Our invention relates to pumping systems, and more particularly to a vacuum type pumping system for use in a dredge for raising free gold and gold-bearing materials from the beds of streams and other bodies of water. This application is a continuation in part of the application of Will S. Taylor, Serial No. 38,995, filed September 3, 1936.

It is well known that suction dredges are old and such dredges have been heretofore in gold-recovering operations. Attempts have been made to use such dredges in recovering gold from stream beds and the like with little success. The greater portion of the gold, in deposits of this kind, usually lies below a stratum of sand, gravel and rock. Embedded in this stratum are stones varying in size from pebbles up to rocks six or eight inches in diameter.

Ordinarily a suction pipe of about three inches in diameter is employed with a pump which can create a suction sufficient to raise a rock six or eight inches in diameter. As a result, when such a rock is encountered, or in fact any rock of moderate size which will not pass through the pipe, it is drawn upward to engage more or less tightly over the end of the suction pipe. Immediately the flow of water and material up through the pipe is completely or largely blocked. With its intake obstructed the pump will begin to draw air through its outlet and will consequently lose its prime, whereupon a vacuum will no longer be created and the rock will drop from the end of the pipe. At this point, however, no water is flowing through the pump, and it must be reprimed and the whole operation started over again after this event. Moreover, when the pump has been reprimed it will not flow full or build up to its highest vacuum for some little time. Since rocks are frequently encountered, a large amount of time is ordinarily lost in repeatedly resuming operations after they have been interrupted by blocking of the pipe.

It is the principal object of our invention to provide a mechanism which will prevent any substantial delay in resuming dredging operations after the suction pipe has been clogged by a rock or other foreign material.

With this general object in mind it is a particular object to provide mechanism for starting operation of the pump at full capacity after the obstruction has been dislodged from the suction pipe, thereby obviating the delay attending the building up of the operating vacuum and volume and of the pump after it has been reprimed, if such repriming is necessary.

It is a further object to prevent the necessity of repriming the pump in an operation for dropping a rock which is held over the end of the pipe by the suction thereof.

Still a further object of our invention is to provide a mechanism for positively dislodging any obstruction in or at the end of the suction pipe.

Another object of our invention is to provide an indicator to warn the operator instantly that the suction pipe has been obstructed so that he may take immediate steps to free the pipe.

A still further object of our invention is to provide means for producing a sustained vacuum affording a continued suction in the suction pipe, even after it has become blocked, for example by an object seating over the end of the pipe to cut off or at least to decrease substantially the flow therethrough.

All these objects are obtained with simple mechanism having few parts. Furthermore, our mechanism is of rugged construction, so that it will be reliable in operation and cannot be injured by passage therethrough of heavy and jagged pieces of rock, nor can it become easily clogged by pieces of material of a size to pass through the mouth of the suction pipe.

Other objects, and more particularly those inherent in the preferred construction of our device, will be apparent from a study of the drawings in connection with the following description.

Our invention includes the novel parts, and in particular the arrangement of such parts each with relation to the other, as shown in the drawings, described in the specification, and defined in the claims appended to the latter.

The mechanism shown in the drawings is one which we have found operates satisfactorily to carry out our method, but it is to be understood that this device is merely illustrative and the proportion and arrangement of parts may be varied to some extent without appreciably affecting the efficient operation of the device.

Figure 1 is a perspective view showing the general arrangement of typical mechanism.

Figure 2 is a plan view of our device.

Figure 3 is a sectional view of the vacuum tank taken along the line 3-3 of Figure 2.

Our system is primarily intended to be mounted on the scow S, so that it may be located easily for efficient operation upon gold bearing material located along stream beds or on lake and ocean shores. Our device can be operated, however, in any place where water, either naturally present or artificially furnished, overlies the gold bearing material. As necessary elements of our pumping system, we employ a prime mover which may take the form of an internal combustion engine I, and a vacuum creating pump of the type which can pass solid masses of fair size, commonly known as a rock pump. Such a pump is indicated by the numeral 20, the customary long bearing 21 being associated with the pump.

Numerous pumping systems have employed an internal combustion engine and a rock pump
In combination, but as far as we are aware no one has combined with these devices a vacuum tank of the type which we employ, or has operated any tank according to our method. A rock pump, or any other type of pump, with which we are familiar, is inefficient alone to carry out a continuous dredging operation in material through which are scattered rocks of a size larger than the suction pipe mouth, which may be blocked by them. Therefore, in order to clear the pipe of a portion of small gravel may be pumped with such an arrangement, but the moment the flow is obstructed appreciably the pump starts to lose its prime and the vacuum diminishes and soon disappears.

Our arrangement a vacuum tank 3 is located between a suction pipe 4, controlled by a valve 41, and a pump intake 5, controlled by a valve 51 and connected to the pump 20. Any suitable type of suction pipe and nozzle (not shown) may be employed, and it may be supported upon the end of a flexible hose 40. From the discharge side of the pump 20 extends a discharge pipe 6 which may empty into a sluice box arrangement (not shown) where the values may be recovered. The key feature of our invention is the provision of a vacuum tank 3, and through the tank 3, and the particular construction of which is shown in Figure 3. In general this tank consists of a cylindrical casing which may be provided at the lower end with any suitable clean-out fitting 36. In the upper end of the tank is connected a filling pipe 7 which is controlled by a valve 70 for injecting water into the tank. Also provided in the head of the tank is a pet cock 76, the purpose and operation of which will be explained later.

The suction pipe 4 enters the side of the tank 3 at a point spaced from the top thereof. A discharge pipe 5 is connected to the tank, preferably on the side opposite the connection of the suction pipe 4, and also preferably slightly above the connection of the pipe 4 with the tank. This pipe 5 is connected to the intake of the pump 20. Its other end, after projecting upon the tank a slight distance, is provided with a part 59, which extends well downward therein and terminates near the bottom of the tank.

The proportions of the various parts and their positions are believed to be important in the maintenance of the most efficient operation of the device. As an example of one satisfactory installation we recite the following structure. A pump having a capacity of 325 gallons per minute was employed, with a vacuum tank 28½ inches in diameter. For strength the tank was provided with two convex heads, in the lower one of which was located a clean-out connection. In the upper head are connected the filling pipe 7 and the pet cock 76. To one side, at a point 14 inches from the top of such side, is connected the suction pipe 4 intake pipe 5 enters the side of the tank preferably opposite that to which the pipe 4 is connected, and at a distance of 10 or 12 inches down from the top of the tank side. The down pipe 50 is located near the tank wall, both to prevent undue strain upon the pipe supporting it, to facilitate a smooth flow through the tank from the pipe 4 on the opposite side thereof into the lower end of the pipe 50.

Before operation of the system commences, and during the operation of dislodging an obstruction from the suction pipe, water must ordinarily be delivered to the tank 3, in carrying out our method which will be described hereafter. For this purpose we provide a water pump 21, driven by the engine 1, and having its outlet 72 connected with the valve 70 which controls the filling pipe 7.

To prime the pump 21 through the intake pipe 23, an open auxiliary tank 8 is employed, which tank may be filled, for example, from a self-acting water supplying device, for instance, a water wheel. After the pump 21 has been primed, its water supply will be obtained from a branch pipe projecting down through the bottom of the scow from the pump intake pipe 23. Further branches 74 and 75 from pipe 22 may be provided to fill the tank 8 and to supply water to sluice boxes, respectively.

When the pumping operation is to be started the first step is to fill the tank 3 with water through the filling pipe 7 by means of the pump 21. This filling operation is preferably performed with the pet cock 76 open so that the air may escape from the upper end of the tank. As the filling operation proceeds, the pipes 50 and 5 will normally also be filled, and water will run down into the pump 20 to prime the same. When the tank has been completely filled this fact will be indicated by water being ejected from the pet cock 76. At this point the pet cock is closed, and the valve 70 may also be closed to shut off the inflow of water to the tank 3 through the pipe 7.

The pump 21 is then operated by the water which has been completely filled and the pet cock has been closed. If it is started before the valve 70 is closed, water may flow into the tank both through the suction pipe 40 and the pipe 1, and pressure exerted by the water flowing in through the latter pipe will clear any air pockets in the pipe 5.

With the device operating under these conditions after the valve 70 is closed, the suction pipe 40 will be kept beneath the surface of the water, but above the stream bed. Since there is no air in the tank 3 it will remain full of water. At this point the pet cock 76 is opened, but only for an instant, to admit a small amount of air to the top of the tank 3. Previous to the admission of this air, as mentioned, the tank was full of water and hence operated merely as a conduit. Now, however, the pressure of the air admitted acts to break the seal between the water and the head of the tank, and forces the water surface downward under the evacuating action of the pump 21. In the particular installation which we have described, sufficient air is admitted so that the water level drops to a point about a foot from the top of the tank, or to about the center line of the pipe 5, where it passes through the wall of the tank 3. The system will now be under normal operating conditions, the vacuum in the top of the tank 3 being somewhat less than that which would be created directly by the pump 20. The suction pipe 40 may now be lowered into the stream bed to pick up solid material along with the water pumped.

The operation could also be started by filling the tank 3 almost but not quite full of water, leaving a very small air space in the top thereof, prior to commencement of the pumping operation. It is difficult, however, to stop the filling operation and to close the pet cock 76 at precisely the proper moment. If too large an air space is left, or if too much air is admitted, then the water must be drawn down far so that the pump can create a vacuum in the tank of the proper magnitude to the vacuum-creating capacity of the pump itself before the end of the pipe 50 is uncovered, as will be discussed more fully hereafter. It is essential, therefore, that only a very small amount of air be admitted for proper operation of the device. When the requisite amount of air has been ad-
mitted, and the water level in the tank has dropped to the proper point for normal operation, the inlet pipe 4 should be slightly below the water surface, so that a smooth discharge into water is obtained rather than a spray into the vacuum space, and yet no appreciable back pressure from a head of water above the intake pipe connection will be present.

The outlet pipe 5, we have found, should have its discharge about at the surface of the water in the tank, and yet the down pipe 50 should reach almost to the bottom of the tank. A pump does not operate properly under forced pressure, and hence the pipe 5 should not connect near the bottom of the tank so that the pump would be subjected to the head of water within the tank. It is desirable to draw water from the bottom of the tank, however, so that large pieces of rock and the heavy material, including the gold values, will pass out through the pipe 5 instead of settling to the bottom of the tank 3, and so that the dredging operation may be carried out. Also efficiency of the system is increased by locating the pipe 50 on the side of the tank opposite the pipe 4 to give a smooth flow through the tank, instead of a turbulent one as would be the case were the two side of the tank.

If an obstruction lodges in or against the end of the suction pipe, water will cease flowing into the tank through the pipe 4 under the influence of the vacuum created in the upper portion of the tank 3. The pump vacuum, however, is unchanged, and since it is greater, to some extent than the vacuum in the tank 3, water will continue to flow from the tank through the pipe 50, thus lowering the water level perceptibly in the tank. In order to apprise the operator that water has ceased to flow into the tank through the pipe 4, owing to some stoppage in the suction pipe, a gauge glass 31 is provided. It will be seen that if no steps are taken to free the suction pipe, although no water is flowing into the tank 3, water will be pumped out of the tank by the pump 20 until the vacuum in the upper part of the tank approaches that of the vacuum which the pump 20 can create. Naturally the surface of the water will have dropped to a point near the bottom of the tank when such a vacuum is reached, and the pump will appear in the gauge glass indicating to the operator that the pipe 40 is obstructed. If the pipe is not cleared before the tank vacuum approaches the pump vacuum in value, water will cease to flow through the pipe 5, and the pump will lose its prime.

If the end of the suction pipe 40 is projected only a small distance down into the stream bed, it may easily be raised above the bed. If the stoppage is caused by a stone engaged over the end of the suction pipe, this may be released by closing the valve 41 for an instant, thus momentarily cutting off the vacuum which enables the stone to be held against the end of the suction pipe. The valve 41 may then be opened once more and the dredging operation continued without interruption, for ordinarily this manipulation will be all that is necessary in the case of frequent or continuous stoppage due to the presence of the rush water in the tank 3 has been lowered to the critical point at which water ceases to be pumped out.

During the time the pipe 40 is being raised and the valve 41 is being shut and opened again, the water level in the tank 3 will have dropped in the manner described, but since water has been continuously flowing through the pump 20 from the tank 50 the prime of the pump will not have been destroyed, nor will its operating volume ordinarily have decreased materially. The vacuum in the tank 3 will, of course, have increased, but since the suction pipe 40 is opened again, water will flow into the tank 3 somewhat more than it flows out, and will continue to do so until an equilibrium has again been reached where the level of the water in the tank 3 will be the same as it was originally, namely, at about the center line of the pipe 5. Without the vacuum tank the pump would lose its prime almost immediately, and there would be nothing to warn the operator that the suction pipe was blocked.

If the suction pipe 40 has been projected a considerable distance down into the ground, or if the obstruction is one which has lodged within the suction pipe, and is not merely a rock held against the end thereof, then it is desirable to force out the obstruction by positive action without raising the suction pipe. To accomplish this operation a valve 51 in the pipe 5 is closed and the pump 20 will lose its prime. The valve 10 will then be opened, and the pump 71 will pump water into the tank 3 until it is filled. Thereupon a pressure will be exerted back through the pipe 4 and suction pipe 40 to drive out the foreign material lodged therein or to force away from the mouth thereof a rock which has engaged thereon at a distance below the surface of the stratum. Any pipe furnishing water under pressure to the pipe 4, would, of course, drive out the obstruction.

When the pipe has thus been cleared, the valve 51 will be opened and the valve 41 will be closed. Water will thus be forced down through the pipe 5 and through the pump 20 to prime the same, to clear out any air pockets in the pipes 50 and 5, and to start the pump 20 pumping at full capacity. Since the air in the top of the tank 3 has not been let out the pump will immediately operate at full capacity, drawing water from the tank 3, which for the moment is being supplied only by the pipe 7. The water level will begin to drop to the operating level at the center line of pipe 5. The valve 41 will now be re-opened to resume the pumping operation, and the valve 10 will be closed.

Thus although a positive force has been applied to the suction pipe 40 by water flowing counter to the direction in which it normally flows, the pumping operation is interrupted for only a brief interval. When it is restarted the operation is at the full capacity of the pump, although the pump has had to be reprimed. This operation is accomplished by positively forcing water through the pipes 50 and 5 by water flowing in through the pipe 7, instead of allowing the vacuum and the operating volume of the pump to be built up gradually by the pump's own effort, as it would be necessary to do in the absence of the tank 3.

When the valve 70 has been closed the water surface in the tank 3 may still be higher than its normal level. Although the flow through the pipe 5 is normal in volume, the flow through the pipe 4 will be somewhat below normal due to the water level in the tank has again dropped to its equilibrium position, substantially at the center line of the pipe 5.

By the arrangement described it will be seen that a substantially continuous pumping operation is obtained, although momentarily interrupted at frequent intervals to clear the suction pipe. Without the vacuum tank 3 and with the pipe 5 connected directly to the suction pipe 40 it will be seen that considerable delay must be entailed each time the suction pipe 40 becomes blocked. The increased efficiency of our system will therefore be apparent.
What we claim as our invention is:

1. In a pumping system of the type described, a suction pipe, an evacuating pump connected to said suction pipe, a pressure pipe adapted for communication with said suction pipe, and control means whereby to interconnect for communication said suction pipe and said pressure pipe to interrupt communication between said suction pipe and said evacuating pump.

2. In a pumping system of the type described, a suction pipe, a pump intake pipe, a pressure pipe, means interconnecting said three pipes, a pump having its intake connected to said intake pipe, and control means operable to close said suction pipe and to establish communication between said pressure pipe and said pump intake pipe and to interrupt communication between said suction pipe and said pump intake pipe.

3. In a pumping system of the type described, a suction pipe, a pump intake pipe, a pressure pipe, means interconnecting said three pipes, a pump having its intake connected to said intake pipe, and control means operable to close said suction pipe and to establish communication between said pressure pipe and said suction pipe to force water outward through the latter, or alternatively to close said pressure pipe and to establish communication between said suction pipe and said pump intake pipe to draw water therefrom.

4. In a pumping system of the type described, a vacuum tank, a suction pipe connected to said tank and discharging thereinto, an outflow pipe connected to said tank and extending downward therein, a pump connected to said outflow pipe, and a pressure pipe connected to said tank for positively filling said tank with water.

5. In a pumping system of the type described, a vacuum tank, a suction pipe and a pump intake pipe both connected to said tank, a pressure pipe connected to the top of said vacuum tank, and valve, one in each of said pipes, operable to establish communication between any two of said pipes while the third pipe is closed, or alternatively operable to establish communication between all three pipes through said vacuum tank.

6. In a pumping system of the type described, a vacuum tank, a suction pipe connected thereto, a pump, a pipe interconnecting the pump intake and the vacuum tank, a second pump, a pipe connecting the outlet of said second pump to the top of said vacuum tank, and valve, one in each of said pipes, operable to establish communication through said vacuum tank between said second pump's outlet and said suction pipe to force out an obstruction in the latter, or operable to establish communication through said tank between said second pump's outlet and said first pump's intake to forcibly prime said first pump, or operable to establish communication through said tank between said suction pipe and said first pump's intake to raise water through the suction pipe.

7. In a pumping system of the type described, a vacuum tank, a suction pipe connected to said tank and discharging thereinto, an outflow pipe connected to said tank, a pump connected to said outflow pipe, means for positively filling said tank with water, and means for admitting air to the upper end of said tank.

8. In a pumping system of the type described, a vacuum tank, a suction pipe connected to said tank near the upper end thereof and discharging thereinto, an imperfect outflow pipe terminating in a cozy open end within and near the bottom of said tank, extending upward in said tank to a point above the connection of said suction pipe with the tank, and thence outward through the wall of said tank, a pump having its inlet connected to said outflow pipe, a filling pipe connected to the upper end of said tank, and a pet cock in the upper end of said tank for admitting air thereto.

9. The method of pumping a mixture of water and solid matter with a pump connected through a tank to a suction pipe, which comprises filling the tank almost but not quite full of water, leaving a small air space therein, prior to starting the pump, sealing the tank against escape of air from such space, and thereafter creating a partial vacuum space in the top of the tank by operating the pump to draw the water level down in the tank, and to induce a flow of water and solid matter into the tank through the suction pipe.

10. The method of pumping a mixture of water and solid matter with a pump connected through a tank to a suction pipe, which comprises completely filling the tank with water, sealing the tank from ingress of air, starting operation of the pump to draw water through the suction pipe, tank filled with water, and pump, during such operation admitting a small amount of air to the tank, to enable the pump to draw down the water level therein to an equilibrium point thereby inducing a flow of water and solid matter into the tank through the suction pipe, and out of the tank into the pump, and again sealing the tank from ingress or egress of air.

11. The method of operating a pump for the elevation of gravel, values, and the like, the intake pipe of which pump is liable to blocking by an object held over the end thereof, which comprises providing a water reservoir in the intake pipe between the open end thereof and the suction pipe, drawing water from the reservoir with and through the pump to preserve its prime as soon as the intake pipe is blocked, raising the open end of the intake pipe above the surface of the bed but keeping it beneath the surface of the water, closing the intake pipe momentarily to destroy the suction therein and to release the obstructing object while still drawing water from the reservoir with the pump to preserve its prime, and thereafter opening the intake pipe to draw water thenceforth in resumption of the normal pumping operation.

12. The method of operating a pump the intake whereof is liable to blocking by an obstruction, which comprises severing the communication of such intake with the suction pump, forcing water in a reverse direction through the intake pipe to drive out the obstruction, forcing water in pumping direction through the pump to repriming it and force it into operation at substantially full capacity, and restoring communication between the intake pipe and the pump.

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