March 12, 1946. J. D. WILLIAMS, JR 2,396,308

TIMING SYSTEM FOR ICE MAKING APPARATUS

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Fig. 1.

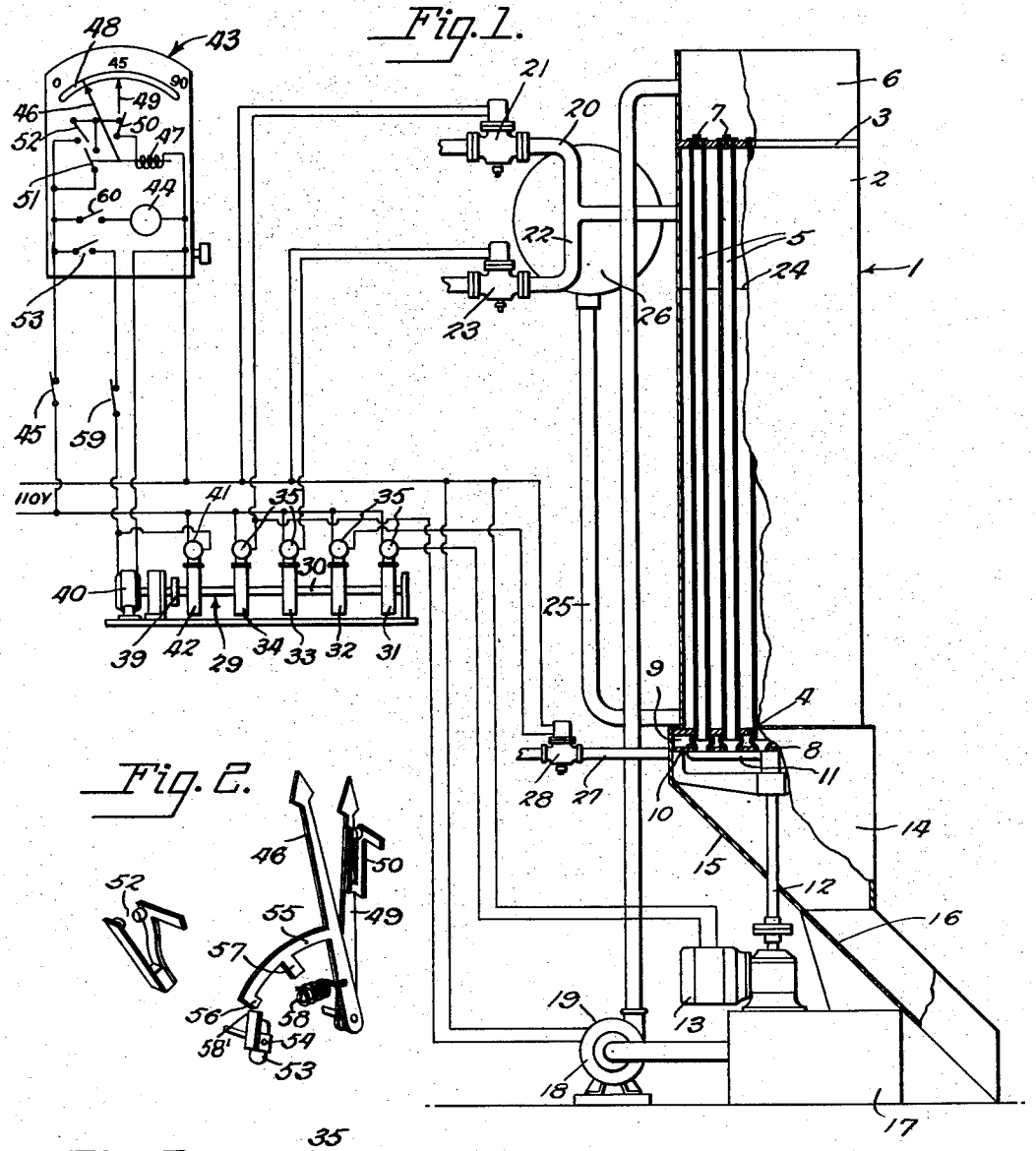
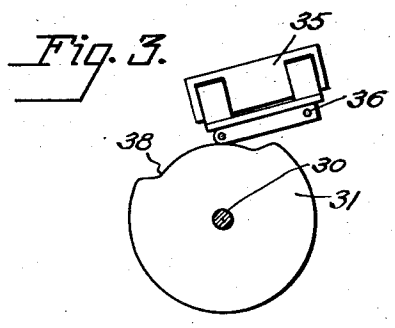


Fig. 2.

Fig. 3.



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TIMING SYSTEM FOR ICE MAKING APPARATUS

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9 Claims. (Cl. 62—4)

This invention relates to the variable timing of the freezing periods in an ice machine of the type in which the duration of the automatically repeated cycles of operation of the ice machine is the sum of an evacuation period of constant length, and a freezing period.

The invention comprises a timing system employing correlated instrumentalities particularly adapted for the control of the freezing and evacuation phases of a tube ice machine such as is described in the patent to Kubaugh, No. 2,239,234, granted April 22, 1941. In this machine, the product ice may be of relatively thick cylindrical dimensions, or a thin cylindrical shell which shatters into "crushed" ice when sized, the character of the ice depending upon the length of the freezing period.

One of the objects of the present invention is the provision of a rotary controller operated by a constant speed motor for controlling the operation and sequence of operation of the instrumentalities involved in the evacuating and freezing phase of the recurrent cycles of operation of the ice machine, said motor being operated periodically, the running periods of said motor being of equal length and effecting the evacuation function of said controller, the alternate inactive periods of said motor and controller effecting and being concurrent with the freezing phase of the ice machine, and a timer control switch closing the motor circuit at the beginning of repeated intervals of equal duration, the length of which intervals is the sum of the evacuation and freezing periods of the ice machine, with means for adjusting the timer control switch to change the duration of the intervals between successive closures of the motor circuit whereby the length of the freezing period may be changed.

Another object of the invention is the provision of respective starting and holding circuits for the constant speed controller motor, the starting circuit including the timer control switch and the holding circuit being controlled by a switch which operates responsive to the movement of the controller itself, in which the starting switch is operated from a motor of the type which is synchronized with the A. C. pulsations and which acts through the intermediary of a spring retracted arm drawn away from said switch by said motor and momentarily released therefrom to close said switch by an impact blow, the purpose being to relieve the motor from carrying the load of the switch and which again picks up said arm as soon as the blow has been struck. Since the controller motor operates the controller very slowly through gear reduction, it may be some little time before the switch of the holding circuit is closed so that in order to ensure maintaining the starting circuit closed until the holding circuit has become closed, it is the object of the invention to provide a starting switch of the delayed-opening type.

As the controller, when operated, causes an evacuation phase of the cycle of operation of the ice machine to take place prior to a freezing phase, it is an object of the invention to provide a manual switch in the starting motor circuit which is kept open when the operation of the device is initiated until after the delayed action switch has opened, so that the starting motor circuit is not closed during the initial timing movement of the timer, and the controller consequently does not produce an evacuating operation of the ice machine, the several instrumentalities of the ice machine being in freezing phase during this entire interval, to be succeeded by an evacuation phase at the beginning of the next timing movement of the timer, at which time the manual switch is left closed.

Other objects of the invention will appear as the following description of a preferred and practical embodiment thereof proceeds.

In the drawing which accompanies and forms a part of the following specification and throughout the several figures of which the same reference characters have been employed to designate identical parts:

Figure 1 is a view largely diagrammatic and partly in section, showing a single unit tube ice machine to which the present invention is particularly adapted under the control of a timing system embodying the principles of the subject invention;

Figure 2 is a view in perspective, showing several switch elements of the timer in approximately operative relations;

Figure 3 is a cross-section through the shaft of the controller, showing one of the cams with the tilting mercury switch controlled thereby, which is essentially any one of the associated cams and switches constituting the controller.

Referring now in detail to the several figures, the numeral 1 represents as a whole a tube ice machine including a shell 2 having the upper and lower headers 3 and 4 and the bundle of spaced parallel longitudinally extending tubes 5 which open in the upper face of the top header 3 and project a short distance through the bottom header 4. Above the upper header 3 the shell 2 forms a water box 6 for supplying water dis-

tributively to the tubes 5 through nozzles 7 individual to the tubes, so constructed as to direct the water along the inner surfaces of said tubes. Below the bottom header 4 is a transverse partition 8 defining with the header 4 a chamber 9 for thawing water. The thawing water discharges from said chamber through nozzles 10, which surround the lower projecting ends of the tubes 5, and which open through the partition 8.

Beneath the partition 8 is a rotary cutter 11 mounted at the upper end of a shaft 12 driven by the cutter motor 13. The cutter 11 is surrounded by a hopper 14, the lower wall 15 of which is inclined, constituting a discharge chute. An intermediate part 16 of said chute is perforated. This perforated part is above a water receiving tank 17. A pump 18 has its induction end in communication with the water chamber 17 and its eduction end communicating with the water box 6. The pump 18 is driven by a motor 19.

The shell is in alternative communication with the suction side of a compressor by means of the conduit 20 controlled by a normally closed solenoid opened valve 21, and with the hot refrigerant gas under pressure from the condenser by means of the conduit 22 controlled by the normally closed solenoid opened valve 23.

The shell 2, during the freezing phase of the machine, is filled with liquid refrigerant up to the level indicated by the reference character 24. The bottom of the shell is in communication by way of the conduit 25 with a liquid refrigerant receiver 26 externally of the shell, and the thaw water chamber 9 is supplied with water from the conduit 27 controlled by a normally closed solenoid opened valve 28.

During the freezing phase the valve 28 is closed so that no thaw water is supplied to the chamber 9. The cutter is inoperative. The hot gas valve 23 is closed. The pump 18 is operating, drawing water from the tank 17, discharging it into the water box 6, from which it flows through the tubes 5 against the inner surfaces of said tubes and is discharged into the hopper 14 through the perforated portion of the chute 15, back into the tank 17. A surface film of water is frozen against the inner surfaces of the tubes 5 which grows thicker as the freezing period is prolonged. When the ice tube is of sufficient thickness, the pump 18 is stopped, discontinuing the flow of water to the water box 6. The suction valve 21 is closed and the hot gas valve 23 is opened. The thaw water valve 28 is also opened and the cutter motor 13 started. Now begins the evacuation phase of the ice machine. Hot gas under pressure enters the shell 2 and displaces the liquid refrigerant which passes through the conduit 25 into the receiver 26. The hot gas thaws the surface film of tube ice within those portions of the tubes 5 which are within the shell 2, and the thaw water melts the surface of said tube ice in those portions of the tubes which project below the header 4. The ice tubes thus freed from the tubes 5 descend gravitationally into the path of the cutter 11 where if the ice tubes are frozen substantially solid they are cut into cylindrical pieces of sized length, while if the ice tubes are in the form of thin shells, they are shattered by the cutter into "crushed" ice. The sized cylindrical pieces or the crushed ice, as the case may be, are discharged down the chute 14, the thaw water passing through the perforated portion 16 of said chute into the tank 17. When the ice tubes for their entire length have passed through the cutter, the evacuation phase is ended. The valve 23 is closed, cutting off the hot gas. The suction valve 21 is opened, suction drawing liquid refrigerant from the receiver 26, through the conduit 25, and refilling the shell 2 with liquid refrigerant up to the desired level which is float controlled by means not shown. The water pump 18 is started and the thaw water cut off. Under these conditions the freezing phase is repeated.

In the illustrative embodiment of the invention the functioning of the several instrumentalities which coordinately participate to produce the alternate evacuation and freezing phases of the ice making apparatus is governed by a controller 29 consisting of a shaft 30 carrying a series of fixed cams 31, 32, 33 and 34, each of which is associated with a switch 35, preferably of the tiltable mercury type in a circuit including the device or devices controlled by said cams. Figure 3 shows one cam and associated switch and is illustrative of all. The switch 35 is pivoted at 36 and has a roller resting upon the peripheral surface of the cam. Said cam has a notch 38. When the roller descends into the notch the switch tilts in one direction; when it rises from the notch the switch tilts in the opposite direction. Thus, the circuit or circuits controlled by the cam is opened or closed. The cams are so displaced on the shaft 30, and the lengths of the respective notches are such, as to break or close the several circuits in the proper order and duration to produce the result desired.

The cam 31 starts and stops the cutter motor 13.

The cam 32 controls the circuit of the solenoid of the thaw water valve 28.

The cam 33 controls the circuit of the solenoid of the hot gaseous refrigerant valve 23.

The cam 34 starts and stops the water pump motor 19 and also controls the circuit of the solenoid which opens the suction valve 21.

The controller 29 is driven through reduction gears 39, by a constant speed motor 40, preferably of the shaded pole type. The motor 40 runs periodically, rotating the controller through one complete revolution, and then stops, the controller effecting one complete evacuation phase at each revolution, and leaving the several instrumentalities governed thereby in their freezing phase relation when the controller stops. They remain in this relation until the controller motor is again started.

The controller motor is in two parallel circuits. It is started by the closing of a starting circuit, as will be presently explained. Its operation is continued by a holding circuit, including the mercury switch 41 tilted to closed or open position by the cam 42 on the shaft 30. This last named cam and mercury switch may be similar to the cam and switch assembly shown in Figure 3. The controller motor is stopped through the breaking of the holding circuit by the dropping of the switch into the notch of the cam 42. The controller motor is of the conventional type having a brake for immediately dampening the momentum of the motor when the motor circuit is broken. Consequently, the controller always stops in precisely the same angular position.

Repetitive operation of the tube ice machine is accomplished by a timer control switch of known commercial type, diagrammatically illustrated at 43 in Figure 1, and which starts the motor 40 at timed periods.

The timer control switch consists in its essentials of the following elements:

A motor 44 in circuit with the A. C. service lines

and running continuously unless cut off by the opening of the manual switch **45**;

A pointer **46** which is also a switch actuator and which is clutch-connected to the motor **44**;

A solenoid **47** which when energized engages the clutch;

A scale **48** with minute markings;

A pivoted index **49** with adjusting means for setting it at any point on the scale;

A self-closing time limit switch **50** carried by said index;

A switch **51** closed by said solenoid when energized, said switch and said time limit switch being in series circuit with said solenoid;

A self-opening switch **52** in a shunt circuit about the solenoid operated switch;

Manual switches **45** and **60**, by means of which the solenoid circuit and the circuit of motor **44** may be opened or closed.

The pointer **46** oscillates in immediately recurring periods through an amplitude from zero on the scale to the scale point at which the index **49** is set. When at its zero limit, it mechanically closes the normally open shunt switch **52**. When at its opposite limit, it mechanically opens the time limit switch **50**. The pointer is spring-biased in the zero direction.

The timer control switch operates as follows: Before the manual switch **45** is closed, the motor **44** is not running, the time limit switch **50** is closed, the solenoid **47** de-energized, the pointer **46** de-clutched from the motor, the switch **51** open, and the shunt switch **52** closed by said pointer.

Upon the manual switches **45** and **60** being closed, the motor **44** begins to run, and a circuit is closed through the shunt switch, time limit switch and solenoid. The energized solenoid connects the clutch and closes switch **51**. The pointer begins to climb upward along the scale synchronous with the movement of the motor. As soon as the pointer leaves zero position, the shunt switch **52** opens, but since the switch **51** has closed, the solenoid circuit remains unbroken. When the pointer reaches the index, it opens the time limit switch **50**, de-energizing the solenoid, de-clutching the pointer, which immediately falls to zero under the urge of the spring **58**. The shunt switch **52** is again closed by the pointer and the timing cycle begins to repeat. Opening of the time limit switch does not affect the motor **44**, which runs continuously unless the manual switches **45** and **60** are opened.

In the ordinary use of this known timer, as described, the circuit of the device or apparatus to be controlled by the timer is connected into the circuit of the shunt switch **52** at such point as to be controlled by said shunt switch so that each time the pointer falls to zero and closes the shunt switch, a timing impulse is given to the controlled device. Since the pause of the pointer at zero position is but momentary, the shunt switch opens immediately after closing. For this reason it would be impractical to control the starting circuit of the controller motor **40** by the shunt switch, for it requires some little time for the controller to turn through a sufficient angle to close its holding circuit, and the momentary closing of the starting circuit would cause the controller motor to stop before the holding circuit is closed.

The present invention, therefore, provides a delayed opening switch **53** in series with the service lines and the starting circuit of the controller motor **40**. This switch is positioned to be closed mechanically by the pointer **46** as the latter drops to zero position, and which remains closed after the pointer leaves zero position on its upward climb, a sufficient length of time to permit the controller motor to turn the controller through a sufficient angle to close the switch **41** of the holding circuit. Said delayed opening switch, as shown in Figure 2, is of the tilting mercury type mechanically actuated by the pointer **46**. The switch mechanism shown is illustrative of equivalents which may be employed within the purview of the invention. The switch **53** is pivoted at **54**, being shown in full lines in open circuit position and in broken lines in closed circuit position. The pointer **46** carries an arm **55** having spaced short and long lugs **56** and **57**, respectively. The tilting switch **53** has a nose **58'** and the switch is so mounted with respect to the path of movement of the arm **55** that when in open position the nose is cleared by the short lug, while when in closed position the nose is engaged by the short lug which meanwhile has overridden the nose on the zeroward movement of the pointer and is on the far side of the nose. The switch is tilted to closed position by the engagement of the long lug **57** with the nose **58'**, and tilted to open position by the pulling of the short lug upon the nose as the pointer moves in the opposite direction. The space between the lugs gives the delayed opening action to the switch.

By the time the switch has moved to open position, the controller has turned sufficiently to close the holding circuit and the controller motor continues to operate until it is stopped at the end of one revolution of the controller through the opening of the holding circuit switch by the controller.

Since the duration of the freezing phase of the tube ice machine is the interval between successive running periods of the controller motor, and the time of the beginning of the successive running periods is the duration of travel of the pointer **46** between zero position and the position of the time limit switch **50**, it follows that the scale interval in minutes from zero to the adjusted position of the index is equal to the evacuation phase of the ice machine (the time of one revolution of the controller) plus the freezing phase, and as the evacuation period is constant, adjustment of the index varies the freezing period.

The freezing period for producing "shell" or "crushed" ice may, for example, be 13 minutes. For thick cylindrical "sized" ice it may be 60 minutes. To provide "crushed" ice, therefore, the operator adjusts the index to a scale figure representing the constant evacuation period, which for example, may be 5 minutes, plus 13 minutes, or at the 18 minute figure on the scale. For a 60 minute freezing period he will set the index at the 65 minute mark. Until the adjustment is changed, the timer will conduct the ice machine through a series of cycles having the same length of freezing period and producing the same type of ice.

It is obvious that when the apparatus is initially started after a period of inactivity, the timing control system would, in the absence of preventive means, cause an evacuation before any ice has been frozen. To prevent this, a manual switch **59** is provided in the starting circuit of the controller motor **40**, which is left open when initially starting the timer until after the delayed opening switch has opened, and then closed during the first climb of the pointer **46** toward the index. The controller will thus not be operated during

the first timing interval, and the entire interval will be a freezing period.

It will be understood from the above description, to those skilled in the art, that I have produced a system of timed control for ice making apparatus, and particularly a tube ice machine of the type disclosed, whereby repetitive cycles of evacuation and identical freezing conditions are determined and maintained and successive batches of ice pieces continuously produced having identical characteristics of size or state of comminution for a selected timing adjustment, and that by a simple change in the adjustment of the timer, without interrupting the sequential automatic operation of the apparatus, the length of the freezing period may be changed and the character of the ice product may thus be varied at will.

While I have in the above description disclosed what I believe to be a preferred and practical embodiment of the invention, it will be understood to those skilled in the art that the specific details of construction and arrangement of parts is by way of example and not to be construed as limiting the scope of the invention defined in the appended claims.

What I claim as my invention is:

1. In combination, a periodically operated constant speed motor, a controller comprising a shaft operated by said motor through speed reduction means, cams on said shaft, switches operated by said cams, circuits controlled by said switches for controlling the operation of devices whose correlative state of action or inaction determines the respective freezing and evacuation phases of an ice making apparatus, the positions of said cams when said controller is stationary corresponding to the freezing phase, and when rotating, to the evacuation phase of said apparatus, a starting circuit and a holding circuit for said motor, an additional cam on said shaft and a switch operated thereby, closing said holding circuit after said motor begins to run and opening said holding circuit after said motor has run through the period of an evacuation phase, to stop said motor, a delayed-opening switch controlling said starting circuit, and a continuously operating timer having an element movable in immediately recurring periods of timed amplitude, momentarily engaging and closing said delayed-opening switch at the beginning of each timed period to effect immediate operation of said motor.

2. In combination, a periodically operated constant speed motor, a controller comprising a shaft operated by said motor through speed reduction means, cams on said shaft, switches operated by said cams, circuits controlled by said switches for controlling the operation of devices whose correlative state of action or inaction determines the respective freezing and evacuation functions of an ice making apparatus, the position of said switches when said controller is stationery corresponding to the freezing phase, and when rotating, to the evacuation phase of said apparatus, a starting circuit and a holding circuit for said motor, an additional cam on said shaft and a switch operated thereby, closing said holding circuit after said motor begins to run and opening said holding circuit after said motor has run through the period of an evacuation phase, to stop said motor, a delayed-opening switch controlling said starting circuit, a continuously operating timer having an element movable in immediately recurring periods of timed amplitude, momentarily engaging and closing said delayed-opening switch at the beginning of each timed period to effect immediate operation of said motor, and a manual switch in said starting circuit designed to be opened when initially starting said timer until after the delayed-opening switch has opened to prevent the operation of said motor prior to the initial freezing phase of said apparatus.

3. In combination, a periodically operated constant speed motor, switches closing and opening responsive to the rotation of said motor and an ice making machine having a freezing phase followed by an evacuation phase in which those instrumentalities which cooperate in the freezing phase are electrically controlled by certain positions of said switches assumed and maintained substantially throughout the operative periods of said motor, and those instrumentalities which cooperate in the evacuation phase are controlled through certain positions of said switches assumed at the end of the operative periods of said motor and maintained throughout the rest periods of said motor, a starting circuit and a holding circuit for said motor, a switch responsive to the movement of said motor for sequentially closing said holding circuit in the early part of the period of rotation of said motor and opening said holding circuit at the end of the period of rotation of said motor, to stop the motor, a normally open delayed-opening switch in said starting circuit maintaining said starting circuit closed until said holding circuit switch closes, and means for periodically momentarily engaging and closing said delayed-opening switch between equal time intervals, the length of which interval is greater than the period of rotation of said motor.

4. In combination, a periodically operated constant speed motor, switches closing and opening responsive to the rotation of said motor and an ice making machine having a freezing phase followed by an evacuating phase in which those instrumentalities which cooperate in the freezing phase are electrically controlled by certain positions of said switches assumed and maintained substantially throughout the operative periods of said motor, and those instrumentalities which cooperate in the evacuation phase are controlled through certain positions of said switches assumed at the end of the operative periods of said motor and maintained throughout the rest periods of said motor, a starting circuit and a holding circuit for said motor, a switch responsive to the movement of said motor for sequentially closing said holding circuit in the early part of the period of rotation of said motor and opening said holding circuit at the end of the period of rotation of said motor, to stop the motor, a normally open delayed-opening switch in said starting circuit maintaining said starting circuit closed until said holding circuit switch closes, means for periodically momentarily engaging and closing said delayed-opening switch between equal time intervals, the length of which interval is greater than the period of rotation of said motor, and means for adjustably varying the length of the time intervals between actuations of said delayed-opening switch, with the length of the running period of said motor as the minimum limit.

5. In combination, a periodically operated constant speed motor, switches closed and opened responsive to the rotation of said motor and an ice making machine having a freezing phase followed by an evacuation phase in which those instrumentalities which cooperate in the freezing phase are electrically controlled through the

closed and open positions of certain of said switches assumed and maintained substantially throughout the operative periods of said motor, and those instrumentalities which cooperate in the evacuation phase are controlled through the closed or open positions of said switches assumed at the end of the operative periods of said motor and maintained throughout the rest periods of said motor, a starting circuit and a holding circuit for said motor, a switch responsive to the movement of said motor for sequentially closing said holding circuit in the early part of the period of rotation of said motor and opening said holding circuit at the end of the period of rotation of said motor, to stop said motor, a normally opened delayed-opening switch in said starting circuit maintaining said starting circuit closed until said holding circuit switch closes, a timing motor in an alternating circuit operating synchronously with the A. C. impulses, and an arm oscillating in immediately succeeding periods movable with said motor in one direction from repose position, and spring returned in the opposite direction momentarily released from said motor for engaging and closing said delayed-opening switch adjacent its repose position at determined time intervals the length of which interval is greater than the period of rotation of said motor.

6. In combination, a periodically operated constant speed motor, switches closed and opened responsive to the rotation of said motor and an ice making machine having a freezing phase followed by an evacuation phase in which those instrumentalities which cooperate in the freezing phase are electrically controlled through the closed and opened positions of certain of said switches assumed and maintained substantially throughout the operative periods of said motor, and those instrumentalities which cooperate in the evacuation phase are controlled through the closed and open positions of said switches assumed at the end of the operative periods of said motor and maintained throughout the rest periods of said motor, a starting circuit and a holding circuit for said motor, a switch responsive to the movement of said motor for sequentially closing said holding circuit in the early part of the period of rotation of said motor and opening said holding circuit at the end of the period of rotation of said motor, to stop said motor, a normally open delayed-opening switch in said starting circuit maintaining said starting circuit closed until said holding circuit switch closes, a timing motor in an A. C. circuit operating synchronously with the A. C. impulses, an arm oscillating in immediately succeeding periods electrically clutched to said motor to move therewith in one direction from repose position and spring returned in the opposite direction for momentarily engaging and closing said delayed-opening switch adjacent its repose position at determined time intervals the length of which interval is greater than the period of rotation of said motor, an adjustably positioned limit switch engaged by said arm in its movement from repose position to de-clutch said arm, and another switch engaged by said arm adjacent repose position for re-clutching said arm to said motor.

7. Time responsive controller for causing the repeated performance of a two-phase operation, comprising a constant speed, periodically operating motor, instrumentalities actuated thereby for performing one phase substantially concurrently with the running periods of said motor and the other phase substantially concurrently with the rest periods of said motor, the latter being in a holding circuit including a switch which operates responsive to rotation of said motor, closing in the early part of its period of rotation, and opening at the end of said period of rotation to stop the motor, said motor being also in a starting circuit including a normally open delayed-opening switch the closing of which starts the motor, the delay in said switch being arranged to extend until the holding circuit switch closes, and a movable timer element momentarily closing said delayed-opening switch between equal time intervals, the length of which interval is greater than the period of rotation of said motor.

8. Time responsive controller for causing the performance of a two-phase operation, comprising a constant speed, periodically operating motor, a shaft driven thereby through gear reduction, a switch actuating element on said shaft, a switch actuated by said element having an open and closed position, said switch being in a circuit the active and inactive periods of which are instrumental in the performance of the respective phases of operation, said switch being actuated to assume one position during the early part of the period of rotation of said shaft and to assume the other position near the end of the period of rotation of said shaft, said motor being in a holding circuit including a switch which operates responsive to rotation of said motor, closing in the early part of its period of rotation, and opening at the end of said period of rotation, to stop the motor, said motor being also in a starting circuit including a normally open delayed-opening switch, the closing of which starts the motor, the delay in said switch being arranged to extend until the holding circuit switch closes, and a movable timer element momentarily closing said delayed-opening switch between equal time intervals, the length of which interval is greater than the period of rotation of said motor.

9. Time responsive controller for causing the repeated performance of a two-phase operation, comprising a constant speed, periodically operating motor, instrumentalities actuated thereby for performing one phase substantially concurrently with the running periods of said motor and the other phase substantially concurrently with the rest periods of said motor, the latter being in a holding circuit including a switch which operates responsive to rotation of said motor, closing in the earily part of its period of rotation, and opening at the end of said period of rotation to stop the motor, said motor being also in a starting circuit including a normally open delayed-opening switch the closing of which starts the motor, the delay in said switch being arranged to extend until the holding circuit switch closes, a movable timer element momentarily closing said delayed-opening switch between equal time intervals, the length of which interval is greater than the period of rotation of said motor, and means for adjustably varying the length of the time intervals between actuations of said delayed-opening switch, with the length of the running period of said motor as a minimum limit, whereby the phase of operation concurrent with the rest periods of the motor may be varied, the other phase of operation remaining constant.

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