct connections between the locks and the compression chamber to permit the pressure in a lock to be raised above said equalization pressure.

8. In an apparatus for conducting operations under pressure, a compression chamber, a plurality of air locks for passage of men or material into or out of said compression chamber, a source of air pressure, valve controlled duct connections from the source of air pressure whereby compression may be applied to the compression chamber and locks, and valve controlled duct connections between the locks whereby the pressure in one lock may be utilized to raise pressure in another lock.

WILLIAM B. UPDEGRAFF. 60