An electronic automatic faucet device wherein an emitting element of visible or invisible rays, a receiving element for said rays, and a magnet valve are provided for the faucet of a water conduit, wherein the beam path between both the elements is momentarily intercepted, that is, the beam is shut for a short time and the original irradiating state is immediately recovered, thereby to energize the magnet valve into the water feeding state. When the beam path is subsequently intercepted for a moment, the magnet valve is deenergized into the water stopping state. Furthermore, simultaneously with initiation of the water feeding state, a timer circuit starts so as to automatically change said water feeding state to the water stopping state when a predetermined period of time has elapsed.
The present invention relates to an electronic automatic faucet device which is disposed in the way of a water conduit for a washstand, a cookery, etc., so as to automatically control the water supply. More particularly, it relates to improvements in an electronic automatic faucet device of a system in which the beam path between a ray emitting portion and a ray receiving portion containing therein a photoelectric semiconductor element is momentarily intercepted, whereby a switching circuit formed of a semiconductor element is on-off-controlled to open and close a magnet valve disposed on the output side of the switching circuit. Herein, the expression “momentary interception of the beam path” means that the beam path is temporarily intercepted, being crossed by a hand or by an object, whereupon the original irradiating state is immediately recovered. It does not mean that any interrupting operation is rapidly effected.

In a prior-art electronic automatic faucet device of this type, a ray irradiated on a photoelectric element accommodated in a ray receiving portion is momentarily intercepted, whereby a bistable multivibrator circuit of vacuum tubes or transistors is caused to conduct in an inverting operation. Due to the inversion, a switching circuit connected to the output side of the multivibrator circuit is changed in operation to the “on” state. Through a relay incorporated into the switching circuit, a magnet valve is energized to open a water conduit. Thereupon, the water feeding state is continued. If, under this state, the interception of the beam path for stopping water is forgotten, useless water feed for a long time is unpreferably conducted. Moreover, the bistable circuit employed in the automatic faucet device of the prior-art system is indefinite as to which one of a pair of transistors constituting the bistable circuit falls into the “cut-off” state or the “on” state at switching on of a power source due to, for example, recovery of a power supply in case of service interruption. In the automatic faucet device which adopts the bistable circuit, the magnet valve can accordingly be brought into the opened state at the switching on of the power source of the device. In that case, the water feed state is inconveniently continued until the interception of the beam path to the photoelectric element is carried out.

The present invention has been accomplished in view of these points, and has its object in providing an electronic automatic faucet device constructed such that a switching circuit is brought into the “off” state automatically at the time of lapse of a fixed period after initiation of water feed or, when it is desired to stop water before the lapse of the fixed period, by performing a momentary interception of a beam path at such time, that a magnet valve is thereby deenergized so as to close a water conduit, and that the magnet valve is brought into the closed state at switching on of a power source without fail, whereby the inconveniences in the prior-art device as above stated can be eliminated.

**Fig. 1** is a side view showing a state in which an electronic automatic faucet device according to the present invention is mounted on a wall; **Figs. 2(a) and 2(b)** are a side sectional view and a plan sectional view, respectively, showing a ray emitting element and a ray receiving element; **Figs. 3(a) and 3(b)** are schematic views showing different arrangement systems for the ray emitting element and the ray receiving element; **Fig. 4** is a block diagram of an embodiment of the present invention; **Fig. 5** is a detailed circuit diagram of the embodiment; and **Fig. 6** is a circuit diagram of a further embodiment of the present invention.

**Detailed Description of the Preferred Embodiments**

Referring to **Fig. 1**, numeral 1 designates the body of a faucet portion as a reflecting mirror, for example consisting of a nickel-chrome-plated casting, a stainless case or a die-casting case. Shown at 2 is a universal water feed cock. Numeral 3 indicates an adaptor for regulating the amount of water, which is fixedly mounted on a wall 4 and which is simply connected to the faucet portion body through a box nut 5. The adaptor 3 is provided with a universal water feed cock (which is different from that 2, and which is not shown since it extends towards the back of the drawing) which can be subjected to an opening or closing operation by means of a knob 6. Accordingly, the operations of supplying and stopping water can be freely conducted manually independent of the automatic operation. Shown at 7 is a cap cord. A six-terminal type plug 8 is connected to an amplifier case (not shown). Numeral 9 represents an infrared ray filter which is attached to the front of each of the ray emitting and receiving portions 10 as will be stated below with reference to **Fig. 2**, and which is watertightly set in a beam path window 11. A bottom cover plate 12 tightly clamps and fixes thereon the faucet portion body 1 through clamp nuts 13 at the water inlet part of a magnet valve 14 (shown in phantom outline) and the port part of the universal water feed cock 2, to thereby form a perfect waterproof structure. Reference numeral 15 designates in phantom outline an excitation coil of the solenoid valve 14.

**Figs. 2(a) and 2(b)** are diagrams of an embodiment of the ray emitting and receiving portions, in which the former is a side sectional view and the latter a plan sectional view thereof. Referring to the figures, numeral 16 designates a cassette of the ray emitting and receiving portions 10 (refer to **Fig. 1**). Numeral 17 indicates a semiconductor photo-diode, while numeral 18 represents a condensing lens. In this case, the distance between the photo-diode 17 and the condensing lens 18 is adjusted so that a focus 20 may be located on a mirror 19, whereby reflection beam paths are made parallel lines. The inclination angle of the mirror 19 is adjusted so that a photoelectric element constituting the ray receiving portion, for example, a silicon photo-diode or phototransistor 21 may receive the reflected light rays. The photoelectric element 21 has its internal resistance rapidly changed without time delay in such way that the beam path of invisible rays 22 transmitting through the infrared ray filters 9 and reflecting upon the mirror 19 is intercepted by a hand or by an object.
Thus, a photoelectric conversion portion for the invisible rays is formed by the infrared ray emitting diode 17 and the photoelectric element 21. In the embodiment in FIGS. 1 and 2, the ray emitting portion and the ray receiving portion are closely provided at one set, and reflected rays are utilized as illustrated in FIG. 3(a). As shown in FIG. 3(b), however, the ray emitting and receiving portions can also be disposed so as to oppose each other. With either system, no difference occurs in the function and the effect of the present invention as will be stated below.

FIG. 4 is a block circuit diagram showing an embodiment of the present invention, while FIG. 5 illustrates a practical circuit arrangement thereof. In accordance with the apparatus of the embodiment in FIGS. 4 and 5, infrared rays which are emitted from a radiant element contained in a ray emitting portion 26 are irradiated on a ray receiving element contained in a ray receiving portion 27. The change in the electric resistance of the ray receiving element between a case where an obstacle, such as fingers, is inserted into the beam path between the ray receiving and emitting elements and a case where it is not inserted, is derived as a signal. A control device is actuated by the signal, to subject a circuit corresponding to an on-off control between them to be open and close a magnet coil 29. As being apparent from the block circuit diagram in FIG. 4, the control device is composed of a bistable multivibrator circuit 33 for feeding signals to the switching circuit 28, a timer circuit 32 for imparting a time limit property to one of the output signals of the multivibrator circuit 33, a trigger input circuit 36 receiving trigger input signals from the ray receiving portion 27 and the timer circuit 32, a circuit 35 for subjecting output signals of the trigger input circuit 36 to wave-form shaping, a bistable input circuit 34 receiving outputs of the waveform shaping circuit 35 and having the function of making negative pulse signals to the bistable circuit 33, and although being omitted from FIG. 4, a starting compensator circuit which serves to always set to a bistable circuit 33 in one of the stable states when a power source is made "on," etc. Further, the apparatus of the invention is provided with a power source portion 23 for supplying DC voltages to the whole control device, the ray emitting portion 26 and the ray receiving portion 27, a full-wave rectifier circuit 24, smoothing circuits 25 and 30, and a constant-voltage circuit 31.

The construction and operation of each circuit and each portion will be first described with reference to FIG. 5. The power source portion 23 comprises a transformer T which has the primary side connected to an AC power source a.c., and has the secondary side connected to the full-wave rectifier circuit 24. The full-wave rectifier circuit 24 is formed of four diodes D2 to D5. It supplies direct current to the control device, the switching circuit 28, etc., and supplies direct current to the ray emitting portion 26 which is interposed between the connection ends of the diodes D2 and D5 and an intermediate terminal of the secondary winding of the transformer T. A diode D1 and a capacitor C1 constitute a smoothing circuit which serves to remove ripples from a direct current flowing through the ray emitting portion 26. In the embodiment in FIG. 5, the switching circuit 28 employs a thyristor SCR and is constructed such that a series circuit consisting of the thyristor and a solenoid coil RY of a relay is connected across the DC output terminals of the full-wave rectifier circuit 24. When a control signal is fed to the control terminal G of the thyristor SCR, it is turned on. The solenoid coil RY is thereby rendered conductive, to close its normally-open contact a and open a magnet valve MGV. In this case, if a magnet valve adapted to be directly opened and closed by direct current is used, it is also possible that, without providing the relay coil RY and its normally-open contact a, the solenoid coil of such magnet valve is connected in series with the thyristor SCR. In the above case, a diode D3 connected in parallel with the solenoid coil RY absorbs counter electromotive force of the solenoid coil and sets switching action of the thyristor SCR is turned off without fail. Thus, the operation of the magnet valve MGV becomes reliable.

The control terminal G of the thyristor SCR is connected through a resistor R3 to the earth side, and is connected through a resistor R4 to the collector terminal of one transistor TR1 of a bistable circuit. The bistable circuit is a multivibrator constructed such that the collector terminals of a pair of transistors TR3 and TR4 are connected to the base terminals of the other transistors via resistors R4 and R5, respectively. When one transistor is in the "on" state, other transistor is in the "off" state. When a negative pulse signal is inputted to an input terminal or the common emitter terminal of the transistors TR3 and TR4, in the circuit of the embodiment, the transistor being turned "on," is turned "off," and simultaneously, the transistor having been in the "on" state then, is inverted to the "off" state. An integrated circuit can be employed for the bistable multivibrator circuit. In the general bistable circuit of this type, however, it is indefinite which transistor is turned "on" or "off" at switching on of the power source. In case where, as in the present invention, the output signals of the bistable circuit are utilized to effect the on-off control of the switching circuit 28, there is an inconvenience that the on-off state continues for any length of time in, e.g., the absence of a man occurs unless the state of the bistable circuit is such that the magnet valve is always brought into the closed state at, e.g., the switching on of the power source due to recovery of service interruption. In order to eliminate the inconvenience, a starting compensator circuit for the bistable circuit is provided in the embodiment in FIG. 5.

The starting compensator circuit is constructed in such manner that a switching transistor TR3 is connected between the base terminal of one transistor TR3 of the bistable circuit 33 and the earth, that the collector terminal of the switching transistor TR3 is connected to the (+) side of the DC power source through a resistor R4, and that the base terminal thereof is connected to the (+) side of the DC power source through a capacitor C2 and to the earth side through a parallel circuit consisting of a resistor R4 and a diode D6. With such construction, when the power source a.c. is turned on to apply a voltage across the (+) and (-) DC terminals, the DC voltage is fed through the capacitor C2 to the base terminal of the transistor TR3 and renders the transistor TR3 conductive. In consequence, one transistor TR3 of the bistable circuit 33 has its base terminal grounded through the transistor TR3 and falls into the "off" state, while the transistor TR3 falls into the "on" state. For this reason, no control signal is applied to the control terminal G of the thyristor SCR as being connected to the collector terminal of the transistor TR3.
The thyristor SCR accordingly continues the non-conductive state, to keep the magnetc valve MGV closed. Subsequently, the capacitor $C_2$ is charged in saturation after a time predetermined by the time constant between it and the resistor $R_{11}$ for example, several tens to several hundreds milliseconds. Thus, the transistor $T_{R_2}$ falls into the "off" state, and the bistable circuit 33 falls into a state under which it can conduct the inverting operation in response to arrival of an input signal. The reason why the diode $D_3$ in the reverse direction is connected in parallel with the resistor $R_{11}$ in the above starting compensator circuit is that, at service interruption or the like, the stored charge of the capacitor $C_1$ instantaneously discharged through the diode $D_3$ in subsequence to the service interruption. In this way, even if the interruption of service is recovered within the usual discharging time of the capacitor $C_1$ (i.e., the discharging time in the case where the diode $D_3$ is not comprised), e.g., within several tens to several hundreds milliseconds and the DC voltage is again applied, the transistor $T_{R_3}$ falls into the "on" state simultaneously with the voltage application, and the bistable circuit 33 is brought into the stable state under which the side of the transistor $T_{R_3}$ is cut off. Although, in the circuit arrangement of the embodiment, the starting compensator circuit has been described as being constructed of the transistor, a thyristor is similarly employable instead of the transistor.

Now, description will be made of the timer circuit 32. The timer circuit 32 is constructed as below. A time constant circuit in which a resistor $R_{4}$ and a capacitor $C_2$ are connected in series, and a voltage divider circuit in which two resistors $R_{3}$ and $R_{4}$ are connected in series are arranged in parallel. The emitter terminal A of a programmable unijunction transistor PUT is connected to the connection point between the resistor $R_{4}$ and the capacitor $C_2$ of the time constant circuit. In addition, the second base $G_3$ is connected between the resistors $R_{2}$ and $R_{4}$ of the voltage divider circuit. The first base $C_1$ is connected to the trigger input terminal of the bistable circuit 33 through a diode $D_2$ and a resistor $R_{4}$. The emitter terminal A is further connected to the collector terminal of one transistor $T_{R_3}$ of the bistable circuit 33 through a short-circuiting transistor $T_{R}$, which is arranged in parallel with the voltage divider resistor $R_{4}$. With such construction, when the transistor $T_{R_3}$ of the bistable circuit 33 is cut off, the short-circuiting transistor $T_{R_1}$ is turned on. When a pulse signal is input to the input terminal of the bistable circuit 33, the output state of the bistable circuit is inverted to turn on the transistor $T_{R_3}$, the base voltage of the short-circuiting transistor $T_{R_1}$ drops to cut off the short-circuiting transistor. The potential of the terminal A rapidly rises. Thus, charging is started for the capacitor $C_2$. When the potential of the terminal A becomes equal to that of the terminal G at the time at which a predetermined period has elapsed, the transistor PUT is rendered conductive at that time. Thus, the potential of the output terminal of the thyristor SCR hereinafter rises through the diode $D_2$, and its effect extends to the input circuit 34 of the bistable circuit 33 through the wave-form shaping circuit 35, and the bistable circuit 33 is inverted to bring the transistor $T_{R_3}$ into the cut-off state. Simultaneously, the transistor $T_{R_3}$ is turned on. Thus, the thyristor SCR and accordingly the magnet valve MGV fall into the non-conductive state, to stop the water feed. In the above case, it is further possible to make the resistor $R_{4}$ of the time constant circuit a variable one and to adjust the charging time of the capacitor $C_2$ by regulating the resistor $R_{4}$.

The wave-form shaping circuit 35 is composed of a Schmitt trigger circuit consisting of transistors $T_{R_4}$ and $T_{R_5}$, and a wave-form reversing circuit formed by a transistor $T_{R_6}$. The collector terminal of the transistor $T_{R_4}$ for the wave-form reversing circuit is connected to the common emitter terminal of the bistable circuit 33, and serves as an input terminal for inverting the bistable circuit. The Schmitt trigger circuit is a circuit having the function of shaping continuous waves into square waves, and the base terminal of the transistor $T_{R_4}$ of the circuit is connected through a resistor $R_{22}$ to the trigger input terminal 37. The potential of the trigger input terminal 37 is normally lower than the emitter potential of the transistor $T_{R_4}$. Therefore, the transistor $T_{R_4}$ is in the "off" state, the transistor $T_{R_5}$ is accordingly in the "on" state, and the transistor $T_{R_3}$ is in the "off" state. Thus, the bistable circuit 35 sustains the stable state.

The trigger input terminal 37 is at an intermediate connection point of an integrating circuit composed of a series circuit consisting of a diode $D_3$ and a capacitor $C_2$. One end of the capacitor $C_2$ being remote from the connection point is grounded. One end of the diode $D_3$ being remote from the connection point is connected to the collector terminal of the transistor $T_{R_4}$, and is connected through a resistor $R_{22}$ to the (+) side of the DC power source. The emitter terminal of the transistor $T_{R_6}$ is grounded, while the base terminal is connected through a resistor $R_{22}$ to a series circuit consisting of the ray receiving portion 27 and a resistor $R_{26}$. One end of the ray receiving portion 27 is connected to the (+) side of the DC power source, and another end is grounded through the resistor $R_{26}$.

When the circuit arrangement of the embodiment in FIG. 5 which has the foregoing construction is in a state in which infrared rays generated from the ray emitting portion 26 irradiate the ray receiving portion 27, the resistance of the photoelectric semiconductor element accommodated in the ray receiving portion 27 is low. The transistor $T_{R_4}$ is accordingly in the "on" state, so that the potential of its collector terminal and accordingly that of the trigger input terminal 37 are substantially zero. The transistor $T_{R_7}$ falls into the "off" state, the transistor $T_{R_6}$ into the "on" state, and the transistor $T_{R_3}$ into the "off" state. Thus, the bistable circuit 33 has no input signal, and is stably maintained with one transistor $T_{R_3}$ in the "on" state and the other transistor $T_{R_3}$ in the "off" state. Since the transistor $T_{R_3}$ is in the "on" state, the control signal to the control terminal of the thyristor SCR is connected to its collector terminal which is zero. Consequently, the solenoid coil $R_Y$ of the relay is non-conductive, its normally-open contact a continues the open state, and no excitation current flows through the magnet valve MGV. Therefore, the water conduit holds the water stopping state.

Under these states, interception in the other sense is carried out for the infrared ray irradiation on the ray receiving portion 27 by a hand or an obstacle. Then, the resistance of the photoelectric semiconductor element in the ray receiving portion 27 increases abruptly. For example, in case of employing a silicon photodiode element, it is easy to obtain a ratio of 1:100 in resistance between the time of the ray irradiation and the
time of the interception. In this way, the transistor TR₄ has its base potential lowered abruptly, and is cut off. The transistor TR₃ is turned on, the transistor TR₂ is turned off, and the transistor TR₁ is turned on. Due to the conduction of the transistor TR₂, a negative pulse signal is generated at its collector terminal or the common input terminal of the bistable circuit 33. The negative pulse signal inverts the "on" state the state of the transistor TR₃ having been "off" then, and into the "off" state the state of the transistor TR₄ having been "on". Due to the inversion of the transistor TR₄, from the "on" state to the "off" state, a signal "I" is applied to the control terminal G of the thyristor SCR, the solenoid coil RY is rendered conductive, its normally-open contact a is closed, the excitation current is caused to flow through the magnet valve MGV, and the water conduit is brought into the water feeding state.

When, under this state, the interception of the beam path between the ray emitting portion 26 and the ray receiving portion 27 is released to irradiate infrared rays on the ray receiving portion 27 again, the resistance of the portion 27 is returned to the original value to turn on the transistor TR₃. At the following stages, TR₃ is turned on, TR₄ is turned off, and TR₅ is turned off. Since, however, a pulse signal generated at the collector terminal of TR₃ then is a positive one, the bistable circuit 33 does not affect the inverting operation. That is to say, according to the circuit arrangement of the embodiment in FIG. 5, the magnet valve MGV having been in the water stopping state till then is brought into the water feeding state by the momentary interception of the beam path, and the water feeding state can be continued thenceforth.

On the other hand, in the bistable circuit 33 having affected the inversion operation by the momentary interception of the beam path as described above, at the same time that the transistor TR₃ falls into the "on" state due to the inversion, the short-circuiting transistor TR₆ of the timer circuit 32 is cut off, and the transistor PUT is accordingly cut off. Herein, charging is initiated for the capacitor Cₙ. When a fixed time limit determined by the resistor Rₙ and the capacitor Cₙ has elapsed, the transistor PUT is turned on. The voltage at the first base terminal C of the transistor PUT is supplied through the diode Dₕ and the resistor Rₜ to the trigger input terminal 37. Thus, the transistor TR₅ is turned on, TR₆ is turned off, and TR₇ is turned on. In consequence, a negative pulse signal is fed to the input side of the bistable circuit 33 so as to again invert the circuit to return to the original state. Namely, the transistor TR₇ returns to the "on" state, and the transistor TR₅ to the "off" state. As a result, the thyristor SCR of the switching circuit 28 becomes "off", the excitation current of the magnet valve MGV vanishes, and the water conduit falls into the water stopping state. As stated thus far, if the water feeding state is once brought by the momentary interception of the beam path, it is automatically turned into the water stopping state at the time of lapse of the fixed time limit. Therefore, even when it is forgotten to stop water, useless water feed is avoided.

When it is desired to artificially stop water before the lapse of the time limit, it is a matter of course that the water feeding state can be changed to the water stopping state similarly in such way that the ray irradiation on the ray receiving portion 27 is momentarily inter-}

cepted by a hand or an object. Since this can be easily understood from the above explanation, a repetitive detailed description is omitted.

Although, in general, the bistable circuit is uncertain as to which transistor falls into the "on" state or the "off" state when the power source is turned on, the circuit arrangement of the embodiment in FIG. 5 is provided with the starting compensator circuit with which, as has been already stated, the side of the transistor TR₃ is always brought into the cut-off state or the water stopping state is always brought forth at the switching on of the power source. The useless water feed can also be prevented in this respect.

FIG. 6 is a circuit diagram showing another embodiment of the present invention, which employs a latching relay L RY in place of the bistable circuit. The latching relay is a self-holding type relay. It has such property that when it has power supplied by applying a pulse signal thereto, the contact alternately opening or closing operation is effected, that even if the power supply is released, the contact state is self-held as it is, and that the contact state is returned to the original one by applying the next pulse signal. The holding is effected magnetically or mechanically, and either type can be employed for the circuit arrangement of the embodiment in FIG. 6. Reference numerals and characters of the respective components in FIG. 6 are the same as in FIG. 5. Herein, a indicates a normally-open contact of the latching relay L RY, and b a normally-closed contact thereof. As illustrated, the normally-open contact a is connected in series with the magnet valve MGV, and besides, connected to one terminal of the AC power source a.c. The normally-closed contact b is connected in parallel with the capacitor Cₙ of the time constant circuit of the timer circuit 32.

The Schmitt trigger circuit 35 and the circuit on the input side thereof are quite the same as in FIG. 5. The transistor TR₄ connected on the output side of the Schmitt trigger circuit 35 effects a switching action similar to that of the thyristor SCR in the case of FIG. 5, and the coil of the latching relay L RY is connected on the collector side of the transistor.

In the circuit arrangement of the embodiment in FIG. 6 having the above construction, the infrared ray irradiation on the ray receiving portion 27 is now intercepted momentarily. Then, as in the case of FIG. 5, the transistor TR₅ is turned off, the transistor TR₆ is turned on, while the transistor TR₇ is cut off. In consequence, the switching transistor TR₇ is turned on, to bring the latching relay L RY into the power-supplied state. Due to the power supply, the normally-open contact a is closed, an excitation current flows through the magnet valve MGV, and the valve is opened into the water feeding state. When the momentary interception of the beam path of the infrared rays falling on the ray receiving portion 27 is completed to recover the original irradiating state, the transistor TR₅ is brought into the "on" state. As a result, the switching transistor TR₇ is cut off, and the power supply to the latching relay L RY vanishes. As previously stated, however, the contact a is still kept closed, and the water feeding state is continued.

On the other hand, at the same time that, in the above, the momentary interception of the beam path is carried out to start the power supply to the latching relay L RY and to start water feed, the normally-closed contact b connected in parallel with the capaci-
tor \( C_2 \) of the time constant circuit of the timer circuit 32 is opened. As a result, the potential of the second base \( C \) is suddenly raised to cut off the programmable unijunction transistor PUT, and charging is initiated for the capacitor \( C_2 \). When the potential of the emitter \( E \) becomes equal to that of the second base \( G \) at the time of lapse of a predetermined period, the transistor PUT turns on at that time. As a result, the potential of the trigger input terminal 37 rises through the diode \( D_2 \), to turn on the transistor TR of the Schmitt circuit 35 and cut off the transistor TR. The switching transistor TR is accordingly turned on, to bring the latching relay \( L \) 188RY into the power-supplied state. Due to the power supply, the latching relay \( L \) 188RY has the contact operated so that the contact a may be opened to bring the magnet valve MGV into the water stopping state. Thus, also with the circuit arrangement of the embodiment in FIG. 6, useless feed water is avoided in such manner that, when a certain time limit determined by the resistor \( R_2 \) and the capacitor \( C_2 \) has elapsed, the water feeding state of the water conduit is automatically changed into the water supply stopping state. Also in the case of FIG. 6, it can be easily understood from the above explanation that, when it is desired to artificially stop water before the lapse of the time limit, the water feeding state can be changed to the water stopping state by momentarily intercepting the beam path at such time.

As having thus far been described, according to the present invention, it is also possible that, after starting water feed by the momentary interception of a beam path to a ray receiving portion and before lapse of a certain fixed time, the state of stopping water is reverted by artificially conducting the interception of the beam path. Even when, for example, the artificial interception of the beam path is forgotten, water can be automatically stopped by and at the lapse of the predetermined time. The predetermined time can be freely fixed merely by changing capacitance or resistance. It is possible to apply the device of the present invention to all kinds of faucet devices for a cookery, a washstand, etc. by simply altering the set time. Further, if the fixed time is determined in conformity with the sizes of the respective containers for a cookery, a washstand, etc., it is possible to automatically stop water when the containers fall into the filled state. In all the above aspects of use, the waste of water for use can be reduced. Accordingly, the invention is greatly effective in practical use.

The arrangement of this invention may obviously be employed to control the operation of the magnet valve 14 with any combinations of any emitting and receiving elements 26 and 27. The magnet valve 14 of this invention would operate when the resistor \( R_30 \) changes its value, and consequently many various means such as visible and invisible rays, electromagnetic waves of any wave length, X-rays, supersonic wave, etc., are possible to be used.

While this invention has been shown and described in certain particular arrangements herein, it will be understood that the equipments, features and general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An automatic electronic faucet device comprising: a fluid faucet which includes control means to open and close a fluid conduit; first means for causing a change in the electrical impedance of an electrical element in response to a controlling event; switching means responsive to said change in the electrical impedance of said element to energize said control means in response to a first occurrence of the controlling event and thereby open said fluid conduit, and to deenergize said control means in response to a second occurrence of the same controlling event and thereby close said fluid conduit; and timing means for generating a timing signal for said control means independently of said switching means after a predetermined time has elapsed after said control means has been energized, the operation of said timing means starting about simultaneously with the energization of said control means.

2. The device as set forth in claim 1, wherein said first means includes a ray-emitting element and a ray-receiving element in an operative association, said electrical impedance being the electrical resistance of said ray-receiving element and said controlling event being the interception of a beam path between said ray-emitting element and said ray-receiving element, whereupon the electrical resistance of said ray-receiving element changes in response to said interception.

3. The device as set forth in claim 2, wherein said switching means includes a pulse generating circuit for providing electrical pulse signals each time the electrical resistance of said ray-receiving element changes, and a bistable multivibrator circuit which conducts an inverting operation in response to said pulse signals from said pulse generating circuit, the on-off state of said switching means being controlled by the output signals from said bistable multivibrator circuit, said control means being controlled to be opened and closed by the output signals from said switching means, said timing means starting its operation at said time.

4. The device as set forth in claim 3, wherein said control means is a magnetically actuated valve, said pulse-generating circuit is a semiconductor circuit, and said timing means is a semiconductor timing circuit.

5. The device as set forth in claim 4, wherein said controlling event is the momentary interception of said beam path.

6. The device as set forth in claim 3, further including means for stabilizing said bistable circuit into the same state when a source of power is provided to said device.

7. The device as set forth in claim 6, wherein a base terminal of one of a pair of transistors comprising said bistable multivibrator circuit is grounded through a collector and an emitter of a third transistor, and a base terminal of said third transistor is connected to an intermediate connection point of a time constant circuit which comprises a capacitor connected in series with a parallel circuit comprising a resistor and a diode, whereby said bistable circuit is always stabilized into an identical state at switching on said power source.

8. The device as set forth in claim 1, wherein said control means is a magnetically actuated valve and wherein said switching means is connected to a latching
relay which operates to control said magnetically actuated valve to open and close said valve each time the electric impedance of said electrical element is changed.

9. An automatic electronic faucet device comprising: a fluid faucet which includes control means to open and close a fluid conduit; first means for causing a change in the electrical impedance of an electrical element in response to a controlling event; switching means responsive to said change in the electrical impedance of said element to energize said control means in response to said controlling event and thereby open said fluid conduit and to deenergize said control means in response to a second controlling event; timing means for generating a timing signal for said control means independently of said switching means after a predetermined time has elapsed after said control means has been energized, the operation of said timing means starting about simultaneously with the energization of said control means; a source of DC power; and said timing means includes a semiconductor timing circuit comprising a time constant circuit including a capacitor and a resistor connected in series, a voltage divider circuit in which at least two resistors are connected in series, and said time constant circuit and said voltage divider circuit being connected in parallel across said DC power source, and a unijunction transistor including an emitter terminal operatively connected to an intermediate connection point of said time constant circuit, and a second base terminal connected to an intermediate connection point of said voltage divider circuit, one of said resistors of said voltage divider circuit being adapted to be short-circuited whereby said timing signal is generated from a first base terminal of said unijunction transistor by the shortcircuit when the predetermined time set by said time constant circuit has elapsed.

10. An automatic electronic faucet device comprising: a fluid faucet which includes control means to open and close a fluid conduit; first means for causing a change in the electrical impedance of an electrical element in response to a controlling event; switching means responsive to said change in the electrical impedance of said element to energize said control means in response to said controlling event and thereby open said fluid conduit and to deenergize said control means in response to a second controlling event; timing means for generating a timing signal for said control means independently of said switching means after a predetermined time has elapsed after said control means has been energized, the operation of said timing means starting about simultaneously with the energization of said control means; and a source of DC power, wherein said timing means includes a semiconductor switching circuit comprising a parallel circuit which includes a relay coil for controlling said control means comprising a magnetically actuated valve, a diode in the circuit with said coil, and a thyristor connected in series with said parallel circuit, the series circuit being connected across said source.

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