June 11, 1968 SHUZO MIZUNO 3,387,782

APPARATUS FOR PRODUCING A FOUNTAIN INCLUDING A STROBOSCOPIC LIGHT

Original Filed Nov. 30, 1964 4 Sheets-Sheet 1

FIG. 1

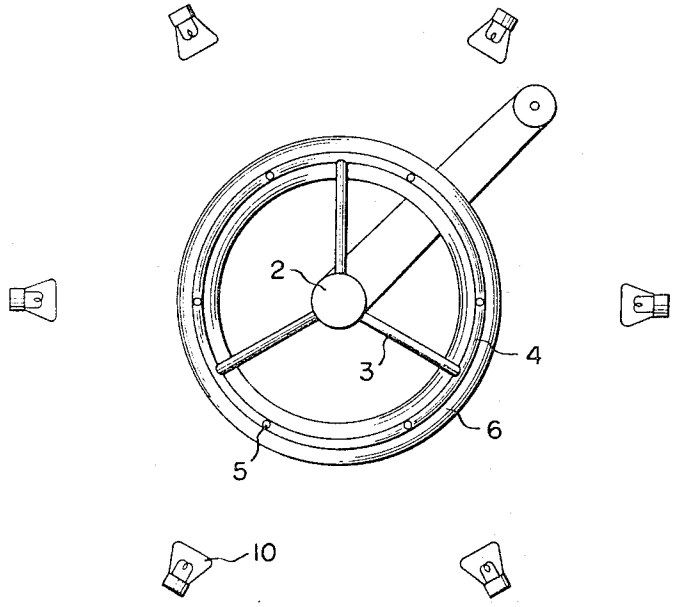
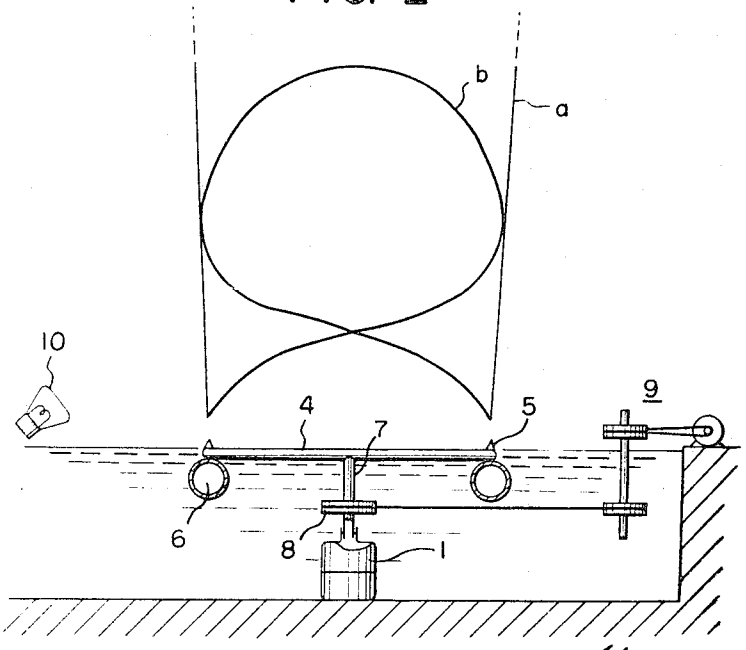


FIG. 2



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APPARATUS FOR PRODUCING A FOUNTAIN INCLUDING A STROBOSCOPIC LIGHT

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FIG. 3

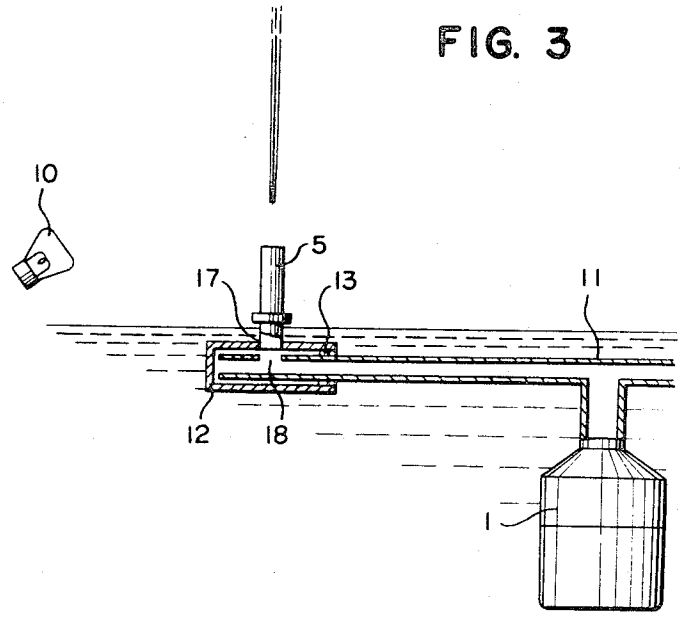
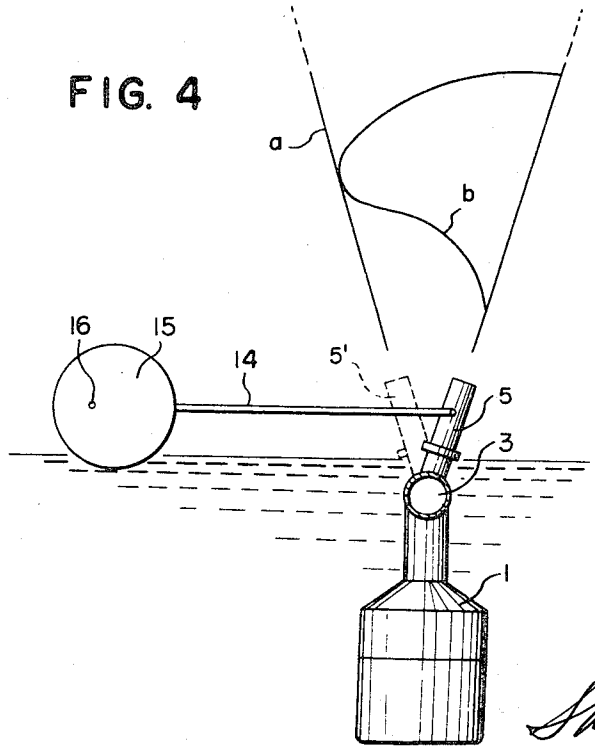


FIG. 4



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APPARATUS FOR PRODUCING A FOUNTAIN INCLUDING A STROBOSCOPIC LIGHT

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FIG. 5

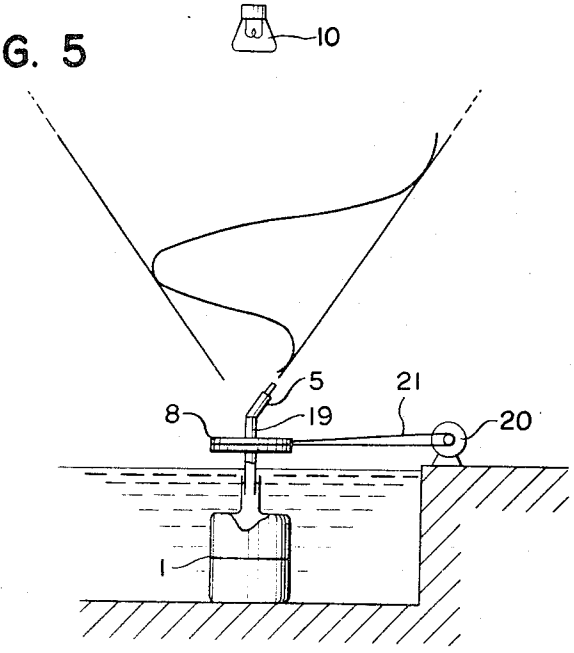


FIG. 6

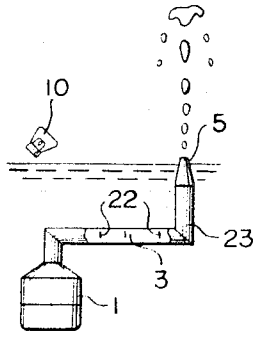


FIG. 7

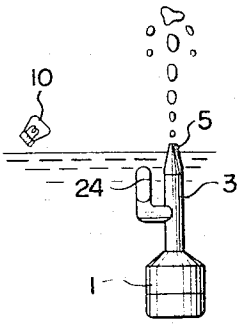


FIG. 8

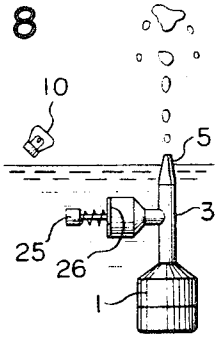
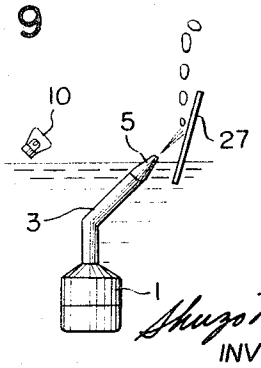


FIG. 9



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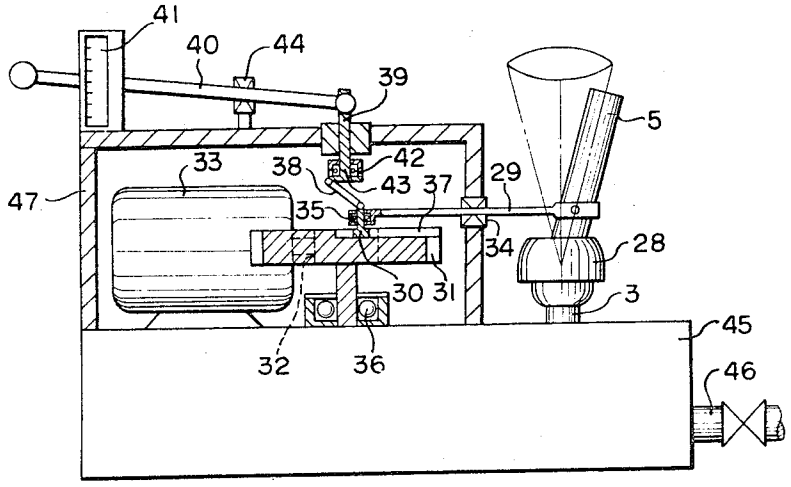
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APPARATUS FOR PRODUCING A FOUNTAIN INCLUDING A STROBOSCOPIC LIGHT

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FIG. 10



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3,387,782

APPARATUS FOR PRODUCING A FOUNTAIN INCLUDING A STROBOSCOPIC LIGHT

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Continuation of abandoned application Ser. No. 414,783, Nov. 30, 1964. This application Mar. 8, 1967, Ser. No. 621,709

Claims priority, application Japan, Dec. 6, 1963, 38/65,292; Feb. 29, 1964, 39/11,004

15 Claims. (Cl. 239—20)

ABSTRACT OF THE DISCLOSURE

An apparatus for producing a fountain, comprising a liquid containing open topped tank, a jetting nozzle having at least one jet nozzle thereon, a liquid immersible pump at the bottom of said tank and on which said jetting nozzle member is mounted at a level above the level of the surface of the liquid in the tank, said pump having a pumping capacity sufficient for pumping a stream of liquid from the bottom of the tank through said jet nozzle to a height high enough to form a liquid curtain, means acting on said jetting nozzle member to give to said stream a periodic motion, whereby a curtain of liquid is formed, and a stroboscopic light positioned laterally of the jetting nozzle a distance sufficient to enable it to be directed toward the curtain of liquid to shine on the outside surface of the configuration of the curtain of liquid, said light being directed toward and illuminating said liquid curtain after it has left the jet nozzle.

This application is a continuation application of applicant's prior copending application Ser. No. 414,783, filed Nov. 30, 1964, now abandoned.

The present invention relates to a new and useful apparatus for producing a fountain by creating static or dynamic patterns by varying the streams of jetted water and the apparatus for producing a fountain consists of the jetting nozzle which is connected with a pumping device to produce a water curtain with periodic motion, and a source of short-peak intemittent light which is positioned at an appropriate point for illuminating said water curtain.

According to one example of the present invention, the apparatus is designed to obtain a beautiful fountain by setting up jetting nozzles on a rotor, rotating said rotor while spouting water from said nozzles, projecting the light on the jetted water which light has a short peak of illumination and incessantly goes on and off. The object of the apparatus is to obtain a beautiful fountain by producing static or dynamic tracks of water and varying said tracks.

According to another example of the present invention, the apparatus is designed to develop static or dynamic figures by irradiating, by means of the aforesaid short-peak light which incessantly goes on and off, a water screen formed by spouting water from said nozzles while moving said nozzles in a reciprocating fashion.

The object of the apparatus is to provide a beautiful fountain by varying the linear or parabolic streams of jetted water as produced by the device and thereby producing broadening, static, converged or zigzag tracks of water.

According to a third example of the present invention, the apparatus is designed to produce static or dynamic forms by setting up jetting nozzles on a line not including the axis of rotation, revolving said nozzles while spouting water, casting the foresaid short-peak intermittent light on the water screens thus produced and also adjusting the velocity of revolution and the period during which

the light is intermittently projected. The object of the apparatus is to create a beautiful fountain by producing the static or dynamic tracks of water and varying said tracks.

In other words, the object is to produce such a fountain which, while usually being the same as an ordinary fountain, can present a variety of forms by darkening the neighborhood thereof, or during the night time keeping streaked or spotted patterns at rest in the air or gradually moving said patterns up or down.

According to another modification of the present invention, the apparatus is designed to rotate circularly the end or the whole of the nozzle. The object is to obtain a decorative fountain or jetted water for sprinkling purposes which the pattern of the jetted water can be varied by adjusting the rotation of said nozzle.

The present invention will be more clearly understood by reference to the following examples as illustrated in the attached drawings. It should be noted, however, that the present invention is not limited to these examples, but that adequate modifications thereof can be used, so long as they do not widely depart from the basic concept of the present invention. In the following examples the same parts are described using the same notations.

Summary description of the attached drawings

FIG. 1 is a schematic plan view of the water-jetting apparatus claimed in the present invention;

FIG. 2 is a side elevation view thereof, partly in section;

FIG. 3 is a sectional elevation view of one modification of the aforementioned apparatus;

FIG. 4 is a sectional elevation view, partly in section, illustrating one mechanism whereby the jetting nozzles of such modification are vibrated;

FIG. 5 is a schematic side elevation view of another modification of said apparatus;

FIGS. 6 to 9 are schematic diagrams of various devices of said apparatus;

FIG. 10 is a secttional elevation view showing part of a third modification of the aforesaid apparatus.

First in FIGS. 1 and 2, the number **1** shows a water-immersible motor pump, the number **2** a water supply chamber, the number **3** water pipes, the number **4** an annular water pipe, the number **5** jet nozzles, the annular water pipe being a ring and together with jet nozzles **5** and radial pipes **3** constituting a jetting nozzle, and the number **6** floats. The water supply chamber **2** is provided on the delivery side of the water-immersible motor pump **1**.

The water supply chamber **2** and the annular water pipe **4** are supported by and connected with the radially arranged water pipe **3**, the pipes **3** and annular pipe **4** constituting a rotor.

Under the annular water pipe **4** are fitted floats **6** to offset the weight thereof. While the water-immersed motor pump is secured to the bottom of a water filled open topped tank, its upper part is engaged with the water pipe **7** by a bearing which connects said pump with the water supply chamber **2**. Said water pipe **7** is fitted with a pulley **8** receiving the driving force from the driving mechanism **9**. Said driving pulley rotates the annular water pipe **4** through the water pipe **7** and revolves the jetting nozzles at any desired speed.

In this case, the driving mechanism is provided, where necessary, with a non-step speed change gear (not shown) to regulate the rotation. The jet nozzles spout water while being revolved by means of the water-immersed motor pump **1** and the driving mechanism **9**, and produce a cylindrical water screen or curtain *a*. The aforesaid nozzles are set up on the periphery of the an-

nular water pipe 4, there being a plurality, for example, six, and are designed to be rearwardly and inwardly inclined so that water falls on the spouting point.

A series of intermittently illuminated lights, for example, strobolights 10 are arranged laterally of the jetting nozzle beyond the outer periphery of the water jetting apparatus having the aforementioned construction and are directed toward the water curtain to illuminate the whole of the outside surface of the water curtain *a*. In this case the period during which the strobolights intermittently cast light is controlled by a noncontact switch (not shown). When the jetted water revolves at a rate of 10 r.p.s. and the strobolights go on and off at a rate of 60 cycles per second the water screen *a* appears to have tracks crossing each other. Again where the illuminating period of said strobolights is varied the patterns projected are changed accordingly, thereby producing a dynamic and beautiful fountain.

The aforementioned example will be further detailed hereinafter. In this apparatus five jet nozzles are mounted on a rotor, for example, a rotating disk or ring (in this example the annular water pipe 4). Said nozzles are connected with the water-immersed motor pump 1 through the water pipe 7. Water is spouted while said rotor is turned by the driving mechanism. When said nozzles are mounted on the same periphery of the rotor they are arranged at equal intervals. When the rotating velocity is set at about 10 r.p.s., for example, in case six nozzles are mounted on the same periphery, a cylindrical water screen *a* is formed around a rotating circle. The aforementioned nozzles may be set upright. However, when it is desired to have the jetted water fall again on the same spouting point it will be necessary to tilt said nozzles at an adequate rearwardly inclined angle so as to offset the propulsion or momentum at the periphery of the revolving nozzles. Said angle of inclination can not be fixed due to the varying rotation velocity, volumes of jetted water or nozzle diameters. Moreover, since changes in said angle result in varying patterns of jetted water, it should be kept variable. When the jet nozzles are perpendicular to the line connecting the rotating axis with said nozzles the jetted water falls outside the rotating periphery due to centrifugal force. Therefore to cause the water fall on the spouting point, it is necessary for the jet nozzles to have sufficient inclination to produce a horizontal component corresponding to the radial component of the centrifugal force. Since variations in this angle of inclination help to increase the beautiful effects of a fountain, said angle is made adjustable.

Thus a cylindrical water screen *a* is produced by the revolution of the jet nozzles 5. The whole area *b* is exposed to a short-peak intermittent light. The projection of light may be made from the inside or outside of the water screen *a*.

1/500 of a second is preferable as the time of intermittent illumination. So long as the light continually goes on and off, any source of light may be used. In this example a light source is used which projects light with a variable period of intermittent illumination. For instance, the strobolights 10 are connected with a non-contact switch (not shown) or rotating mirrors may be used for this model. The standard period of intermittent light is that which corresponds to certain multiples of the period adjusted in such a way that the light is illuminated again the next time the nozzles return to the same position after the first illumination (for instance, when six nozzles on the same periphery are revolved at 10 r.p.s. the standard period is 60 cycles per second). Said period can be slightly varying as desired. When the aforementioned period is used in projecting intermittent light images are produced on the whole surface *b* of the water screen *a*. Again when said period is progressively changed the patterns thus produced vary in the same, reverse, upward or downward directions relative to the direction of the nozzle revolution. Furthermore, when the nozzle inclination is changed more interesting images are obtained. These variations in the forms of images projected can also be achieved by adjusting the rotating velocity of the rotor, instead of the light period. In this instance the water jetting apparatus can be driven not only by the external rotating device 9, but also by supporting the whole of said apparatus on the floats 6 and rotating it with streams of water jetted into the pond. Also the rotor on which the jet nozzles are mounted is not limited to a rotating disk or ring. Radially extending pipes 3 extending from chamber 2 bearing said nozzles at the end or somewhere on the length thereof may also serve as a rotor. The mechanism for causing intermittent operation of the light source may consist, in addition to the strobolight, of any other electrical or mechanical devices.

Next in FIGS. 3 and 4 illustrating another modification of the apparatus of the present invention, the water-immersed motor pump is connected with a communicating water pipe 11 on the end of which is pivotally mounted an outer cylinder 12. On the rotating outer cylinder 12 is a jet nozzle.

Said cylinder is designed to make a reciprocal rotation around the axis of the communicating water pipe 11. This pipe is provided with a peripherally extending notch 18 extending partly around the periphery and opposite the position of the nozzle joint 17 on said rotating outer cylinder. The water to be jetted is introduced into the communicating water pipe 11 by the driving of the water-immersed motor pump and spouted from the jet nozzle 5 after passing through the notch 18. Said communicating water pipe 11 and the rotating outer cylinder 12 are completely closed by sealing material 13.

In FIG. 4 the number 15 is an eccentric cam which rotates on the axis 16. Said cam has a rod 14 connected to the periphery thereof, and is driven by an adequate D.C. motor (not shown), the velocity of said rotation being adjustable. The other end of the rod 14 is connected with the end of the jet nozzle 5.

Said rod provides a lateral stroke by the rotation of said eccentric cam 15. Said nozzle moves back and forth between positions 5 and 5' around the communicating water pipe 11.

Thus said nozzle 5 makes reciprocating movements, while jetting water, during the driving of the water-immersed motor pump 1 and the eccentric cam 15, and a sectorial water screen *a* is obtained along the reciprocating plane of said nozzle. Then light is projected all over the water screen *a* by the strobolight 10. The illumination period of said strobolight is adjustable by means of a non-contact switch (not shown).

An example of the apparatus with the aforementioned construction will be described hereinafter.

The frequency of the nozzle vibration should be adjusted to 15 to 20 cycles per second while water is spouted. A narrow or sectorial water screen *a* is obtained by the nozzle vibration of 15 to 20 cycles per second. When a short-peak light, for example, the strobolight 10 which goes on and off in the same period as that of vibration is projected on said water screen, static or dynamic zigzag water tracks *b* are obtained. When the adjustable period of the intermittent light source is varied images are projected in a static or dynamic form, thereby obtaining a beautiful fountain. When the period of the intermittent light source is shorter than the reciprocating period of the nozzle, narrowing zigzag water tracks are produced, and when the period of said light source is longer broadening zigzag water tracks are obtained. With the aforementioned type of apparatus, a rotating mirror or movie projector can be used instead of the strobolight. In addition to the D.C. motor, a non-step speed change gear may be used as a mechanism for varying the rotating velocity of the eccentric cam 15. Also the intermittent period of the strobolight may be adjusted by other means, namely, electrically or mechanically.

Next in FIG. 5 illustrating another modification of the apparatus of the present invention, the water-immersed motor pump 1 is connected with the rotating water pipe 19. A jet nozzle is mounted at the top of said water pipe, the angle of said nozzle being adjustable. The pulley 8 secured to said rotating water pipe is driven by the driving motor 20 through the belt 21. Said driving motor is provided with an adequate non-step speed change gear (not shown). Above the jet nozzle 5 is positioned a strobolight 10 to illuminate the water screen *a*. In this case, the illumination period of said strobolight is designed to be varied by a non-contact switch (not shown). Thus an intermittent light is projected on the water screen *a* formed by rotating said nozzle 5 while spouting water.

An example of the apparatus with the aforementioned construction will be described hereinafter. When the jetting nozzle is rotated at 20 r.p.s. and the illumination period of the strobolight is set at 20 cycles per second one water track stands at rest.

When the period of said strobolight is varied images produced on the water screen *a* are changed accordingly. When the illumination period is set at 40 cycles per second two water tracks stand at rest. Also a change in the frequency of the nozzle rotation and its angle produce varied patterns, thereby obtaining a beautiful fountain.

In the foregoing example, when the jet nozzle 5 is placed at a position on the pulley 8 offset from the rotating axis thereof, and the pulley is rotated while spouting water, said water assumes a zigzag line rotating around said axis in a funnel shape. When the nozzle rotates at a higher speed or when a number of nozzles are used a funnel-shaped water screen is obtained. When a short-peak intermittent light is projected on said water screen static or dynamic images appear thereon. The light source may be placed above, beside or below the water screen or anywhere else. Also any color of light is usable.

Since the type of light, duration of illumination, intermittent period and mechanism of producing intermittent light are the same as in the case of the previously described embodiments, a description thereof is omitted. Production of varied beautiful images depends on the way in which water is spouted, so that variations in the jetting pressure and nozzle direction and the resultant changes in the forms of jetted water can effectively vary said images.

Next in FIGS. 6 to 9 showing a third modification of the apparatus of the present invention, the number 22 represents baffle boards, 23 is a curved section, 24 is sealed air, 25 is a vibrator, 26 is a vibrating membrane, and 27 is a vibrating board. The method for pulsating the streams of jetted water consists in causing the water to pulsate before or after it is spouted from the jet nozzle 5 or in vibrating the nozzle itself in the direction of the jetted streams. In this modification of the apparatus, pulsation before jetting can be achieved, as shown in FIG. 6, by providing curved section 23 or baffle boards 22 in the water pipe 3 extending from the water immersed motor pump to the jet nozzle 5 to produce turbulent streams in the water passing therethrough or, as shown in FIG. 7, by providing a sealed air chamber in the water channel and ejecting said air. As illustrated in FIG. 6, baffle boards 22 and curved sections are equally spaced in the water pipe 3.

The water discharged by the water-immersed motor pump turns into turbulent streams and develops pulsation while passing through the water pipe 3, thus being spouted in the form of drops.

When a short-peak intermittent light is projected from the light source, for example, the strobolight, varied patterns are obtained. As shown in FIG. 7, the sealed air chamber installed in the water pipe 3 works as a source of vibration and imparts pulsation to the water streams passing through said pipe. In this case, it is not always necessary to place said baffle boards, curved sections, and sealed air chambers near the jet nozzle 5, but they can be spaced therefrom. Pulsation thus produced does not have a constant period, but slightly varies. However, these variations are the necessary factor in changing the forms of jetted water, thus obtaining an interesting pattern in the fountain.

Another method of imparting pulsation to the water before it is spouted from the jet nozzle consists, as shown in FIG. 8, in installing a vibrator 25 to impart vibration externally. This method makes it possible to control the period of pulsation.

In this case, the vibration generated by the vibrator 25 is transmitted to the vibrating membrane. The vibration of said membrane pulsates the streams in the water pipe 3. Said vibrator may be operable either electrically or mechanically.

Next pulsation after jetting may be accomplished, as shown in FIG. 9, by impinging jetted water streams on the vibrating board 27.

This board is fixed at one end. The water spouted from the jet nozzle receives pulsation by impinging on said vibrating board and expands into a sectorial shape. It is, of course, possible to shake the vibrating board mechanically and impinge water streams thereon. In this case the pulsating period can be adjusted in any way desired. When an intermittent light, for example, the strobolight 10 is projected on the surface of the sectorial water screen co-centric patterns are made to stand at rest or move. When the pulsating water streams strike against the fixed impingement board 27, the same forms of fountain are obtained.

When the pulsating period of the jetted streams and the light period concur the patterns produced remain motionless. When both periods vary the patterns rise or fall. The patterns vary with the way in which the nozzle is set up or the water is spouted.

Where water is simply jetted upward, a continuation of water drops appears in the rising streams, whereas, in the falling streams, rings of water continuously extend in an umbrella shape. When the jetted water impinges on the aforesaid board concentric sectorial patterns are developed around the center of impingement. When water is jetted in lateral, downward or other directions many different forms of fountains are obtained.

An example of the apparatus with the aforementioned construction will be described hereinafter. It is preferable to pulsate the water streams at a rate of 10 to 30 cycles per second.

However, a higher or lower rate of pulsation may be used.

Any light source is usable if it emits short-peak intermittent beams. For instance, a rotating mirror or movie projector may be used in addition to the aforementioned strobolight. When wide varieties of color of light are projected in addition to white, the beautiful effects are increased. When the intermittent period of the light source concurs with the pulsating frequency of the water streams or multiples thereof the patterns produced stand at rest. When these periods are slightly varied the patterns rise up in progressively enlarging forms or come down in narrowing shapes. For further varieties of patterns, the periods of pulsation and light emission are adjusted by the vibrator 25 and/or the light source having a variable period of projecting light. Other effective methods may consist in changing the water pressure or the rotating direction of the jet nozzle. Further to produce fanciful images, the strobolight and ordinary illumination can be used alternately in addition to the use of the strobolight alone. As a result, interesting changes of forms appears from the type of fountain produced by this apparatus as compared to that produced by the ordinary device. Also an ordinary water jetting apparatus, fitted with a simple adaptor, is capable of producing variable beautiful forms of fountains. When variegated illu-

mination is applied in different combinations the beauty of the forms will be increased.

Next in FIG. 10 showing a fourth modification of the apparatus of the present invention, the jet nozzle 5 is joined with the water pipe 3 by a joint 28 in such a way that its outermost end can be rotated. To said nozzle is attached one end of the rod 29.

Said rod is supported on a fulcrum 34. The other end of the rod is engaged with the pin 30 through a water-immersed bearing 35.

The gear 31 is rotatably mounted within the apparatus body 47 in another water-immersed bearing 36, and connected with the water-immersed motor 33 through a worm gear 32. A channel 37 is provided extending in a radial direction on the top surface of the gear 31.

The lower end of the pin 30 is slidably fitted in said channel 37. The lower end of a rotating link 38 is rotatably connected with the upper end of the pin 30. The upper end of said rotating link is connected with a rotating board 43 at one point, which board in turn is mounted on rod 39 rotatably mounted in another water-immersed bearing 42. A handle 40 is supported on a fulcrum 44 and is connected with the upper end of the rod 39.

The number 45 represents a water storage tank, and 46 a feed water pipe connected with said water storage tank 45.

Thus in an example of the apparatus with the aforementioned construction, the driving force of the water-immersed motor 33 is transmitted to the gear 31 through the worm 32 to rotate said gear.

At this time the pin 30 which is secured to one point in the channel 37 is made to turn due to the rotation of the aforementioned gear 31. As a result, the rotating link 38 and the rotating board 43 which are connected with said pin 30 also rotate.

Since one end of the rod 29 engages with the pin 30 by means of a bearing, both ends of said rod 29 make a separate circular motion, thus imparting rotation to the outer end of the jet nozzle 5. Under such conditions, when water is supplied through the feed water pipe 46 and spouted from the jet nozzle 5 it forms a spiral fountain opening at the top. To vary the forms of jetted water, the rotating velocity of said gear 31 is changed in any way desired.

When the handle 40 is raised the rod 39 is lowered, and the rotating axis is laterally moved, the pin 30 being moved outwardly along the channel 37 to a greater radius, which in turn increases the size of the circle of rotation of the outer end of the jet nozzle 5. In this case, the channel 37 is tilted outwardly so as to ensure the smooth movement of the pin 30. In a reverse operation to the above, when the handle 40 is pushed down, the rod 39 comes up, drawing the pin 30 nearer to the center and reducing the size of the circle of rotation.

In this model of the apparatus, the aforesaid channel 37 is provided as a guide for the pin 30. However, this may be changed into a convex type of guide. Furthermore, the size of the circle of rotation can be varied through the raising or lowering of the rod 39 by means of the water-immersed motor 33. In this model of the apparatus, the base of the jet nozzle 5 is fixed by the joint 28, leaving only the end to rotate in order to obtain a spiral form of fountain opening at the top. However, to produce an ordinary spiral fountain and vary its amplitude, it is possible to secure the jet nozzle to the end of the rod 29 and connect the nozzle base with the water pipe 3 using an adequate flexible member in place of the joint 28.

In this case, the end and base of the nozzle rotate in parallel, the size of the circle of rotation depending on the position of the pin 30.

We claim:

1. An apparatus for producing a fountain, comprising a liquid containing open topped tank, a jetting nozzle having at least one jet nozzle thereon, a liquid immersible pump at the bottom of said tank and on which said jetting nozzle member is mounted at a level above the level of the surface of the liquid in the tank, said pump having a pumping capacity sufficient for pumping a stream of liquid from the bottom of the tank through said jet nozzle to a height high enough to form a liquid curtain, means acting on said jetting nozzle member to give to said stream a periodic motion, whereby a curtain of liquid is formed, and a stroboscopic light positioned laterally of the jetting nozzle a distance sufficient to enable it to be directed toward the curtain of liquid to shine on the outside surface of the configuration of the curtain of liquid, said light being directed toward and illuminating said liquid curtain after it has left the jet nozzle.

2. An apparatus as claimed in claim 1 in which said jetting nozzle member comprises a rotor having a plurality of jet nozzles thereon, and said means acting on said stream to give to the stream periodic motion comprises means coupled to said rotor for rotating said rotor.

3. An apparatus as claimed in claim 2 in which said rotor is a rotating disk having a center and has water pipes extending radially from the center to said disk.

4. An apparatus as claimed in claim 2 in which said rotor is a rotating ring and has water pipes extending radially from the center to said ring.

5. An apparatus as claimed in claim 1 in which said jetting nozzle member has a single jet nozzle thereon and includes a conduit member to said pump on which said nozzle member is pivotally mounted, and said means acting on said stream to give to the stream periodic motion comprises means coupled to said nozzle member for pivoting said nozzle member.

6. An apparatus as claimed in claim 5 in which said nozzle member is mounted for pivotal movement back and forth in a single plane, and said means coupled to said nozzle member comprises a rod coupled to said nozzle member, an eccentric cam coupled to said rod, and rotating means coupled to said cam for rotating said cam.

7. An apparatus as claimed in claim 5 in which said nozzle member is a rotary disk on which said nozzle is mounted at an angle to the vertical, and said means coupled to said nozzle member comprises means for rotating said disk.

8. An apparatus as claimed in claim 5 in which said nozzle member is mounted for pivotal movement in any direction about a point, and said means coupled to said nozzle member comprises a rod having one end coupled to said nozzle member, a fulcrum at which the middle portion of the rod is supported, and a rotatable member to which the other end of said rod is coupled, said rotatable member rotating in a plane and moving said nozzle member around an axis through the pivotal point in a generally conical path.

9. An apparatus as claimed in claim 8 in which the coupling of said rod and said rotatable member is adjustable radially of said rotatable member.

10. An apparatus as claimed in claim 1 in which said nozzle member is fixed, and said means acting on said stream of liquid comprises means for pulsing said stream of liquid periodically.

11. An apparatus as claimed in claim 10 in which said coupling between said nozzle member and said pump comprises a conduit, and said means for acting on said stream comprise curved sections in said conduit for producing turbulent portions of the stream passing through the conduit, thereby causing the stream to pulsate.

12. An apparatus as claimed in claim 10 in which said coupling between said nozzle member and said pump comprises a conduit, and said means for acting on said stream comprise baffles in said conduit for producing turbulent portions of the stream passing through the conduit, thereby causing the stream to pulsate.

13. An apparatus as claimed in claim 10 in which said coupling between said nozzle member and said pump

comprises a conduit, and said means for acting on said stream comprises a sealed air chamber coupled to said conduit for producing turbulent portions of the stream passing through the conduit by ejecting the air from the air chamber, thereby causing the stream to pulsate.

14. An apparatus as claimed in claim **10** in which said coupling between said nozzle member and said pump comprises a conduit, and said means for acting on said stream comprises a vibrator acting on the liquid in said conduit for producing vibrations in the stream passing through the conduit, thereby causing the stream to pulsate.

15. An apparatus as claimed in claim **10** in which said means for acting on said stream comprises a vibrating board adjacent said nozzle against which the stream from the nozzle is impinged, thereby causing the stream to pulsate.

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