W. R. DAVIS & G. F. STICKNEY.

SIPHON SPILLWAY.

APPLICATION FILED FEB. 3, 1913.

1,083,995.

Patented Jan. 13, 1914.

3 SHEETS—SHEET 1.

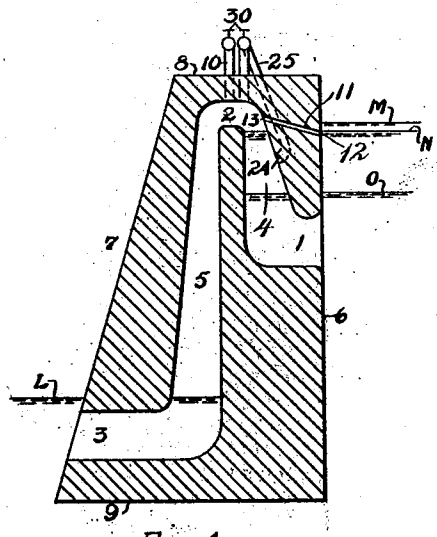


Fig. 1

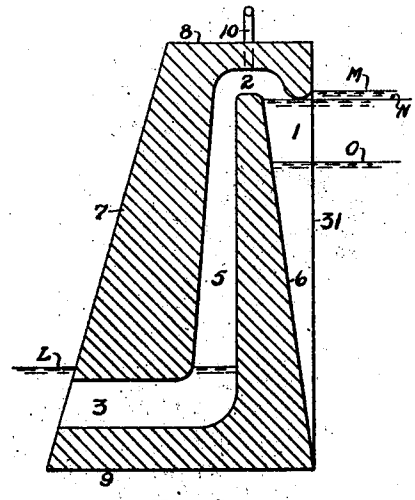


Fig. 2

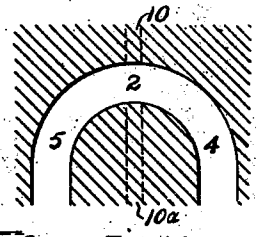


Fig 4A

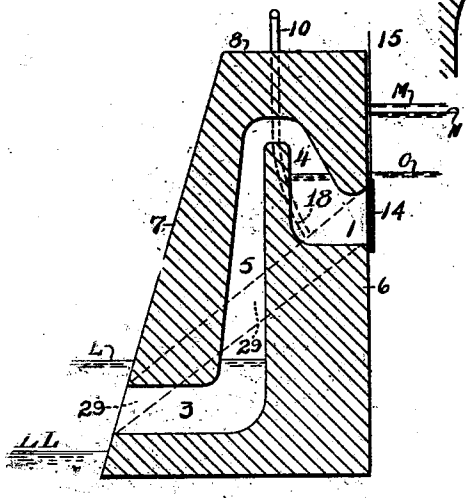


Fig. 3

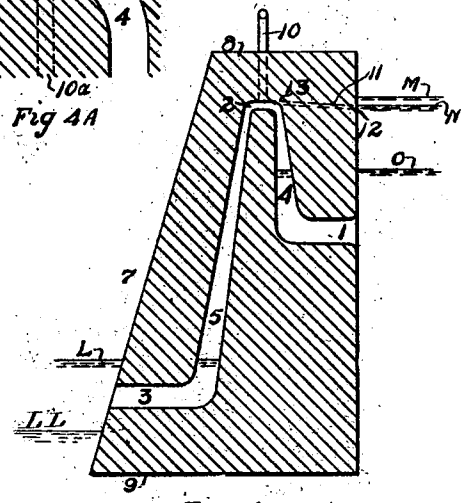


Fig. 4

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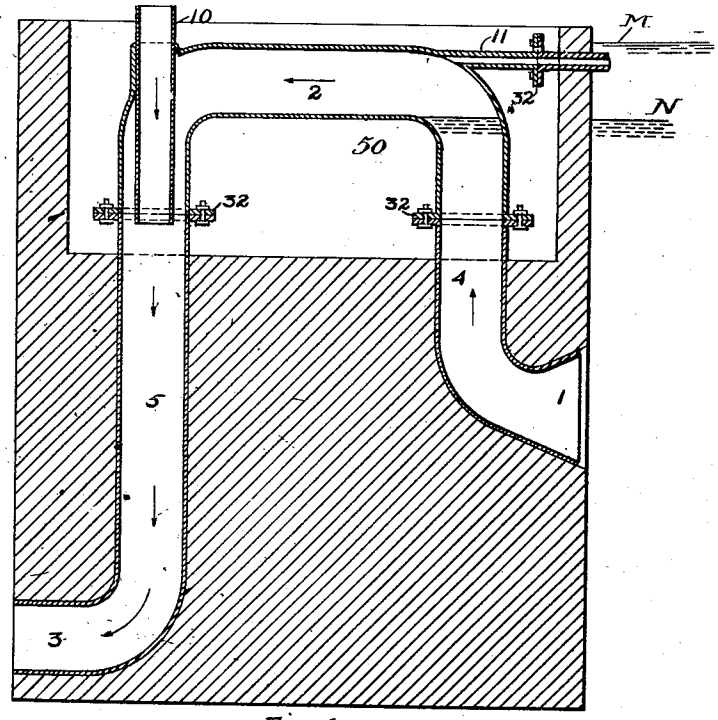


Fig. 6

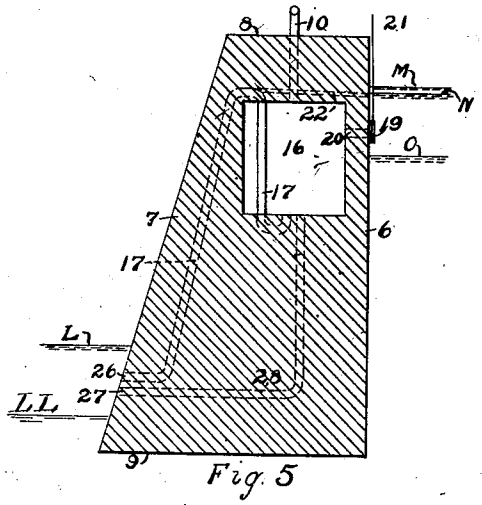


Fig. 5

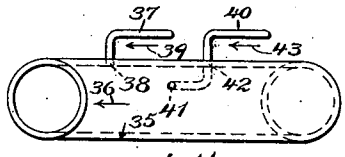


Fig. 11.

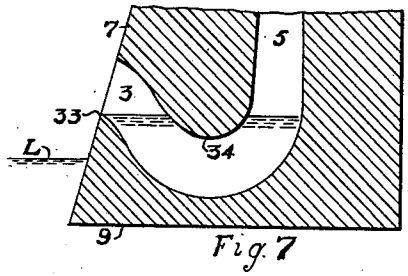


Fig. 7

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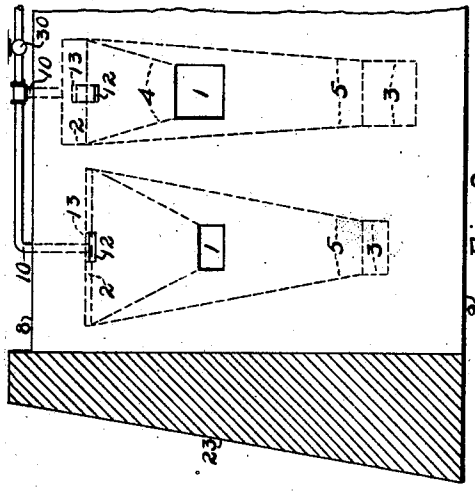


Fig. 9

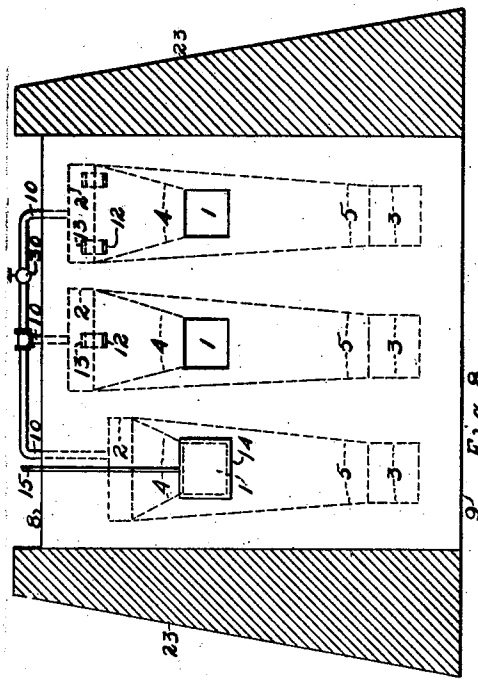


Fig. 8

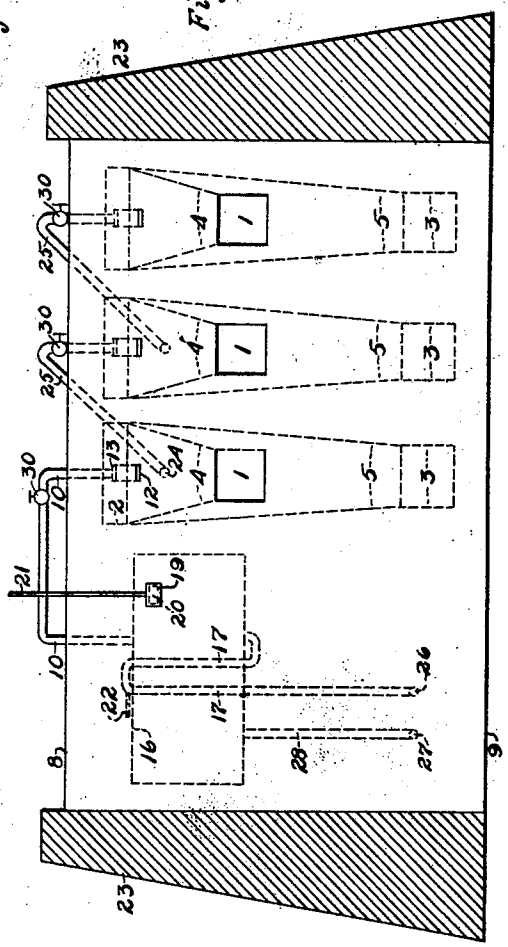


Fig. 10

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UNITED STATES PATENT OFFICE.

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SIPHON-SPILLWAY.

1,083,995. Specification of Letters Patent. Patented Jan. 13, 1914.

Application filed February 3, 1913. Serial No. 745,782.

To all whom it may concern:

Be it known that we, WILLIAM RUSSELL DAVIS and GEORGE F. STICKNEY, citizens of the United States, residing at Albany, in the county of Albany and State of New York, have invented certain new and useful Improvements in Siphon-Spillways; and we do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

Our invention relates to siphons used in dams or spillways for the purpose of discharging water through such dams or spillways, and particularly to siphons having throats or crowns wholly or in part above the high or flood water stage controlled by said siphons, together with means for charging or priming and discharging or breaking the siphons either automatically or by the manipulation of gates or valves.

In siphons heretofore constructed, the lower edge of the throat is placed at the low water stage of the pool formed by the dam or spillway, so that after the true action of the siphon is broken no water will flow through it unless the water is above the low stage. In such siphons the top edge of the throat is placed approximately at the high water stage of the pool in order that the siphons may all be put into action automatically as soon as the high water stage of the pool is reached. It is desirable for well known reasons to so design the dam or spillway as to make the difference between the high and low stages of the pool as small as possible, and for reasons of economy it is desirable to make the length of the structure as short as possible. If the height of opening of siphon at the throat is made small to suit a small difference in the two stages of the pool, the width of that opening measured lengthwise of the dam or spillway must be comparatively large in order to afford sufficient area to properly pass the water. In order to use a throat opening of comparatively small width it is necessary to make the height of such opening much greater than the amount of the difference between the two stages of the pool when such stages are chosen with due regard for the important controlling factors of the design.

Since it is necessary or desirable to place the lower edge of the throat at or above the lower stage of the pool siphons with high throat will not become primed automatically when the water reaches the high stage as is the case with siphons heretofore constructed. It is necessary therefore to provide special means for the priming and breaking of siphons with throats placed too high to be primed by the simple action of the water rising to the high stage, and to provide such means is the object of our invention.

The action of automatic siphons as heretofore built is clearly shown by Patent 991,907 granted to George F. Stickney, May 9, 1911.

This specification with accompanying drawings describes four distinct methods of priming siphons having high throats as heretofore explained. In one method one or more siphons with high throats are primed by a priming conduit placed entirely below the high water stage, said conduit being controlled by a gate valve, or valves, or by a sluice gate or gates, such valves or gates being preferably but not necessarily placed at the entrance to the conduit. In a second method one or more siphons with high throats are primed by a priming siphon having the lower edge of its throat placed approximately at the low water stage and the upper edge placed approximately at the high water stage above the dam, the priming of the priming siphon taking place automatically when the water rises approximately to the elevation of the high water stage. In a third method one or more siphons with high throats are primed by exhausting the air therefrom or rarefying the air therein by means of the suction created in a suitable air pipe connected to a pipe, conduit or penstock in which water is moving at a comparatively high velocity. In a fourth method one or more siphons with high throats are charged by the use of a priming tank built preferably in the body of the dam, or spillway or in one of the abutments therefor. Such priming tank is normally filled with water which is exhausted, when the time for priming a siphon arrives, by the controlled or automatic action of an auxiliary priming siphon or discharge pipe the size of which is small compared with the principal siphon or siphons of the dam or spillway.

Referring to the drawing in which like parts are similarly designated, Figure 1 is a section of a dam or spillway taken through a siphon which has an inlet well below the low water surface and which has a high throat, the lower edge of which is to be placed approximately at or above the low water stage above the dam. Fig. 2 is a section of a dam or spillway which has an inlet placed at the low water stage and which has a high throat, the lower edge of which is to be placed approximately at or above the low water stage above the dam. Fig. 3 is a section of a dam or spillway taken through a priming siphon placed wholly below the high water stage and showing a straight conduit connecting the water above the dam to that below the dam and an air pipe connecting therewith. Fig. 4 is a section of a dam or spillway taken through a priming siphon having the lower and upper edges of its throat approximately at low and high water stages respectively. Fig. 4ª is a section through a curved throat of a siphon showing a special positioning of air pipes. Fig. 5 is a section of a dam or spillway taken through a priming tank which is to be used, when so desired, instead of one of the priming siphons shown by Figs. 3 and 4. Fig. 6 shows a priming siphon constructed of metal pipe embedded in the masonry of the dam or spillway, the upper and lower edges of the throat being disposed at approximately the high and low water surfaces, as is the case of the siphon shown by Fig. 4. Fig. 7 shows the construction at the outlet of a siphon with high throat when such outlet does not come below the water surface below the dam. Fig. 8 is the front elevation of a dam showing a battery of two siphons with high throats and one priming siphon controlled by a sluice gate. Fig. 9 is the front elevation of a part of a dam showing one of a battery of siphons with high throats and one automatic priming siphon having its throat with its lower edge and upper edge at the low water and high water stages respectively. Fig. 10 is the front elevation of a dam showing a battery of three siphons with high throats and the priming tank shown by section in Fig. 5. Fig. 11 represents a portion of a pipe, conduit or penstock with air pipes connected thereto, suction being produced in said air pipes by water flowing in the pipe or penstock at a comparatively high velocity.

Referring now to Fig. 1, the dam or spillway is shown as built of masonry, preferably of concrete, 6, being the upstream face; 7, the downstream face; 8, the top and 9, the bottom which is to rest on the customary foundations. 1, is the inlet and 2, the throat; 3, the outlet; 4, the upstream leg and 5, the downstream leg of the siphon. For the purposes of this invention the outlet end of all siphons with high throats must be placed below the surface of the water below the dam, or must have such outlets effectually sealed against admission of air as indicated by Fig. 7, while the outlets for the priming siphons, although so shown are not necessarily to be placed below said water surface. 10, is an air pipe entering the siphon at some convenient point at the top of the throat, whereby air is to be exhausted from the downstream leg and the throat of the siphon by the suction produced by the priming siphon or otherwise, as hereinafter described. 11, is an air vent of which there may be one or more per siphon, the lower end, 12, of which is placed approximately at the low water stage above the dam and the upper end, 13, of which connects to the throat of the siphon at some convenient point. 25, is an air pipe provided with an entrance, 24, placed in the upstream leg of the siphon below the low water surface for the purpose of priming another siphon with high throat by the use of the siphon shown. 30, is a valve controlled manually or otherwise, whereby air may be admitted for the purpose of breaking the siphonic action. M, is the high water and N, the low water stage above the dam as established by the use of the proposed system of siphons. O, is the low water surface that would of necessity be used with an ordinary dam or spillway of the overflow type. L, is the water surface below the dam.

In Fig. 2, 1, indicates the inlet to the siphon, disposed horizontally at the elevation of the low water surface. 31, indicates a buttress occurring between adjacent siphons; the designations of all other numbers are the same as for Fig. 1.

In Fig. 3, 14, indicates a gate valve or sluice gate, of which a plurality may be used if desired, used for the purpose of controlling the flow through the priming siphon shown or through conduit, 29; and 15, indicates the stem by which the valve or sluice gate may be controlled from the top of the dam. 29, shows a straight conduit connecting the water above the dam to that below the dam, the air pipe, 10, being extended to some point as 18 for the purpose of utilizing the suction produced in the conduit in order to prime a siphon with high throat. The valves or gates may be placed elsewhere if so desired, but are preferably placed at the entrance as shown. L L shows an alternative position of the water surface below the dam for cases where it may prove advantageous to place the outlet of the priming siphon or conduit above such water surface. All other numbers used for Fig. 3 have the same designations as when used for Fig. 1.

In Fig. 4, showing a priming siphon, all the numbers have the same designations as when used for Figs. 1 and 3. In this case the

upper edge of the throat, 2, is placed approximately at the high water stage and the lower edge thereof at the low water stage.

In Fig. 4ª, showing the curved throat of a priming siphon, 2, 4, 5 and 10 have the same designations as when used for Fig. 1. 10ª shows the special position of the air pipe to be used for priming another siphon as hereinafter explained.

In Fig. 5, 16, is an air tight tank used as hereinafter explained, for the purpose of priming a siphon with a high throat. 17, is a siphon used for removing the water from the tank, thus producing a rarefaction of the air in the siphon to be primed. 26, is the outlet of siphon, 17; 28, is a conduit which may be used, in certain cases, instead of the siphon, 17, for emptying tank, 16. 27, is the outlet for conduit, 28; 20, is a supply conduit for tank, 16; 19, is a gate valve or sluice gate for controlling conduit, 20; 21, is a stem for actuating valve, 19, from the top of the dam; 22, is an air vent for automatically breaking the action of siphon, 17, when the water falls to low water stage and uncovers the entrance to the vent. L L shows an alternative position of the water surface below the dam for cases where it may prove advantageous to place the outlet of the priming siphon or conduit above such water surface. All other numbers used for Fig. 5 have the same designations as when used for Fig. 1.

In Figs. 8, 9 and 10, 23, designates the abutments of the dam or spillway; all other numbers used for these figures have the same designations as already explained for Figs. 1 to 5 inclusive.

In Fig. 11, 35, indicates a portion of a pipe, conduit or penstock in which water is flowing at a comparatively high velocity in the direction indicated by the arrow, 36; 37, is a comparatively small air pipe tapped into 35; 40, is a similar air pipe passing through the side of 35 at 42, and is provided with an extension, 41, turned in the direction of the flow of water in 35. The rapidly moving water in 35 produces a strong suction at 38 or 41 and draws air forcibly through air pipes, 37 and 40, in the directions indicated by arrows, 39 and 43, said air being carried away by the water flowing in 35. Inasmuch as a substantial suction is produced in a pipe disposed as is pipe, 40, shown in Fig. 11, by water moving at high velocity through pipe or conduit, 35, in the direction of arrow, 36, and inasmuch as substantial suction is also produced near the upper end of a pipe or conduit through which water flows at comparative high velocity under a substantial head, such suction being a maximum near the upper end of the conduit and decreasing throughout its length to practically nothing at the lower end, and such suction serving to forcibly draw air into the pipe or conduit through an air pipe disposed substantially as is pipe, 37, shown in Fig. 11, it is the purpose of our invention to take advantage of such suction and utilize it for the purpose of priming the principal siphons of a dam or spillway. Any such pipe or conduit irrespective of its shape in plan, elevation or cross section may be utilized in a "siphon primer." When water flows freely under a substantial head from above the dam or from a tank or receptacle which is made practically air tight, it produces a substantial suction irrespective of the shape of the pipe or conduit leading from such reservoir and it is the purpose of our invention to utilize such suction for the priming of the principal siphons of a dam or spillway and such device we term a "siphon primer."

In Fig. 6, a priming siphon made of metal pipe is shown. The designations of numbers 1, 2, 3, 4, 5, 10 and 11 are the same as for Fig. 1. 50, is a recess in the top of the dam which may be provided if desired; 32, are couplings in the pipe, whereby the throat, 2, may be readily removed and cleaned in case it should become clogged or replaced if broken.

Fig. 7 shows in section a portion of a dam or spillway in the vicinity of the outlet of a siphon with high throat. 7, is the downstream face of the dam; 9, is the base; L, is the surface of the water below the dam; 3, is the outlet. In order to prevent the entrance of air through the outlet the downstream leg of the siphon, near the outlet, has an upturn, as shown, bringing the upper edge, 34, sufficiently below the lower edge, 33, to form a basin in the siphon in which water will always stand to the elevation of 33, thus filling the entire cross section of the conduit below 34 with water.

The action of the system, shown by Fig. 8 in elevation and by Figs. 1 and 3 in section, is as follows:—When the power plants at the dam are using the entire flow of the stream the sluice gate, 14, is closed, whereupon there is no flow through the priming siphon or conduit. If then, there is a flow through the other siphons the pool will be gradually lowered until the low stage, N, is reached, uncovering the air vents, 12, whereupon the siphonic action will be broken and the siphons cease action. So long as the power plant continues to utilize the exact amount of water delivered to the pool the water lever will remain stationary. Upon an increase of flow, however, the level will rise until, as it approaches the high water stage, M, the sluice gate, 14, is to be opened. Inasmuch as the throat of the priming siphon is entirely below the level of the water surface, the action of this siphon or of the conduit will be established as soon as the gate is sufficiently opened. At this

stage of the water surface all vents, 12, are closed and inasmuch as the outlets, 3, are sealed, the air imprisoned in the throats, 2, and lower legs, 5, of the battery of the siphons will be rarefied by the suction of the priming siphon or conduit acting through the air pipes, 10, in accordance with the well known action of water passing through closed conduits at high velocities. The suction will continue as long as the priming siphon runs full and until the imprisoned air is entirely exhausted from the battery of siphons, assistance being had toward the close of the exhaustion by the well known action of the water flowing over the lower edge of the throats, 2, of the siphons, an action which begins as soon as the imprisoned air has been sufficiently rarefied to raise the water in the upstream leg of the siphon higher than the lower edge of the throat.

If a sufficient number of siphons has been rovided they will discharge somewhat more than the maximum flow of the stream and therefore the water level will begin to fall as soon as the siphons are all running full; the surface will continue to fall until vents, 12, are uncovered at the low water stage, N, whereupon the siphonic action of the siphons with high throats will be broken and water will be discharged by the priming siphon only. If now the flow of the stream in excess of that used by the power plants is in excess of that discharged by the priming siphon, the water surface will begin to rise, air vents, 12, will be covered, the battery of siphons will be primed again as before and the water surface will fall again until the air vents are uncovered, the cycle being indefinitely and automatically repeated until the sluice gate is closed or until the excess flow of the stream is less than the discharge of the priming siphon. When this condition arises the water surface will begin to fall below the low water stage, N, and the flow of the priming siphon is to be thereafter controlled by the use of the sluice gate and the water surface held at the low stage until the excess flow again exceeds the capacity of the priming siphon, whereupon the sluice gate will be fully opened and the automatic action of the battery of siphons reëstablished thereby.

The action of the system, shown by Fig. 8 in elevation and by Figs. 1 and 4 in section, is as follows: When the power plants use the entire flow of the stream the water will stand at the low stage, N, or at the elevation of the lower edge of the throat of the priming siphon. Upon an increase in flow the level will rise until the throat of the priming siphon is filled and that siphon is put in action. The water surface will then be sufficiently high to seal air vents, 12, and imprison the air in the throats, 2, and downstream legs, 5, of the battery of siphons with high throats. This imprisoned air will be rarefied by the suction of the priming siphon acting through air pipes, 10, exactly as already explained for the manually controlled priming siphon shown by Figs. 8 and 3. Thus at the time the high water stage, M, is reached all siphons will be brought automatically into action and the water level will begin to fall and continue to fall until the air vents are uncovered, breaking the action of all siphons at the low water stage, N. If at this moment the flow is in excess of the consumption of the power plants, the water will again begin to rise and the cycle above described will be indefinitely and automatically repeated.

The action of the system, shown in elevation by Fig. 8 and in section by Figs. 1 and 5, is as follows:—When the power plants are using the full flow of the stream, the water will stand at about the low state, N; valve, 19, is to be open permitting water to enter the air tight tank, 16, through inlet, 20, which is to have a cross section sufficiently great as compared with either siphon, 17, or outlet, 28, to keep the tank always full when valve, 19, is open. Taking first the case where siphon, 17, is used to the exclusion of outlet, 28: Upon an increase in the flow of the stream, the water level rises, seals the air vent, 22, and upon reaching approximately the high stage, M, automatically starts siphon, 17, which draws water from the tank at a less rapid rate than it is supplied by inlet, 20. Valve, 19, is now to be closed, upon which siphon, 17, will begin to empty the tank which tends to produce a vacuum at the top thereof. Air is then drawn into the tank through air pipe, 10, from the throat and downstream leg of a siphon with a high throat until the air therein is sufficiently rarefied to start the full flow of the siphon, the tank being of sufficient size to secure this result before all water is withdrawn from it by siphon, 17. The tank may be made, if desired, large enough to prime all of the siphons with high throats, but as this makes necessary the construction of a needlessly large tank, it is preferred to construct a tank of sufficient size to prime one siphon only, leaving the other siphons to be primed from the first as hereinafter explained. As soon as the full flow of the first siphon is established there is set up a suction on the part of this siphon, in air pipe, 10, which will reverse or partly reverse the flow in siphon, 17, thus filling, in whole or in part, tank, 16, or tending to fill said tank depending on the proportions of siphon, 17, and pipe, 10, and the extent or amount of the suction. The flow in the first siphon having been established, it, in its turn, has the well known effect of producing a suction at the entrance, 24, of air pipe, 25, which, as shown, connects any convenient point below the water surface of the up-

stream leg of the first siphon with the throats of one or more adjacent siphons. By thus connecting the first siphon with the throat of the second and by connecting similarly the second to the throat of the third, and so on, each siphon after the first may be primed in succession by the one preceding it. Instead of connecting with the upstream leg of the siphon as shown, air pipe, 25, (Fig. 1) may be connected, as is evident, conveniently to the lower edge of throat, 2, as indicated by pipe 10^a in Fig, 4^a, it having been found that the most powerful suction is produced through the additional effect of centrifugal force at the lower or convex surface of the material forming the curved throat of the siphon. When the siphons have all been primed and are running full, the water surface will begin to fall and the air vents, 12, will be exposed when the surface reaches the low stage, N, whereupon the siphonic action will be broken and the surface begin to rise again. For the purpose of holding within tank, 16, all the water it then contains, air vent, 22, breaks the action of siphon, 17, at the instant of or just before the action of the battery of siphons is broken. With the arrangement shown the repriming of the siphons cannot be automatically accomplished. It is necessary to open valve, 19, leaving it open until the water has risen sufficiently to charge siphon, 17, and then closing it, whereupon water will be drawn from the tank, the air in the throats will be rarefied, the siphons will be again put into service exactly as heretofore described and the cycle will be repeated. In case outlet, 28, (Figs. 5 and 10) is used in place of siphon, 17, the tank will be emptied if valve, 19, be closed whenever the water falls to the low stage admitting air through vents, 22, to the throats of the siphons and thence through pipes, 10, to the tank, 16. Conduit, 20, being made sufficiently larger than outlet, 28, when valve, 19, is opened tank, 16, will soon become filled. When the water has risen high enough to seal the vents of the siphon and valve, 19, is closed the tank will begin to empty through outlet, 28, and the first siphon will be primed by the suction produced in the tank exactly as already described for the use of siphon, 17.

The action of the priming siphon shown in section by Fig. 6 is exactly the same as for the priming siphon shown by Fig. 4, the only difference being in the details of construction.

In case any priming siphon be of comparatively small capacity it may be desirable to place the lower edge of the throat somewhat below the low water stage, in which case a small but immaterial amount of water may be constantly wasted through such a siphon without affecting the spirit or intent of our invention. In like manner the upper edge of the throat of a priming siphon may be placed lower than the high water stage in case it is desired to start the siphonic action of any siphon or siphons before the high water stage is reached; if desired, in case a plurality of priming siphons be used, their throats may be disposed at varying elevations, bringing the siphons with high throats into action at varying elevations of the water surface above the dam and thus tending to produce a more nearly constant elevation of that surface. In case also, there is a surplus of water which may reasonably be constantly wasted, it may be desirable to put the priming siphons with their throats wholly below the low water stage above the dam without affecting the spirit or intent of our invention, in which case such priming siphons will constantly run full and any siphon with high throat will be primed as soon as the water surface rises sufficiently to seal its vents. The air pipes, 10, may be conducted from siphon to siphon above the top of the masonry as shown or may be buried in the masonry at any convenient point. In cold climates these pipes are subject to being frozen when filled with water, a state which will occur when the siphons are in service. Since this freezing would render the system inoperative, any known method may be adopted for heating or protecting such pipes to prevent freezing.

Although Figs. 8 and 9 show only one priming siphon for a battery of siphons with high throats, it is the intent of our invention that a separate priming siphon may be used, if desired, for each siphon with a high throat or for groups of two or more such siphons; such individual priming siphons would preferably but not necessarily be constructed of metal pipe as indicated by Fig. 6.

It is to be understood that air pipes, 25, shown in Fig. 10 may be used in place of pipes, 10, shown in Figs. 8 and 9, or vice versa, and that other arrangements of pipes may be made, although not shown, which will serve to carry out the spirit and intent of our invention.

With the arrangement of air pipes, 25, shown by Figs. 10 and 1, the air-inlets, 12, may be placed each at a different elevation between the limits fixed by the low and high stages of water above the dam. If in Fig. 10 the inlet of the left hand siphon is at slightly above low water stage, that for the right hand siphon a little below high water stage and that for the center siphon intermediate between the other two, the action will be as follows: With all siphons operative and the water at high stage the water surface will begin to fall until it uncovers vents, 12, of the right hand siphon. If now the other two siphons are of insufficient capacity to

carry the excess flow of the stream the water will begin to rise again until the vent is sealed, whereupon the right hand siphon will be again put into service and the automatic cycle will be repeated until the excess flow is less than the capacity of two siphons. When this condition obtains the water surface will continue to fall until vents, 12, of the center siphon are uncovered and this siphon will then be alternately automatically broken and primed exactly as already described for the right hand siphon. Similarly the left hand siphon will operate through an automatic cycle whenever the excess flow is a material quantity but less than the capacity of a single siphon. This system of varied elevation of vents is to be preferred as it brings the use of the siphon primer into service at comparatively infrequent intervals, in fact such primer will be utilized only upon an increase in flow after a period during which the power plants are utilizing the entire flow of the stream. The use of vents placed at varying elevations is not however to be confined to the use of any special form of siphon primer.

We do not limit our invention to the means herein referred to for exhausting the air from the principal siphons, as any means for producing siphonic action, when such action is automatically broken by the use of suitably disposed air vents, comes within the scope of our invention.

Although Figs. 1 to 7, inclusive, show the siphons or tank built in the dam or spillway as distinguished from the abutment, it is the intent of our invention that a tank or tanks, or a siphon or siphons may be built to operate as heretofore described in either or in both abutments, or elsewhere in convenient proximity to the dam or spillway.

In the case of the siphon shown by Fig. 2, inlet 1 and air vents, 12, are merged into one opening. The action of this siphon is substantially the same as with the siphon shown by Fig. 1, the siphonic action being broken whenever the water falls to approximately the low water stage thereby admitting air into the throat of the siphon below the upper edge of inlet 1.

In the accompanying drawings the siphons are shown with a wider throat, as measured longitudinally of the dam, than the width of inlet or outlet, but such siphons may be built whenever desirable with the width of throat equal to or even less than the width of inlet or outlet without in the least affecting the intent or spirit of our invention.

Although not essential to our invention, air valves, 30, may be inserted in air pipes, 10, or 25, where shown in the drawings or elsewhere, for the purpose of affording control of the action of some or all of the siphons, the action of the siphons being broken whenever air is admitted to the throat in sufficient quantity and restored when the supply of air is cut off by the closing of such valves.

What we claim as our invention and desire to secure by Letters Patent is:

1. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam, such siphon or siphons being primed by a siphon primer.

2. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam, such siphon or siphons being primed by a priming siphon, the action of such siphons being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam at the elevation of the low water stage above the dam, substantially as described.

3. A dam or spillway containing one or more siphons with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; the inlet of each siphon being placed well below the low water stage above the dam; each siphon being primed or actuated by a priming siphon or siphons.

4. A dam or spillway containing one or more siphons with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; the inlet of each siphon being placed well below the low water stage above the dam; and a siphon primer.

5. A dam or spillway containing one or more siphons with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; the inlet of each siphon being placed well below the low water stage above the dam; and a siphon primer; the action of each such siphon being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam at the elevation of the low water stage above the dam, substantially as described.

6. A dam or spillway containing one or more siphons, each of inverted U-shaped form, with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; with one leg of each siphon extending through the upstream face of the dam or spillway at a point well below the low water stage above the dam; the other leg of the siphon extending through the downstream face of the dam or spillway at an elevation lower than the opening for the upstream leg; and a siphon primer.

7. A dam or spillway containing one or more siphons having throats wholly or in part above the elevation of the high water

stage above the dam, such siphon or siphons being primed by the automatic action of one or more priming siphons each with the lower edge and upper edge of its throat placed approximately at the low and high water stages respectively above the dam.

8. A dam or spillway containing one or more siphons, with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; with the inlet of each siphon placed well below the low water stage above the dam; each siphon being primed by the automatic action of one or more priming siphons each with the lower edge and upper edge of its throat placed approximately at the low and high water stages respectively above the dam.

9. A dam or spillway containing one or more siphons, each of inverted U-shaped form, with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; with one leg of each siphon extending through the upstream face of the dam or spillway at a point well below the low water stage above the dam, the other leg extending through the downstream face at an elevation lower than that of the opening for the upstream leg; each siphon being primed by the automatic action of one or more priming siphons each with the lower edge and upper edge of its throat placed approximately at the low and high water stages respectively above the dam.

10. In a dam or spillway, a plurality of siphons each provided with an air vent or vents piercing the upstream face of the dam between the high and low water stages, such vents being placed at varying elevations and serving to automatically break the siphonic action of the various siphons at varying stages of the water surface above the dam.

11. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam, such siphon or siphons being primed by means of the suction produced in pipes connected to the curved lower surface of the throat of the priming siphon, substantially as described.

12. A dam or spillway containing one or more siphons with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; the inlet of each siphon being placed well below the low water stage above the dam; each siphon being primed by means of the suction produced in pipes connected to the curved lower surface of the throat of the priming siphon, substantially as described.

13. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam, such siphon or siphons being primed by means of the suction produced in pipes connected to the curved lower surface of the throat of a priming siphon; the action of each such siphon being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam at the elevation of the low water stage above the dam, substantially as described.

14. A dam or spillway containing one or more siphons, with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; the inlet of each siphon being placed well below the low water stage above the dam; each siphon being primed by means of the suction produced in pipes connected to the curved lower surface of the throat of the priming siphon; the action of each such siphon being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam at the elevation of the low water stage above the dam, substantially as described.

15. A dam or spillway containing one or more siphons each of inverted U-shaped form, with the throat of each siphon placed wholly or in part above the elevation of the high water stage above the dam; with one leg of each siphon extending through the upstream face of the dam or spillway at a point well below the low water stage above the dam; the other leg of the siphon extending through the downstream face of the dam or spillway at an elevation lower than the opening for the upstream leg, each siphon being primed by means of the suction produced in pipes connected to the curved lower surface of the throat of the priming siphon; the action of each such siphon being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam at the elevation of the low water stage above the dam, substantially as described.

16. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam, such siphon or siphons having the upper edge of the inlet placed approximately at the elevation of the low water stage above the dam; such siphon or siphons being primed by the action of a priming conduit; and means for exhausting the air therefrom.

17. A dam or spillway containing one or more siphons having throats wholly or in part above the elevation of the high water stage above the dam; each siphon being of inverted U-shaped form with one leg extending through the upstream face of the dam or spillway at a point well below the low water stage above the dam, the other leg extending through the downstream face at an elevation

lower than the opening for the upstream leg; each siphon being primed by the automatic action of one or more priming siphons; the action of each siphon being automatically broken by the admission of air to the throat through a vent or vents connecting the throat to the upstream face of the dam, substantially as described.

18. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam; such siphon or siphons being primed by the action of a priming conduit and means for exhausting the air therefrom.

19. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam with the inlet of each siphon placed well below the low water stage above the dam; such siphon or siphons being primed by the action of a priming conduit; and means for exhausting the air therefrom.

20. A dam or spillway containing one or more siphons having throats placed wholly or in part above the elevation of the high water stage above the dam; each siphon being of inverted U-shaped form with one leg of each siphon extending through the upstream face of the dam at a point well below the low water stage above the dam, the other leg extending through the downstream face at an elevation lower than that of the opening for the upstream leg; each siphon being primed by the action of a priming conduit; and means for exhausting the air therefrom.

21. A dam or spillway containing one or more siphons, each siphon being primed by the action of a priming conduit; and means for exhausting the air therefrom.

In testimony whereof we have affixed our signatures in presence of two witnesses.

WILLIAM RUSSELL DAVIS.
GEORGE F. STICKNEY.

Witnesses:
FREDERICK W. CAMERON,
GRACE PRIOR.