Dec. 26, 1967 E. A. KOLM 3,360,777

PULSE RECEIVER RESPONSIVE TO PLURAL CODE GROUPS HAVING PREDETERMINED TIME SEPARATION

Filed July 16, 1964 2 Sheets-Sheet 1

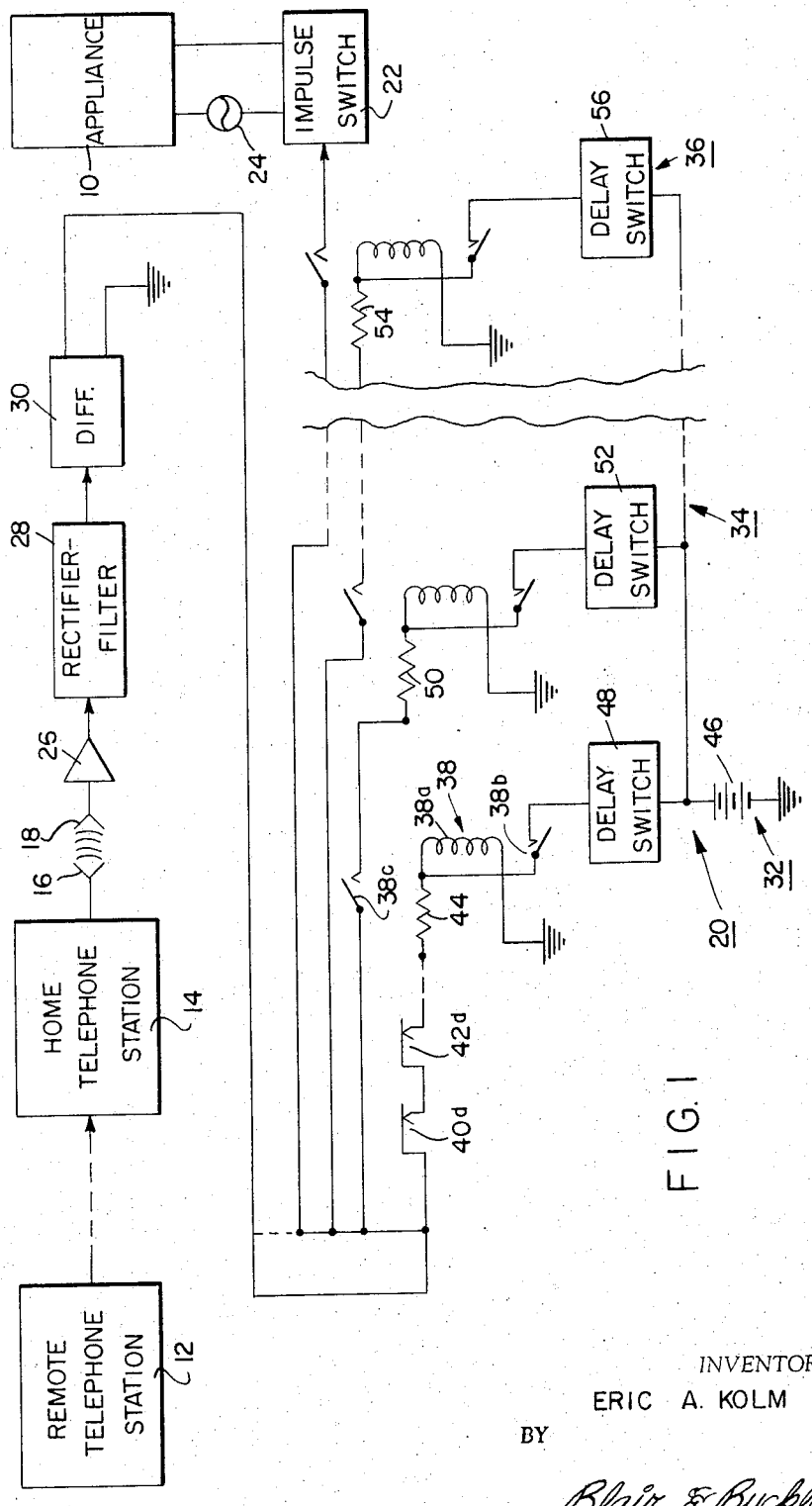

FIG. 1

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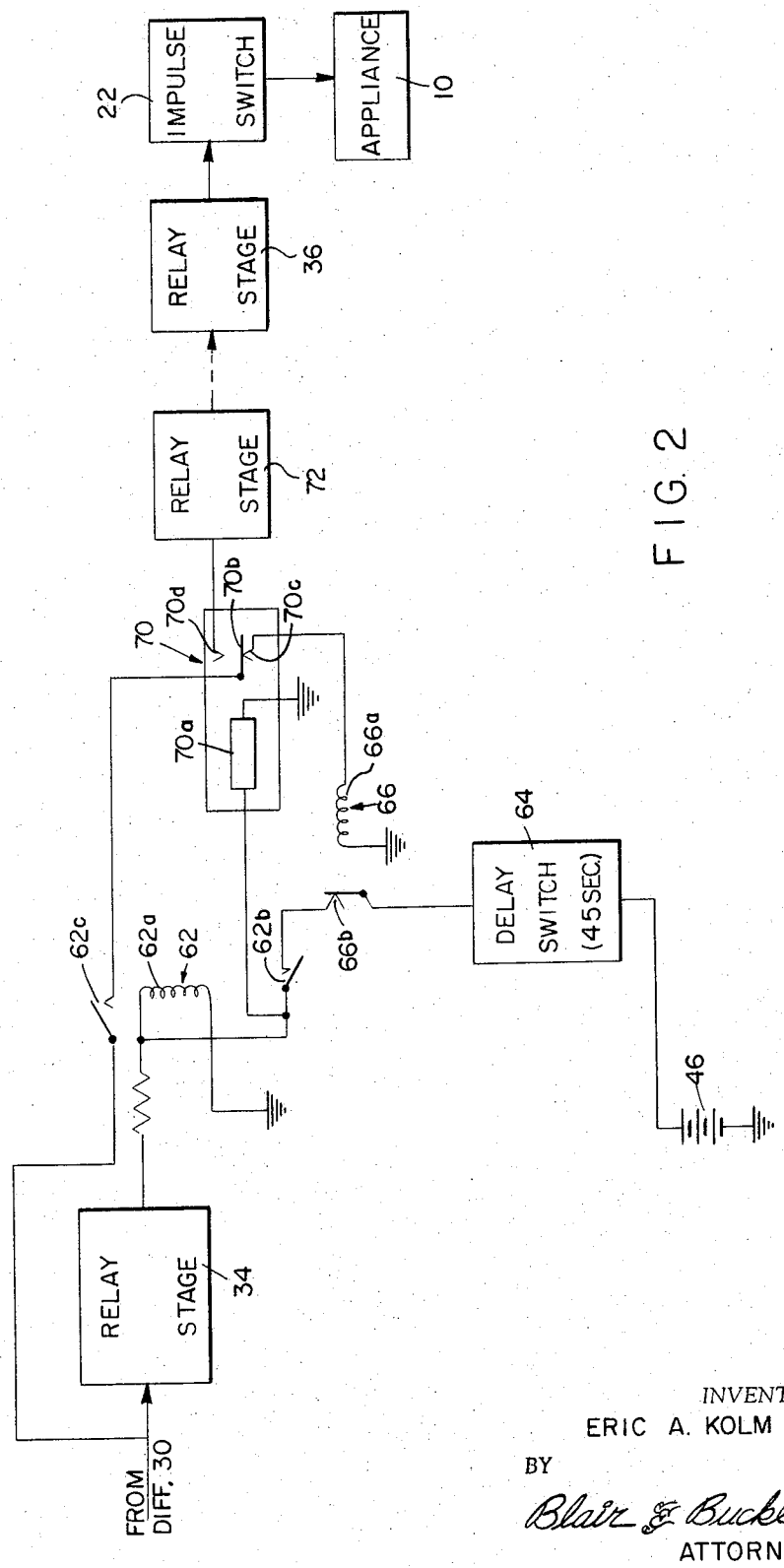

FIG. 2

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PULSE RECEIVER RESPONSIVE TO PLURAL CODE GROUPS HAVING PREDETERMINED TIME SEPARATION

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4 Claims. (Cl. 340—164)

This invention relates to a sonic switch. More specifically, it relates to a switch which may be closed or opened in response to a predetermined sequence of audible signals. The invention is particularly directed to remote operation of electrical devices, such as household appliances, controllable by means of switches or like components.

Remote control systems for such devices may be generally classified into two types, namely wired and wireless systems. The wired systems have the obvious disadvantage of relative inflexibility with regard to change of position of either the controlled device or the source of the control signals. Also, most wired systems are impractical for use over long distances. On the other hand, wireless systems, which use radio or acoustic control signals, are much more flexible with regard to location of the components. However, control from long distances by means of a radio system is impractical in most cases; and it is impossible if a strictly acoustical system is contemplated.

An object of the present invention is to provide a system for remote control of electrically operable devices.

Another object of the invention is to provide a remote control system which is practical for use with household appliances.

Another object is to provide a system of the above type which is operable from various locations far removed from the controlled devices.

A further object of the invention is to provide a system of the above type which is highly flexible in that it does not require the user to transport equipment from one control location to another.

Yet another object of the invention is to provide a remote control system of the above type which is relatively unaffected by spurious signals in the frequency range of the control signals.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic diagram of a remote control system incorporating the invention; and

FIG. 2 is a schematic diagram of a second embodiment of the invention.

In general, the present invention employs a sonic system in which a timed sequence of sounds or soundlike signals actuate a switch to turn on or off the controlled device. For control from a distant location, the telephone system serves to transmit the signals used by the sonically actuated switching network.

More specifically, in the preferred form of the invention a series of relay stages are cascaded between the signal source and the controlled device. The first of these stages is actuated by a first signal from the source and in response thereto, it connects the second stage to the source. The next signal in turn causes the second stage to connect the third stage to the source. When all the stages have been

successively actuated by a series of input signals, the next signal actuates a final stage which connects a power source to the controlled appliance. This final stage is preferably an impulse type relay having two positions, i.e., an "on" position and "off" position. Thus, the first signal reaching this relay turns the appliance on; later the appliance may be turned off by means of another succession of signals, the last one of which actuates the impulse relay.

In order to lessen the danger of operation of the system by spurious signals, each of the relays in the cascaded chain is held, after actuation, by a holding circuit including a time delay element. After a short period of time this delay element releases the relay. Thus, if a further signal is not received within a short period of time after the actuation of a relay in the chain, the consequent release of the relay will open the connection between the signal source and the next relay in the chain, thereby preventing actuation of the latter relay by the next signal. In effect, this resets the entire system and the sequence of signals must be begun again in order to carry a signal through to the end of the relay chain.

The remote control system may be arranged to accept sound signals associated with the human voice. Thus, spoken commands may be used. For example, one using the system may audibly count at a given rate until the number corresponding with the required number of signals is reached.

For operation from a distant location the remote control system may incorporate the telephone network, generally in either one or two modes. In one such mode, the user employs a telephone answering device which may take the form of any of a number of suitable automatic telephone answering devices presently available. The answering device responds to a telephone call by coupling the telephone line to a signal pickup element associated with the relay chain. At the other end of the telephone line, i.e., remote from the user's home substation, the user then utters the required operating signals, to which the relay chain responds in the manner described above.

In another arrangement associated with the telephone network, the relay chain is arranged to respond to the ringing signals. The user dials his home number and a predetermined number of rings accepted by the relay chain results in operation of the controlled device. In order to prevent operation by spurious signals, caused by others who might dial the user's telephone number, a lockout arrangement may be employed which requires the user to dial his number, wait a predetermined number of rings and then hang up and dial again, in order for the ringing signals to be processed through to the end of the relay chain.

FIG. 1 illustrates the operation of the invention in controlling an appliance **10** in the user's home from a remote telephone station **12**. The user dials his home telephone number and the telephone exchange connects the remote station **12** to the telephone station **14** in his home. In the illustrated arrangement the station **14** includes, in addition to a conventional telephone instrument, an automatic telephone answering device. The answering device, either by means of a direct connection to the telephone line or by removing the telephone hand set from its cradle, responds to an incoming ringing signal by connecting the telephone line to apparatus able to "hold" the line and receive subsequent messages or signals transmitted thereover. These signals or messages in turn are passed to an electro-acoustical transducer **16**.

The transducer **16** may, illustratively, be the receiver incorporated in the telephone handset, in which case the answering device is of the type which removes the hand set from its cradle in response to an incoming signal.

The transducer **16** emits acoustical signals which are picked up by a second transducer **18** in close proximity

thereto and reconverted into electrical signals. These signals are processed by a relay chain, generally indicated at **20**, which operates in the manner similar to that of a counter. Thus, when a predetermined number of such signals have been processed by the chain **20**, an output signal therefrom is applied to an impulse switch **22** which connects the appliance **10** to a power source **24**, or alternatively disconnects it therefrom.

More specifically, the signals from the transducer **18** are amplified by an amplifier **26** whose output is rectified by a rectifier-filter **28**. The amplifier **26** preferably has a pass band limited to the fundamental frequencies ordinarily produced by the human voice, so as to limit the spurious signal energy passed to the rectifier-filter. Also it preferably has a high gain together with amplitude clipping, thereby providing an output whose amplitude is fairly independent of the amplitude of the input signals from the transducer **18**.

The rectifier-filter **28** converts the output of the amplifier **26** to a direct-current signal and applies an averaging or smoothing action to this signal. This lessens the probability of noise within the pass band of the amplifier **26** having an appreciable effect on the output of the rectifier-filter.

Next, the signal is passed through a differentiator **30**, which provides an output in response to changes in the output level from the rectifier-filter **28**. This prevents sustained sounds from being acted upon by the system. That is, the differentiator **30** emits an output signal only when there is a change in the level applied to the transducer **18**. With high gain and clipping in the amplifier **26** as described above, this means that there must be virtually a complete cessation and then a re-introduction of the audio level at the transducer **18** for the differentiator **30** to provide an output. Preferably, the differentiator includes a diode arrangement in its output which permits output signals of only one polarity to be passed to the relay chain **20**. Thus, there is a single output pulse from the differentiator **30** for every burst of audio signal passing from the transducer **16** to the transducer **18**.

The relay chain **20** includes a plurality of relay stages **32**, **34** . . . **36** employing relays **38**, **40** . . . **42**. The stage **32**, which is the first stage in the chain, receives the first of a series of input signals from the differentiator **30** and succeeding signals are applied in order to the successive stages, until the final stage **36** has been actuated. The next following signal actuates the impulse switch **22** to turn on or off the appliance **10**.

That is, the first of a series of operating signals from the differentiator **30** is applied to the coil **38***a* of the relay **38** by way of the series combination of normally closed contacts **40***d* and **42***d* of the relays **40** and **42** and an isolating resistor **44**. This pulse brings about closure of a holding contact **38***b* and a carry contact **38***c*. The contact **38***b* is in a holding circuit comprising, in series, a battery **46**, a normally closed delay switch **48** and the coil **38***a*. The battery **46** is merely illustrative of various power supplies which may be used. The switch **48** may be of a conventional time delay switch which opens after current has passed through it a predetermined length of time. Illustratively, it may include a bimetallic movable arm which is heated by a heating element through which the current passes. After the relay holding current has flowed for the desired interval, the temperature of the arm reaches a point at which the arm moves away from a fixed contact within the switch, thereby opening the switch **48** and releasing the relay **38**. This opens the contacts **38***b* and **38***c*. It will be understood that other types of delays can be used in the system, e.g., capacitance-resistance holding circuits.

If a second pulse from the differentiator **30** is received during the interval in which the carry contact **38***c* is closed, this pulse will be passed to the coil **40***a* of the relay **40** by way of an isolating resistor **50**. Again, actuation of the relay in this manner causes closure of a holding contact **40***b* and a carry contact **40***c* and the relay **40** is held by means of a delay switch **52** connected to the battery **46**.

Thus, the next output pulse from the differentiator **30** passes through the contact **40***c* to the coil of the next relay in the relay chain. Assuming, for the purpose of illustration, that the next relay is the relay **42** in the final stage **36**, this pulse energizes the coil **42***a* by way of an isolating resistor **54**. Contacts **42***b* and **42***c* then close and holding current from the battery **46** passes through the contact **42***b* by way of a delay switch **56**.

The next pulse from the differentiator **30** passes through the contact **42***c* to actuate the impulse switch **22**. As an example, the switch **22** may be a conventional two-position rotary impulse switch which shifts from one position to the other each time it receives a pulse from the contact **42***c*. In one position it connects the power source **24** to the appliance **10** and in the other position the appliance is disconnected from the source **24**.

Thus, a series of successive pulses from the differentiator **30**, corresponding to a series of audio signals transmitted from the remote telephone station **12**, causes successive actuation of the relays in the relay chain **20**, with the final pulse actuating the appliance **10**. The number of pulses required depends on the number of stages in the relay chain. With the three illustrated stages connected as shown, four pulses are required, one to actuate each of the relays, and one for the impulse switch **22**. If additional stages are inserted, as indicated by the dotted lines between the stages **34** and **36**, an additional pulse will be required for each stage. Alternatively, the contact **42***c* might connect the impulse switch **22** to the battery **46**, with the resulting current step through the switch **22** actuating it. In that case, the number of pulses from the differentiator **30** required for actuation of the switch **22** will be equal to the number of stages in the relay chain.

The delay switches **48**, **42** and **56** operate to reduce the chance of actuation of the switch **22** by spurious signals. Specifically, whenever a relay has been actuated by a pulse from the differentiator **30**, the next pulse from the differentiator will not be passed to the succeeding stage of the relay chain unless the carry contact of the relay is still closed when the latter pulse arrives. The coil of the actuated relay is de-energized by operation of the associated delay switch within a short period, e.g., ten seconds, after actuation. Thus, for a pulse to be passed by a relay to the next stage in the chain, it must arrive within this short interval following the previous pulse which actuated the relay. Thus, after a relay has been opened by operation of its delay switch without having passed a pulse to the next relay in the chain, the chain is broken. The system is thus reset so that the next pulse from the differentiator **30** will be applied to the first relay in the chain, i.e., the relay **38**.

For proper operation of the relay chain in this manner, only one pulse in a series thereof should be applied to the coil of any given relay. In particular, once the delay switch associated with a relay has opened the holding circuit thereof, the coil of that relay should not receive further pulses from the differentiator **30**. Otherwise, the system may not completely reset to the initial position, i.e., with all relays de-energized, if the period of one of the delay switches is exceeded by the interval between successive input pulses.

This is accomplished by means of the normally closed contacts **40***d* . . . **42***d*, which are closed only when all of the relays following the first relay **38** are de-energized. When any one of the following relays is energized, a contact in the chain from **40***d* to **42***d* is open and thus input pulses are prevented from reaching the coil **38***a*. The circuit through the coil **38***a* can then be completed only after all the other relays are de-energized.

It will be apparent that with operation in the manner described above, it is highly unlikely that noise passed by the differentiator **30** can operate the impulse switch **22**.

FIG. 2 illustrates a modification of the system of FIG. 1 providing for operation of the switch **22** without removing the home telephone from it cradle. This is accomplished by means of a relay stage, generally indicated at **60**, following the stage **34**. The stage **60** includes a relay **62** provided with a coil **62***a*, a normally open holding contact **62***b* and a normally open carry contact **62***c*. The holding contact **62***b* is in series with a delay switch **64** and the normally closed contact **66***b* of a relay **66**, between the battery **46** and the coil **62***a*. An isolating resistor **68** between the relay stage **34** and the coil **62***a* isolates the stage **34** from the holding circuit of the relay **62**. The holding circuit for the relay **62** also operates a double throw delay switch **70** having a thermal element **70***a* parallel with the coil **62***a*. The switch **70** includes a transfer contact **70***b* which is normally closed to a contact **70***c* and transfers to a contact **70***d* after the thermal element **70***a* has been energized for a predetermined length of time. By way of example, passage of current through the element **70***a* for a period of 15 seconds may be required to move the transfer contact **70***b* from the contact **70***c* to the contact **70***d*.

When the coil **62***a* is energized by a signal from the relay stage **34**, the contacts **62***c* and **62***b* close and the current through the contact **62***b* holds the relay **62**. If the differentiator **30** then emits a second signal within 15 seconds after the signal which energized the relay signal **62**, i.e., before the transfer contact **70***b* has shifted to the contact **70***d*, the later signal will pass through the carry contact **62***c* and the contacts **70***b* and **70***c* to energize the coil **66***a* of the relay **66**. This will open the contact **66***b*, thereby releasing the relay **62** and resetting the entire relay chain.

On the other hand, if the next signal arrives after an interval of 15 seconds, but before 45 seconds have passed, the contact **70***b* will have switched to the contact **70***d* and the signal will therefore be passed to the following relay stage **72**. The stage **72** may be similar to the stages **34** and **36**; thus, it is energized by a signal arriving from the stage **60** and it then passes a succeeding signal from the differentiator **30** to the next relay in the chain.

If, after the relay **62** is energized, there is no signal within the next 45 seconds, the delay switch **64** will open, thereby interrupting the holding circuit for the relay **62** and releasing the relay.

Operation of the system with the modification of FIG. 2 is as follows. First, assume that the home telephone station **14** (FIG. 1) does not include apparatus for removing the telephone hand set from its cradle. In this case, the transducer **16** is merely the annunciator or bell incorporated in the station **14** and the transducer **18** thus picks up as its input signals the telephone rings emitted by the transducer **16**. The time constants associated with the rectifier-filter **28** and differentiator **30** are such as to provide a single output pulse for each ring of the telephone. Moreover, the delay switches **48** and **52** are preferably set to hold the relays associated with them for an interval slightly in excess of the period of the telephone rings after the relays have been energized.

The operator of the system thus dials the home station **14** and allows the station **14** to ring three times. The first ring actuates the relay stage **32** and the second ring actuates the stage **34**.

Returning to FIG. 2, the third ring results in a signal which is passed by the relay stage **34** to the stage **60** to energize the relay **62**.

The user then hangs up at the remote station **12** to interrupt the succession of ringing signals at the home station **14**. He follows this by immediately re-dialing the number of his home station and ringing signals are once again emitted by the transducer **16**. However, by this time, the transfer contact **70***b* has shifted to the contact **70***d* and the first ringing signal causes a pulse to be passed through the contacts **62***c* and **70***d* to the relay stages **72**. Succeeding signals are passed to successive relay stages in the manner described above until the stage **36** and then the impulse switch **22** are energized.

If a caller other than the user dials the station **14**, the stage **60** will prevent the resulting signals from actuating the impulse switch **22**. Specifically, the third ring will energize the relay **62** as described above. However, the fourth ring (occurring because the user of the system is away from home and therefore his telephone is unanswered) will occur before the contact **70***b* has transferred to the contact **70***d*. The corresponding signal from the differentiator **30** will therefore be passed to the relay coil **66***a* to open contact **66***b* and thereby release the relay **62**. This will reset the entire relay chain so that, as described above, the next ringing signals will be applied to the relay stage **32** (FIG. 1).

If a caller should hang up immediately after the relay **62** has been energized, an unlikely occurrence, operation of the delay switch **64** will release the relay **62** to reset the system. That is, the switch **64** can be set to operate shortly after the time interval required for the user to hang up and dial his home telephone again after actuation of the relay **62**. Thus, it will just about always reset the system in time to prevent unwanted operation of the switch **22**.

The embodiment of the invention shown in FIG. 2 is not restricted to use with telephone rings. It can be used with a home telephone station **14** incorporating a device for removing the hand set from its cradle. In that case, the user at the other end of the line dials the station **14** and, after the handset has been removed from its cradle he first emits the required number of sounds to actuate the relay **62**. Next he pauses to permit operation of the delay switch **70**, after which he emits the number of sounds required to operate the stages **72** . . . **36** (FIG. 2) and then operate the impulse switch **22**.

The delay switch **56** is the relay stage **36** is set so that it ordinarily prevents a net change in the condition of the switch **22** by someone other than the user of the system, even if a signal should somehow get through to this stage. The first signal passed by the stage **36** operates the switch **22** as noted above. If a second signal is then received within the normal interval between such signals, it will also actuate the switch **22**, thereby returning it to its previous state. The delay switch **56** will then reset the system so that a third section signal wlil not reach the switch **22**.

A somewhat more elaborate arrangement in the final relay stage **36** will provide greater certainty of an unchanged condition of the switch **22**. For example, an additional relay might be incorporated in such manner as to be energized by the signal passed by the relay **42** in the stage **36** and then held. After a fairly long interval during which no further signal is received, a simultaneously energized delay switch would deliver a pulse from the battery **46** through normally open contacts of this further relay to the impulse switch **22**. If a further signal were passed by the relay **36** during this intervnal, it would be used to open the holding circuit for the additional relay in much the same manner as actuation of the relay **66** opens the holding circuit of the relay **62**.

It will be apparent that audible signals are not the only signals which can be used to operate the system. Acoustical signals of any frequency can be used, although, in general, sensitivity to audible signals will lead to the most practical arrangement. Moreover, the underlying principles of the invention may be applied to signals which do not make use of acoustical media. Thus, one may use electrical signals applied directly to the amplifier **26** or rectifier-filter **28**, or the transducer **18** may be sensitive to energy in other forms, such as light energy. In the latter case the system would be operated by a series of flashes of light.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from

the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim:

1. Apparatus for remote control of an appliance or the like, said apparatus comprising

(A) means for detecting input signals emitted by a user of the system and supplying countable signals in response to said input signals,

(B) first counting means for counting said countable signals and supplying an intermediate signal when the number of said countable signals reaches a first predetermined number, said intermediate signal being the next countable signal after said first number,

(C) second counting means,

(D) intermediate relay means responsive to said intermediate signal and arranged to pass countable signals successive thereto to said second counting means if a first interval between said intermediate signal and the first of said successive countable signals is greater than a first value and less than a second value,

(E) said second counting means providing an output signal after a predetermined number of countable signals have been counted thereby, and

(F) power switching means connected for actuation by said output signal.

2. The combination defined in claim 1 in which each of said counting means includes means for resetting said apparatus when the interval between successive countable signals counted thereby is greater than said first value.

3. The combination defined in claim 1 in which

(A) said detecting means includes means for detecting signals emitted by a first telephone substation,

(B) said first value is slightly greater than the interval between countable signals corresponding to ringing signals emitted by said first substation,

(C) said second value is slightly greater than the time required for the user at a second substation remote from said first substation having first dialed said first substation to cause said ringing signals to cease and then to bring about further ringing signals by redialing said first substation.

4. The combination defined in claim 3 in which of said counting means includes means for resetting said apparatus when the interval between successive countable signals counted thereby exceeds the period of said ringing signals by a predetermined amount.

References Cited

UNITED STATES PATENTS

1,867,209	7/1932	Chauveau	340—164
2,600,648	6/1952	Herrick	340—164
2,811,708	10/1957	Byrnes et al.	340—164
3,280,259	10/1966	Cotter	179—2
3,308,239	3/1967	Waldman et al.	179—2

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