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Proios

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[54] **REMOTE BANKING INTERCOM SYSTEM**

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[73] Assignee: **The Mosler Safe Company,** Hamilton, Ohio

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[21] Appl. No.: **302,253**

[52] **U.S. Cl.** ..... **179/1 H,** 179/1 VC

[51] **Int. Cl.** **H04m 1/00**

[58] **Field of Search** ..... 179/1 VC, 1 H, 1 B, 1 HF, 179/81 B, 1 CN, 1 P

[56] **References Cited**

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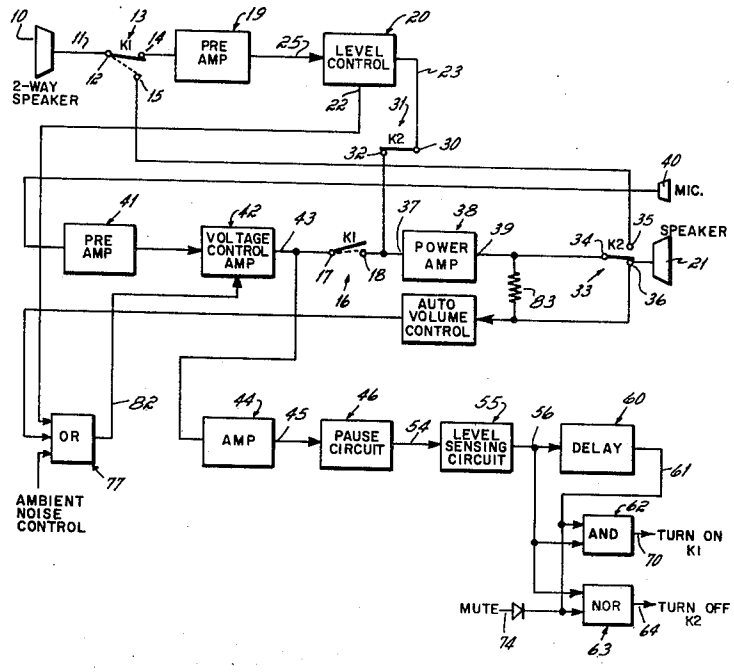
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Primary Examiner—Ralph D. Blakeslee
Assistant Examiner—Bradford Leaheey

[57] **ABSTRACT**

An intercom system for remote banking which facilitates communication between a teller terminal and a remotely located customer terminal. A two-way speaker is provided at the customer's location and a separate microphone and a speaker are provided at the teller's location. An amplifier in the communication path linking the two stations is connected such that normally its input is responsive to the customer two-way speaker with its output feeding the teller speaker, permitting the customer to talk to the teller. When the teller speaks into the microphone, and assuming his volume level exceeds a predetermined first level, the amplifier automatically switches to connect the teller microphone to the amplifier input and the customer two-way speaker to the amplifier output, permitting the teller to talk to the customer. When the level of the teller microphone signal falls below a second predetermined level which is less than the first level to permit the teller's voice to drop without losing control of the direction of communication, the intercom system will switch to again permit the customer to talk to the teller. The system is additionally provided with a muting signal which disconnects the teller speaker whenever the ambient noise level at the customer's location is high due to mechanical movement of a drawer or pneumatic carrier at the customer's location.

16 Claims, 6 Drawing Figures



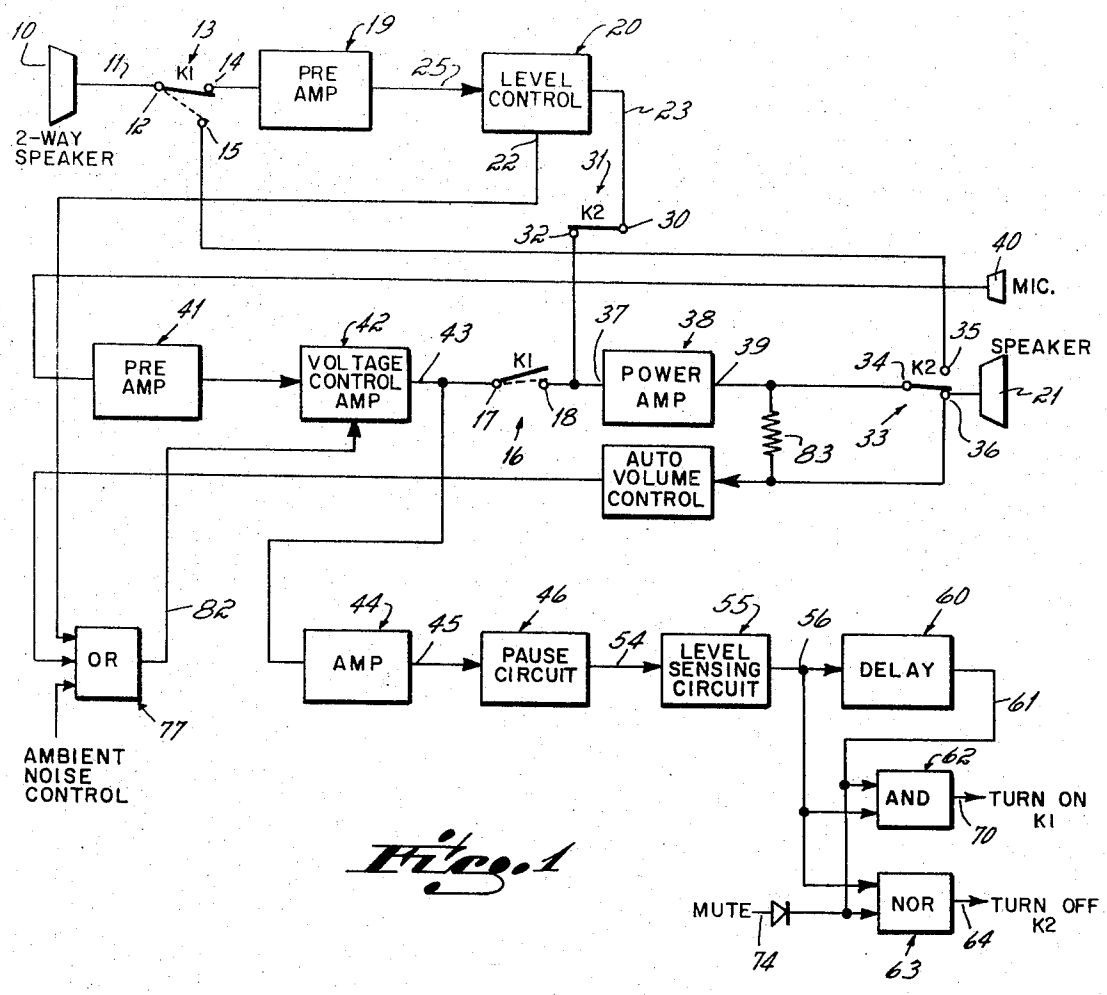

10
2-WAY SPEAKER
11
12
13
K1
14
15
PRE AMP
19
25
LEVEL CONTROL
20
23
22
31
K2
32
30
40
MIC.
41
PRE AMP
42
VOLTAGE CONTROL AMP
43
K1
17
16
18
37
38
POWER AMP
39
34
K2
35
SPEAKER
21
33
36
83
AUTO VOLUME CONTROL
82
OR
77
AMBIENT NOISE CONTROL
44
AMP
45
46
PAUSE CIRCUIT
54
55
LEVEL SENSING CIRCUIT
56
60
DELAY
61
62
AND
TURN ON K1
70
MUTE
74
NOR
TURN OFF K2
64
63

Fig. 1

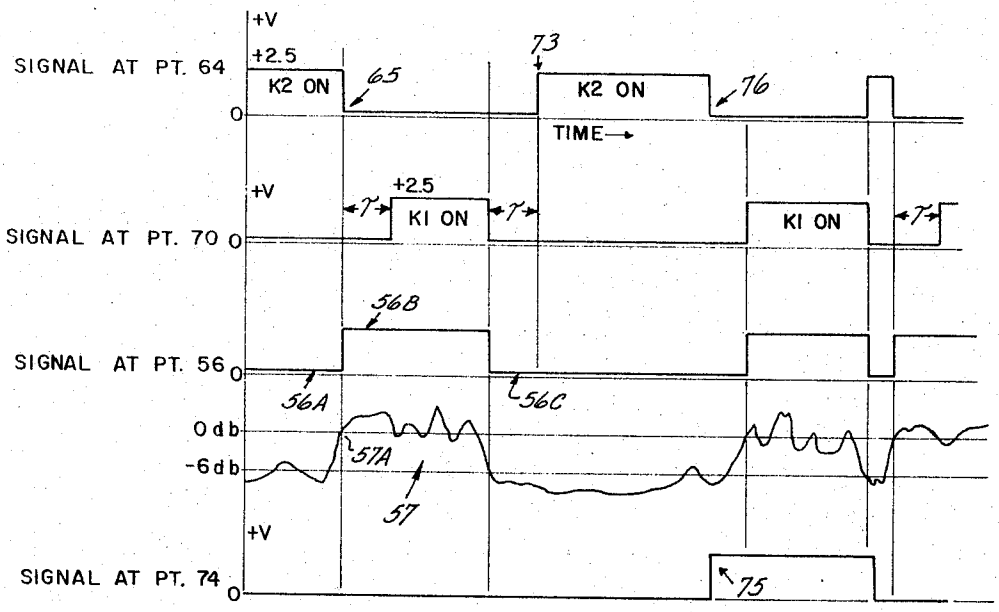

+V
+2.5
SIGNAL AT PT. 64
K2 ON
65
73
K2 ON
76
0
TIME
+V
+2.5
SIGNAL AT PT. 70
T
KI ON
T
KI ON
T
0
56B
SIGNAL AT PT. 56
0
56A
56C
0 db
-6 db
57A
57
+V
SIGNAL AT PT. 74
0
75

Fig. 2

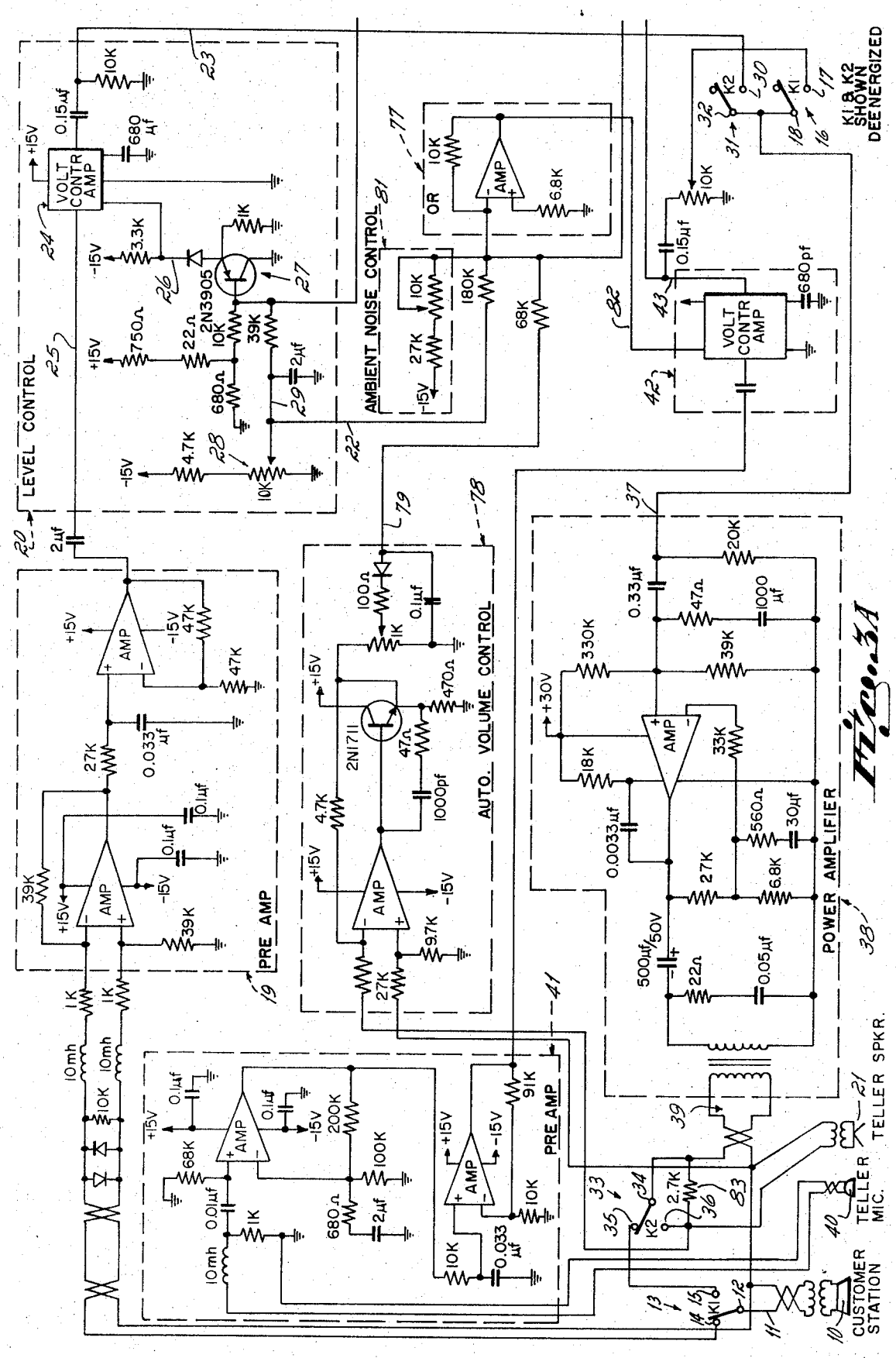

LEVEL CONTROL
AMBIENT NOISE CONTROL
AUTO. VOLUME CONTROL
PRE AMP
PRE AMP
POWER AMPLIFIER
VOLT CONTR AMP
VOLT CONTR AMP
AMP
OR
K1 & K2 SHOWN DEENERGIZED
CUSTOMER STATION
TELLER MIC.
TELLER SPKR.
2N3905
2N1711
+15V
-15V
+30V
10K
0.15μf
680 μf
3.3K
1K
750Ω
22Ω
39K
2μf
680Ω
4.7K
180K
68K
27K
680pf
47K
0.033 μf
0.1μf
100Ω
470Ω
47Ω
1000pf
9.7K
20K
0.33μf
330K
1000 μf
18K
33K
0.0033μf
560Ω
30μf
6.8K
500μf/50V
22Ω
0.05μf
10mh
91K
200K
100K
0.01μf
2.7K
K1
K2

Fig. 3A

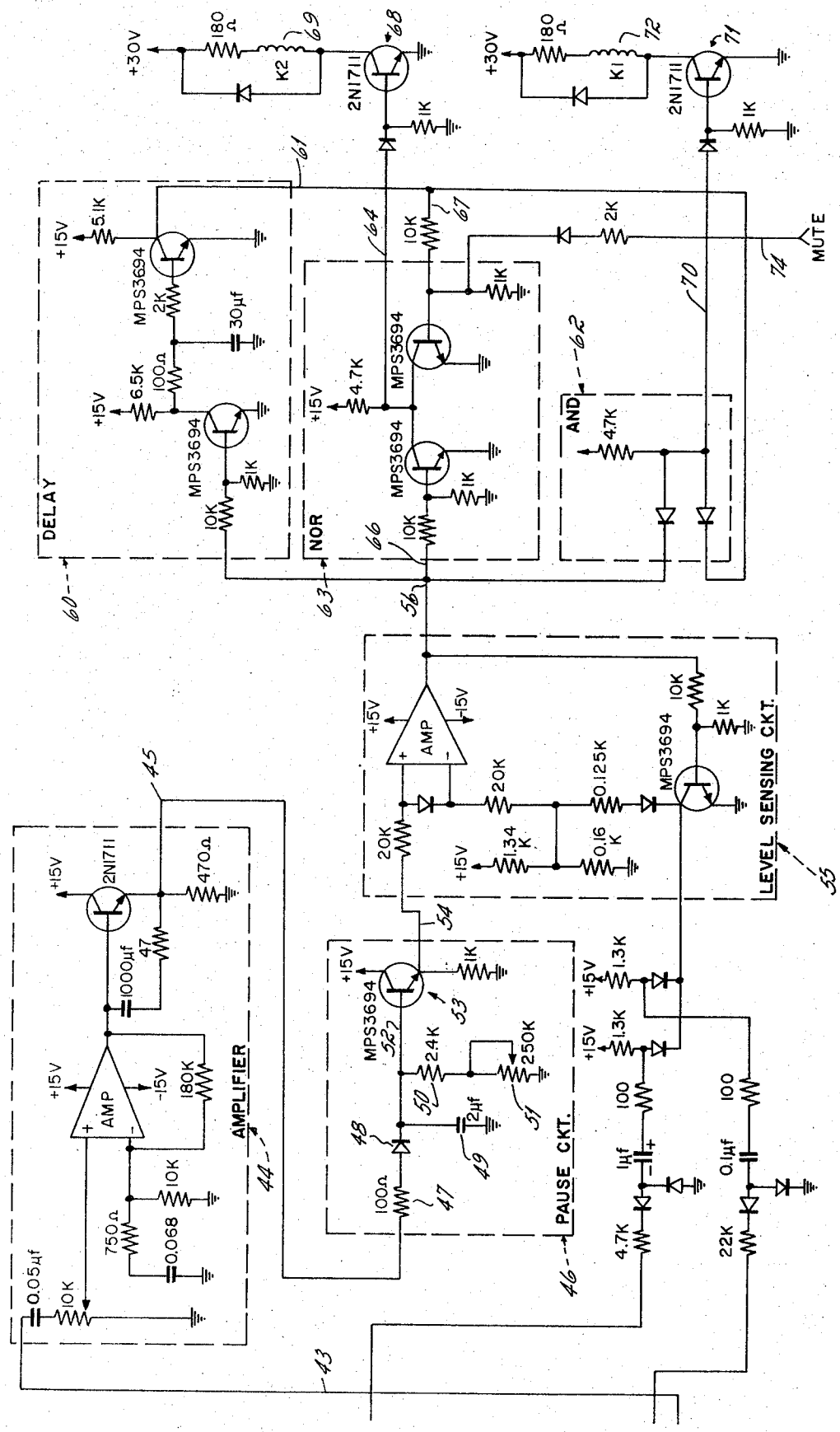

+30V
180 Ω
K2
69
68
2N1711
1K
61
+15V
5.1K
MPS3694
2K
30μf
6.5K
100Ω
DELAY
60
64
10K
67
4.7K
NOR
66
63
58
2K
MUTE
74
70
AND
62
47K
+30V
180 Ω
K1
72
71
2N1711
1K
+15V
AMP
-15V
20K
0.125K
1.34 K
0.16 K
LEVEL SENSING CKT.
55
54
45
2N1711
470Ω
1000μf
47
180K
10K
750Ω
0.068
0.05μf
AMPLIFIER
44
MPS3694
53
52
2.4K
250K
50
51
2μf
48
49
100Ω
47
PAUSE CKT.
46
1.3K
100
1μf
4.7K
0.1μf
22K
43

Fig. 3B

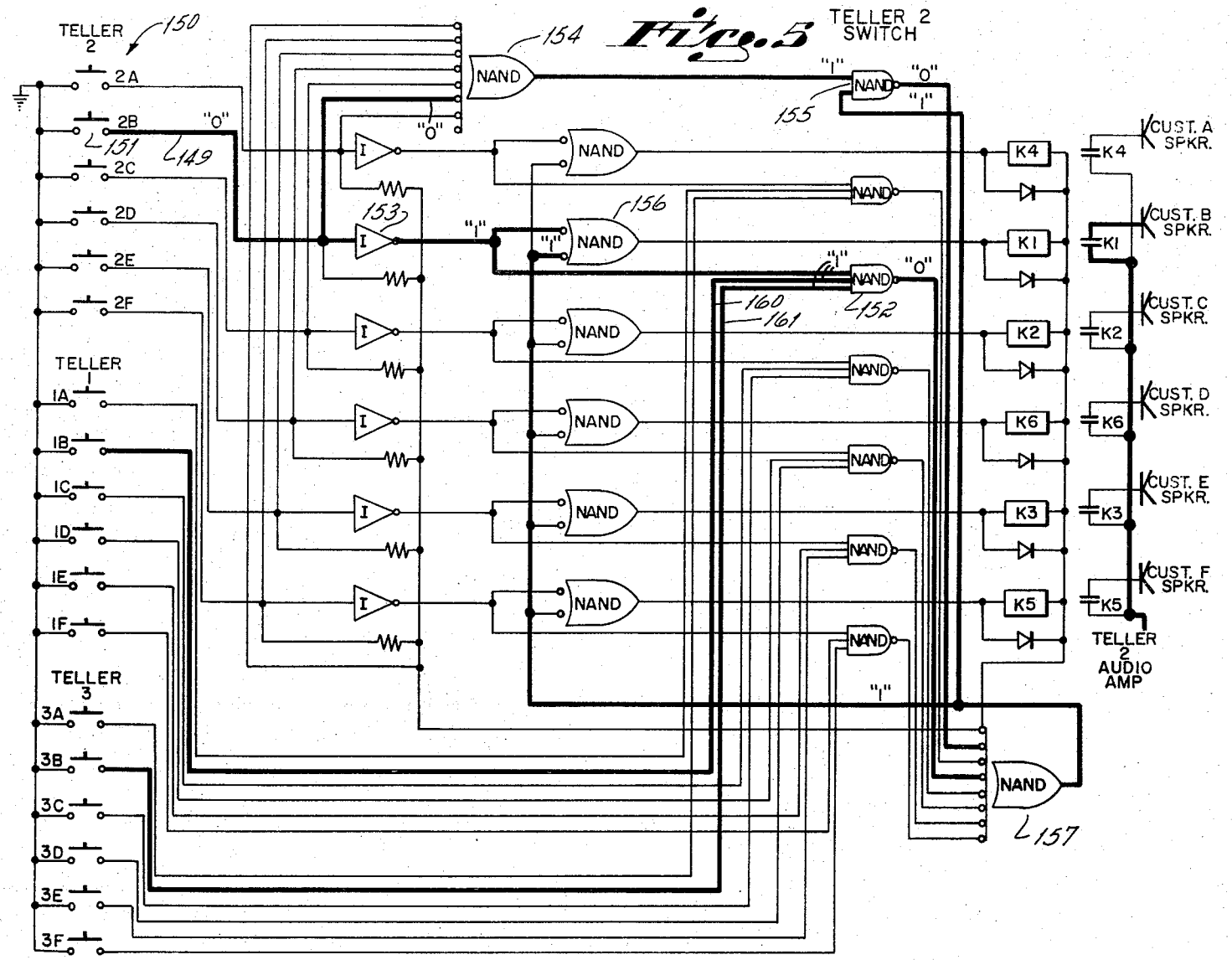

TELLER 2
150
2A
2B
2C
2D
2E
2F
TELLER 1
1A
1B
1C
1D
1E
1F
TELLER 3
3A
3B
3C
3D
3E
3F
"0"
151
149
153
154
NAND
I
"1"
156
155
160
161
152
157
K4
K1
K2
K6
K3
K5
CUST. A SPKR.
CUST. B SPKR.
CUST. C SPKR.
CUST. D SPKR.
CUST. E SPKR.
CUST. F SPKR.
TELLER 2 AUDIO AMP

Fig. 5

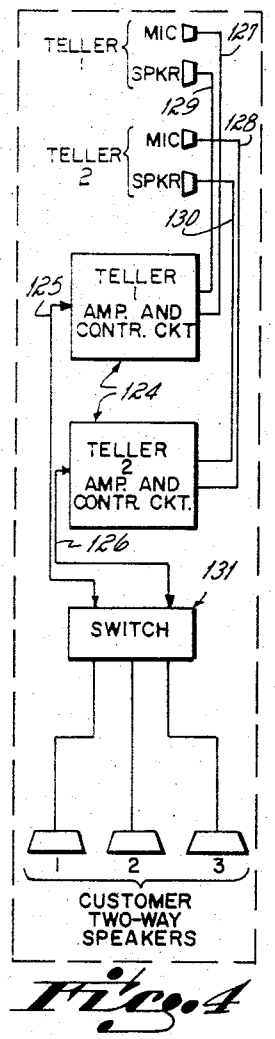

TELLER 1
MIC
SPKR
127
129
TELLER 2
MIC
SPKR
128
130
TELLER 1 AMP. AND CONTR. CKT
125
124
TELLER 2 AMP. AND CONTR. CKT.
126
131
SWITCH
1
2
3
CUSTOMER TWO-WAY SPEAKERS

Fig. 4

REMOTE BANKING INTERCOM SYSTEM

This invention relates to intercom systems and more particularly to a remote banking system intercom for communicating between a bank teller location and a remote customer location.

In the drive-in banking field, a form of remote banking, the bank teller and customer are usually separated by a distance anywhere from 6 to 30 feet, with the customer being in his car and the teller in a fully-enclosed booth attached to the main bank building which has a window looking out on the customer terminal. There may be a single teller station uniquely associated with one customer unit; or alternatively several teller stations servicing an even larger number of customer units, with each teller being able to service any one of the customers. Such drive-in systems, whether multistation or not, permit the customer to conduct banking business from his car. In a related type of remote banking system, a sidewalk window is provided where customers, albeit not in cars, conduct their business from the sidewalk without having to enter the bank.

Remote banking systems of the types described require some method for transferring cash, checks, deposit slips and the like between the teller and the customer. In one form, a sliding drawer, controlled by the teller, is provided. The drawer is opened proximate the customer to permit the customer to deposit a check or cash therein. The teller then closes the drawer and thereafter removes the articles from the drawer. The teller then performs certain operations for accounting purposes before placing a receipt, cash or the like in the drawer. The drawer is again opened to the customer to allow the customer to remove the item from the drawer. While a sliding drawer is commonly used, a pneumatic carrier conveying system is also used, the pneumatic carrier system taking the place of the sliding drawer. An advantage of the pneumatic carrier approach is that it permits the teller to be located large distances from the customer. Pneumatic systems are particularly adaptable to drive-in or walk-up banking systems having many customer locations serviced by one or more tellers.

In all remote banking systems an intercommunication system is necessary to permit conversation between the teller who is in an enclosed booth, and the customer who may be many feet away. The customer must be able to inform the teller of any special request he may have, for example, the type of change he would prefer, and the teller has to be able to speak to the customer, for example, to ask the customer to endorse a check.

Experience has shown that it is preferable to place the teller in control of the direction of communication for the intercom since it is the teller who most often must initiate conversation. Additionally, for ease of operation the communication system should operate with as little manual intervention as possible to permit the teller and the customer to use their hands for other purposes. Accordingly, by permitting the teller's voice to control the direction of communication, not only will the teller be in control, but the teller's hands will be free to write or to use them for some other transaction-related purpose.

An intercommunication system for a remote banking installation must also function in a manner which accommodates varying conditions of use. For example,

while the teller is speaking to the customers, he may have to step back away from the microphone in order to use an adding machine, view cash he is removing from the cash drawer, or the like. While this causes the volume of the teller's voice to drop, it should not cause the communication direction, which is under control of the teller's voice, to switch until the teller has finished talking.

Another variable in a remote banking system is the volume of the customer's voice as reproduced by a speaker at the teller's location. This sound will couple into the teller's microphone, but should not activate the intercom direction switching controls. While the system must reproduce the normal customer's voice at a level loud enough for the teller to hear, means must be provided to prevent the customer's voice from activating the communication direction switching controls should the customer suddenly speak loudly.

A further variable in a remote banking system arises from noise caused by the mechanical movement of the drawers an/or pneumatic carriers or caused by other ambient noise at the customer's location which occurs when the customer is talking. If these customer station noises, when reproduced at the teller station, are picked-up by the teller's microphone, the direction of communication will be reversed, cutting-off the customer.

It is a primary object of this invention to provide an intercommunication system for remote banking installations which permits only the teller to control the direction of communication with his varying amplitude voice while preventing annoyance caused by switching and mechanical sounds.

It is a related object of this invention to prevent customer station-originated noise reproduced at the teller's speaker from switching the direction of communication while the customer is still speaking.

It is still another related object of this invention to prevent the mechanical sounds of drawer opening and pneumatic carrier operation from being reproduced at the teller's location, coupling back into the teller's microphone and reversing the communication direction.

It is another object of this invention to provide an intercom system having a switchable communication direction controlled by the volume of the teller's voice. When the teller's voice rises above a first threshold, the teller is permitted to talk to the customer and limited variation in level of the teller's voice below this threshold is permitted thereafter without changing the communication direction.

These and other objects and advantages are achieved by a remote banking intercom system which includes a two-way speaker at the customer's location which is normally connected to the input of a power amplifier whose output is connected to a speaker at the teller's location,, permitting the customer under normal conditions to talk to the teller. A microphone at the teller's location is provided which is connected to an amplitude-sensing circuit for controlling the direction of communication. When the sensed level at the teller microphone exceeds a first level, the two-way speaker at the customer location is switched from the amplifier input to the amplifier output and the microphone at the teller location is connected to the amplifier input, permitting the teller to talk to the customer. Communication from the teller microphone to the customer two-

way speaker continues as long as the volume at the teller microphone does not fall below a second predetermined level, which is less than the first level. Thus, the volume of the teller's voice can vary within limits without effecting reversing the direction of communication. Of course, if the level at the teller microphone drops below the second threshold, as occurs when the teller stops talking, the system will revert to its normal condition with the customer being able to talk to the teller.

The intercom system of this invention further includes a microphone sensitivity control network for reducing the sensitivity of the microphone under certain conditions. The sensitivity reduction occurs whenever the system is connected to permit communication from the customer to the teller, and operates to prevent a customer, speaking in a loud tone of voice, from switching the communication direction via audible feedback from the teller speaker to the teller microphone. Preferably, the microphone sensitivity is also reduced under conditions of high ambient noise at the teller's station to prevent ambient noise conditions at the teller's location from switching the direction of communication when a customer is talking. In addition, a muting circuit is provided for disconnecting the teller's speaker whenever an interconnected mechanical apparatus, such as a sliding drawer or pneumatic carrier, will produce a high noise level at the customer's location which noise when reproduced at the teller speaker and coupled back to the teller microphone would switch the communication direction.

The foregoing and other objects, features and advantages of this invention will be more readily understood from the following more detailed description of a preferred embodiment thereof taken in conjunction with the accompanying drawings which form a part of this disclosure wherein:

FIG. 1 shows a schematic diagram, in block circuit format, of a preferred embodiment of this invention;

FIG. 2 is a timing diagram showing signals at various points in the schematic diagram of FIG. 1;

FIGS. 3A and 3B are detailed circuit diagrams of one form of the system shown in FIG. 1;

FIG. 4 shows schematically a remote banking intercom system with two teller and three customer locations; and

FIG. 5 shows a switching network for a remote banking intercom system with more than one teller location and also more than one customer location.

Referring now to FIG. 1, a schematic diagram is shown of an intercommunication system particularly adapted for use in a remote banking system. A two-way speaker **10** is provided at the customer location and operates as a microphone for communications from the customer to the teller, while operating as a speaker for communications from the teller to the customer.

An electrical wire **11** is provided to electrically connect the customer two-way speaker **10** to the input terminal **12** of a single-pole, single-throw switch **13.** The electrical wire **11** may be any type of electrical cable having a low d.c. resistance, although a shielded twisted pair or other form of shielded cable is advantageous in reducing stray coupling of spurious electrical signals which may be present in systems where the customer is located at a distance from the teller.

The single-pole, double-throw switch **13** has in addition to the input terminal **12** two output terminals **14** and **15.** The switch **13** may take the form of an electronic switch, or, in a preferred embodiment, may be a relay (K1) activated contact, for electrically connecting the input **12** to one of the two outputs **14** and **15.**

A single-pole, single-throw switch **16** with an input terminal **17** and an output terminal **18** is also provided in the network and is switched at the same time as switch **13.** The switch **16** may also comprise an electronic switch having the same control signal as switch **13,** or may comprise a separate set of contacts controlled by the relay **K1.** Because switches **13** and **16** operate together, the input **12** of switch **13** is connected to the output **14** at the same time as the input **17** of the switch **16** is disconnected from the output **18.** When the switch **13** is changed, the switch **16** will also be changed so that the input **12** for switch **13** connects to the output **15** while the input **17** of switch **16** connects to the output **18.**

The switch **13** has the primary function of switching the electrical connection to the customer two-way speaker **10** to permit the customer to either talk or listen. In the customer talk mode, switch **13** connects the input **12** to the output **14** permitting electrical signals from the two-way speaker **10** to be amplified by a preamplifier circuit **19.** In the customer listen mode, switch **13** connects the input terminal **12** to the output terminal **15** permitting the two-way speaker **10** to be connected to a power amplifier **38** and allow the customer to hear the teller's voice.

In the preferred embodiment shown in FIGS. 3A-3B, the preamplifier **19** comprises two series-connected integrated circuit amplifiers. While an integrated circuit amplifier has been utilized, a discrete component amplifier circuit with similar gain characteristics may also be used without degrading system performance.

The output of the preamplifier **19** is connected directly to the input of a level control means **20** which provides the teller with a volume control for the teller speaker **21.** The level control **20** may take the form of a variable resistor or some other conventional means for varying the level of a signal. The level control means **20** has an output wire **22** for carrying a control signal whose amplitude depends upon the setting of the level control means **20.** This level-indicating signal is utilized by feedback control logic to be described later.

The level control means **20** includes circuitry for controlling the output level of the audio signal on the output wire **23.** In a preferred embodiment, the level control means **20** advantageously comprises a voltage controlled amplifier that has a controllable variable gain characteristic responsive to a control voltage. In FIG. 3A the voltage-controlled amplififer **24** has an input lead **25** connecting to the control terminal of the voltage-controlled amplifier. The output terminal of voltage-controlled amplifier **24** is connected through a high pass filter to the output line **23.** The control signal which is applied to the control terminal of the voltage control amplifier **24** is generated by varying the voltage at point **26.** The varying voltage at point **26** is produced by controlling the current through transistor **27.** This varying current is produced by the adjustable biasing network connected to the base of transistor **27** which includes a variable resistor **28,** normally remotely located at the teller's location to permit volume adjustment. By varying the voltage on the wire **29,** the cur-

rent through transistor 27 can be varied, producing a varying voltage at the control input to the voltage control amplifier 24. The level-carrying wire 22 connects directly to the wire 29 and carries a voltage which is related to the output amplitude of the voltage-controlled amplifier 24.

Referring again to FIG. 1, the output signal on line 23 connects to the input terminal 30 of a single-pole, single-throw switch means 31, the switch 31 being normally closed (K2 on) allowing the signal at the input 30 to be connected directly to the output terminal 32. Another switch means 33 of the single-pole, double-throw type having an input terminal 34 and two output terminals 35 and 36 is provided and is designed to switch at the same time as switch means 31. Normally switch means 33 will connect the input terminal 34 to the output terminal 36 and at the same time, switch means 31 will connect the input 30 to the input 32. When switch means 31 is changed, switch means 33 will also be changed so that the input terminal 30 is disconnected from the output terminal 32 of switch means 31 and the input terminal 34 of switch means 33 is connected to the output terminal 35.

Switch means 31 and 33 may take the form of electronic switches with common control signals, or advantageously may take the form of contacts of a relay K2.

The amplified signal of the customer's voice is carried by a wire from the output terminal 32 of switch means 31 to the input terminal 37 of the power amplifier 38. The power amplifier 38 shown in the preferred embodiment in FIG. 3A is an integrated circuit amplifier, although a discrete component amplifier circuit is equally acceptable. The amplifier output 39 connects directly to the input terminal 34 of switch means 33 and, when switch means 33 is in its normal position (FIG. 1), the amplifier output signal will be connected to the teller's speaker 21. When the relays K1 and K2 are in the normal position shown in FIG. 1 (K1 off and K2 on), the two-way speaker 10 is connected in a talk mode via switch means 13 to the preamplifier 19, the level control means 20, the power amplifier 38 and the speaker 21 permitting the customer to talk to a teller at a remote location.

The teller microphone 40 and the teller speaker 21 are normally located close to each other at a location which is remote from the customer location. The teller microphone 40 is connected to a preamplifier circuit 41 which, in the preferred embodiment shown in FIG. 3A, comprises two series-connected integrated circuit amplifiers. While integrated circuit amplifiers are preferred, other discrete component amplifiers are equally acceptable as long as the amplifier gain is sufficient to provide adequate volume at the customer location to allow the teller to be heard by the customer.

The output of the preamplifier 41 is connected by a wire to the input of a voltage control amplifier circuit 42. The voltage-controlled amplifier 42 controls the microphone gain to prevent feedback from the teller speaker 21 to the teller microphone 40, a feature which will be explained later in greater detail. The output of the voltage-controlled amplifier 42 appears on line 43 and is connected by a wire to the input terminal 17 of switch 16 and to the input terminal of the amplifier 44 which includes, in a preferred embodiment, an integrated circuit amplifier followed by a discrete component driver circuit to produce an amplified teller's signal on the output line 45.

The amplified output of the teller's voice on wire 45 is applied to the input of a pause circuit 46. As shown in FIG. 3B, pause circuit 46 includes a resistor 47 connected at one end to the output line 45 and at its other end to a diode 48, the diode 48 providing a half-wave rectification of the amplified teller's voice. The output of the diode 48 is connected to a capacitor 49 which becomes charged whenever a signal from the teller's microphone is applied to the input of the pause circuit. Connected in parallel with the capacitor 49 is a series-connected resistor 50 and a variable resistor 51 which provide a variable resistance discharge path for the capacitor 49. The diode, the positive lead for the capacitor 49 and the series-connected resistors all connect to the base lead 52 of a transistor 53 which forms an emitter-follower circuit producing an output for the pause circuit at line 54.

In operation the pause rectifies the teller speech signal received on line 45 from amplifier 44. The positive voltage peaks build up a positive charge on the capacitor 49. When the output of the amplifier 44 has a voltage which is less than the voltage across the capacitor 49, the capacitor will discharge gradually through resistors 50 and 51. Since the charge remains on the capacitor 49 after the teller stops talking, the retained charge is used by a level sensing circuit (described later) to maintain control over the direction of communication and permit the teller to pause without changing the communication direction.

The output of the pause circuit 46 is on wire 54 which is connected to the input of a level-sensing circuit 55. The level-sensing circuit 55 is an adjustable though preset circuit which is designed to produce a signal at one level only when the input exceeds a first predetermined reference level and to produce an output at a second level only when the input falls below a second predetermined level which is less than the first predetermined reference level. The output of the level-sensing circuit 55 appears at output point 56 and a typical output signal is shown in FIG. 2 for the input at line 54. With reference to FIG. 2, when the input level of the teller speech signal on wire 54 exceeds an arbitrarily selected reference level shown as zero db. at 57A, the output of the level-sensing circuit 55 shifts from a first level shown at 56A to a second level shown at 56B. Once the output of the sensing circuit 55 switches to the second level, the speech input signal 57 on wire 54 can vary above or below the 0 db. reference level. If the speech signal level at input 54 falls to −6db., the sensing circuit 55 output 56 returns to its first level 56C. By permitting the output of level-sensing circuit 55 to remain constant over a wide range of input amplitudes as will be seen shortly, the teller can maintain control over the communication direction even if the amplitude of his voice at the teller microphone varies above and as much as 6 db. below the arbitrarily selected zero db. reference level required to activate teller communication to the customer.

The level-sensing circuit 55 as shown in FIG. 3B for a preferred embodiment of the present system comprises a Schmitt trigger circuit. It is well known that a Schmitt trigger will produce an output at one level whenever the input signal exceeds a predetermined level which is adjustable by controlling the trigger bias. It is a further known characteristic of Schmitt triggers

that the output is unchanged until the input level falls a predetermined amount below the input level required to produce the switched output. Consequently, a Schmitt trigger circuit is ideally suited for the application in the intercom system because it will permit the teller input signal to drop a predetermined amount without changing the output. While a Schmitt trigger circuit has been shown in FIG. 3B as a preferred embodiment for the level-sensing circuit **55**, it will be recognized by those of skill in the art that certain other circuit configurations may also be utilized to produce the same results achieved with a Schmitt trigger.

Because the output signal from the level-sensing circuit **55** is a two-level signal having an up and a down level, this output signal is ideally suited for driving digital logic circuitry to control the switches **13, 16, 31** and **33.** The signal at point **56** is applied to the input of a delay circuit **60,** the delay output **61** being a signal identical to the input at point **56** delayed by a delay time τ. The delay circuit **60** may take the form of a digital delay line or, as in a preferred embodiment shown in FIG. 3B, may take the form of two amplifier stages with a capacitor in the base circuit of the second amplifier stage whose charging and discharging charging through a resistor is utilized to delay the output on line **61** by a time related to the RC time constant. The delayed signal on line **61** is applied to one input of an AND circuit **62** and one input of the NOR circuit **63.** The second input to AND circuit **62** is the signal on line **56.** This signal is also applied to a second input to the NOR circuit **63.**

In operation, the NOR circuit **63** has an output **64** which is approximately **2.5** volts for the preferred embodiment shown in FIG. 3B when the input on line **56** is approximately zero volts, a condition which indicates that the volume at the teller microphone is below the arbitrary reference level designated 0 db. However, when the input signal on line **56** rises to a positive value as depicted at point **56B** in FIG. **2,** the output **64** of the NOR circuit **63** falls to substantially 0 volts as shown generally at **65.** In fact, if the voltage at either NOR input is positive, the output **64** of the NOR circuit **63** will be substantially zero volts. If both inputs **66** and **67** have a zero or negative voltage applied thereto, the output **64** will be approximately +2.5 volts.

The output **64** of NOR circuit **63** is coupled directly to the base of the K2 relay driving transistor **68.** Whenever the output **64** of the NOR circuit **63** is positive, transistor **68** will be conducting and current will pass through the K2 relay coil **69** causing the relay contacts to be closed. Switches **31** and **33** are controlled by the K2 relay and are drawn in FIG. **1** with the electrical connections corresponding to the conditions when the K2 relay coil **69** has a current flowing therethrough, i.e., K2 is on. When the voltage at the NOR output **64** falls to zero, however, transistor **68** will no longer conduct and the K2 relay will be de-energized, thus changing the electrical connections for switches **31** and **33.**

The AND circuit **62** will produce a positive output signal on line **70** whenever both inputs are at a positive level, and will have a zero voltage if either input is zero. Since one of the inputs is the signal on line **56** and the other input is the signal on line **56** delayed by a time delay τ, the output of AND circuit **62** will rise to a level of approximately +2.5 volts only when both inputs have become positive. Consequently, as seen in FIG. **2,** the output **70** rises to its positive level a time period τ after the signal on line **56** rises which corresponds to the same time delay after the signal on line **64** falls to its substantially zero voltage value.

The signal on line **70** is connected directly to the base circuit of the K1 relay driver transistor **71.** Whenever the signal on line **70** is positive, the transistor **71** will conduct and cause a current to flow through the K1 relay coil **72.** The switching of the K1 relay will cause switches **13** and **16** of FIG. **1** to be changed from the configuration there shown to the connection indicated in dotted lines.

Because of the sequential nature of the logical elements used for controlling the K1 and K2 relays, these relays operate in a predetermined sequence to switch the system configuration. In the system in FIG. **1,** whenever the teller is silent and no signals are being received by the teller microphone **40,** the K1 and K2 relays are positioned as shown and permit a customer to speak into the two-way speaker **10** and talk to the teller. For the configuration which permits the customer to talk to the teller, the K2 relay is energized and the K1 relay is not energized. When the teller speaks, however, the system configuration will be changed sequentially. This is best shown in FIG. **2** at the point **57A** where the teller's voice is of a sufficient volume to begin system reconfiguration. Whenever the teller's voice exceeds the predetermined level indicated as 0 db., the signal at line **64** will fall to its down level as indicated at point **65** to cause the K2 relay to turn off and change the switches **31** and **33.**

When the K2 relay is de-energized, the output of the level control means **20** is disconnected from the switch output terminal **32,** consequently removing the two-way speaker **10** from the input to the power amplifier **38** and preventing customer signals from reaching the input to the power amplifier **38.** Simultaneously, switch **33** is changed so that the output **39** from the power amplifier **38** is connected electrically to the output terminal **35** of the switch **33,** disconnecting the speaker **21** from the power amplifier **38.**

After the time period τ has elapsed, the K1 relay is activated and the switch **13** is changed to connect the speaker **10** to the output of the power amplifier **38.** Simultaneously, the switch **16** is also activated which connects the microphone **40** to the input to the power amplifier **38** which completes the necessary system reconfiguration to permit the teller to speak into the microphone **40** and have the customer hear the teller's voice reproduced by the two-way speaker **10.**

When the teller stops talking for a time period greater than is required for the discharge of the capacitor **49** in the pause circuit **46,** or if the teller speaks at a volume level substantially reduced, i.e., 6 db.'s below the triggering level, the signal at point **56** will again change and initiate a sequential switching of the relays K1 and K2. As shown in FIG. **2,** when the teller signal at point **56** falls to the level indicated generally at **56C,** the signal at point **70** immediately falls to its substantially zero voltage level, causing the K1 relay to de-energize and change the switches **13** and **16** back to their original position as shown in FIG. **1.** A time period τ later, the NOR input **67** will have fallen to its down level which causes the K2 relay to be energized by the rise of the signal on line **64** to its value of approximately +2.5 volts as indicated at point **73.**

The switching reconfiguration when the teller's voice ceases, first operates to disconnect the microphone **40** from the input of the power amplifier **38** and connect the customer two-way speaker **10** to the preamplifier **19.** This early switching of the two-way speaker **10** to the preamplifier **19** is highly advantageous. Delayed by a time period τ after the K1 relay has been switched, the K2 relay is energized causing switches **31** and **33** to change to the configuration shown in FIG. **1** again permitting the customer to speak into the two-way speaker **10** and the teller to hear the customer through the teller speaker **21.**

The sequential switching just described is highly advantageous to the operation of the system. When the configuration is being changed from the customer talk mode to the teller talk mode, the teller speaker **21** is disconnected from the power amplifier **38** at the same time as the customer signals are removed from the power amplifier input **37.** This removing of the teller speaker **21** from the amplifier output **39** prevents the subsequent switching of switch **13** from causing a clicking sound to be heard by the teller. Similarly, the removal of the customer two-way speaker **10** from the power amplifier output prior to the connecting of the teller speaker **21** to the power amplifier output and also prior to completing the connections required in the customer talk mode will prevent a blast of sound from being heard by the teller. The customer two-way speaker **10** will have stored energy therein when the teller stops talking. If the system were immediately reconfigured, this stored energy would be amplified and reproduced by the teller speaker **21.** By connecting the customer two-way speaker **10** to the preamplifier before the teller speaker is connected to the amplifier, the stored energy is dissipated which operates to eliminate any blast of sound in the teller speaker **21** when the system reconfigured from the teller talk to the customer talk mode.

The intercom system of this invention is designed primarily for application in remote banking systems which characteristically have mechanical drawers or pneumatic carriers being moved to permit papers to be transmitted between the customer and the teller. At the customer's location, the pneumatic carrier or drawer is typically located near the two-way speaker. Because these moving elements of the remote banking system generally produce a great deal of noise, it becomes important to prevent this noise from being transmitted to the teller by the intercom system. To prevent the noise associated with mechanical movement at the customer's location from being transmitted to the teller, a muting circuit is provided which includes an input wire **74** which is normally maintained at a substantially zero voltage level. When the teller activates a moving drawer or a pneumatic carrier at the customer's location, a positive muting signal is applied to the muting input **74** which is shown at **75** in FIG. **2.** The positive muting signal can be generated in many ways. For example, when a teller-actuated drawer is moved by the teller, a switch can be activated by the drawer mover mechanism to apply a positive signal on the muting signal input line **74** during the drawer movement. In pneumatic systems, the signal can be generated whenever the pneumatic switch associated with the customer location is set to permit a pneumatic carrier to arrive at or leave from a customer location. This positive muting signal at input **74** is transmitted to the input **67** to NOR circuit **63** and causes the output **64** to drop as shown at **76.** The muting signal, therefore, causes the K2 relay to turn off, a condition which disconnects the speaker **21** from the power amplifier **38** to prevent sounds at the customer's location from being amplified and heard at the teller's location.

The muting signal is also applied to the AND circuit **62** which permits the switching of the K1 relay whenever the output **56** of the level-sensing circuit **55** becomes positive. This permits the teller to speak to the customer if he so desires while the muting signal is present. Communications from the customer to the teller, however, are prevented until the muting signal is removed, a condition which will occur when the mechanical movement of the drawer or pneumatic carrier has been completed.

In intercommunication systems of the type adapted for use in remote banking installations, it is important that the direction of communication be controlled by the teller. Since signals applied to the teller's microphone **40** are used to generate the logic control signal at point **56,** it is important to prevent sounds produced by the speaker **21** from being coupled to the microphone **40** and cause the network to switch when such switching is not desired. For example, a customer might have a very loud voice and it is important to prevent the customer's voice, as reproduced by the speaker **21,** from switching the control relays and cut off the customer's communication with the teller. Further, since the teller can control the level of the customer's voice by the level control circuit, it is desirable to prevent an increased customer volume from switching the direction of communication. Another source of undesirable switching is from the ambient noise conditions at the teller location itself. These noises arise from various activities within the bank itself and, as such, should not activate the switching logic to permit the teller to communicate with the customer.

To prevent the various feedback noises from switching the direction of communication of the intercom system, a feedback control system is included in the intercom system shown in FIG. **1.** The signal-carrying wire **22** has a voltage thereon which is proportional to the teller's setting of the variable resistor **28** which controls the volume of the customer's voice as reproduced by the speaker **21.** This signal is applied directly to the analog summing circuit **77.**

To compensate for the feedback generated by the sound reproduced by the speaker **21,** an automatic volume control amplifier **78** is electrically connected to the speaker **21** for receiving amplified electrical signals coming from the customer's location. The automatic volume control amplifier **78** preferably comprises an integrated circuit amplifier with an output wired to a variable gain amplifier stage whose output **79** is electrically connected to one input of the analog summing circuit **77.** As the volume of the customer's voice increases, the voltage on the output becomes increasingly negative.

The ambient noise control **81** as shown in FIG. **3A** comprises a variable resistance between a negative voltage supply and the input to the summing circuit **77.** The variable resistance is preset to apply a negative voltage to an input of summing circuit **77** which is sufficiently negative to prevent ambient noises of the teller location from causing the communication direction to change.

The summing circuit 77 comprises an electrical connection between the three inputs noted in FIG. 1 which is electrically connected to the input of an integrated circuit amplifier in the connection as shown in FIG. 3A. The output of the summing circuit 77 is applied to the wire 82 and comprises a negative signal which is applied to the control input of the voltage control amplifier 42. The negative signal on the output line 82 has a magnitude which is proportional to the input signal to the summing circuit 77 having the greatest negative magnitude.

The negative output signal from the summing circuit 77 is applied to the control voltage input of the voltage control amplifier 42. As the voltage output of the summing circuit 77 becomes increasingly negative, the gain of the voltage control amplifier is reduced. Consequently, the signals from the teller microphone 40 are not amplified as much by the voltage-controlled amplifier 42 when the output of summing circuit 77 becomes increasingly negative. The reduced gain will prevent the level-sensing circuit 55 from detecting a feedback signal loud enough at the teller microphone to cause the communication direction to change, thus insuring that the teller is in control of the communication direction.

The feedback controls also operate to produce an automatic volume control for the teller's voice. When the teller has switched the communication system to permit his voice to be reproduced by the two-way speaker 10, the resistor 83 is coupled between the power amplifier output 39 and the input to the automatic volume control amplifier 78. This signal is fed back to the voltage control amplifier 42 and automatically adjusts the microphone gain while the teller is speaking and is operative to automatically prevent the teller from producing a very high volume signal at the two-way speaker 10 by reducing the voltage-controlled amplifier gain 42 as the teller's voice level increases.

In a remote banking installation where more than one teller is available to assist more than one customer, a switching network is required to allow the teller to select which customer location he will assist. Such a network is shown in FIG. 4 where, for example, two teller locations and three customer locations are shown. This system includes a microphone and a speaker at each teller location and a two-way speaker at each customer location. There is an amplifier and associated control circuits 124 connected to the microphone and speaker at each teller location, each amplifier and associated controls comprising a network like that shown in FIGS. 3A and 3B. The customer connection points 125 and 126 correspond to the input line 11 and serve to carry the electrical signals going to and coming from the customer location. The microphone inputs 127 and 128 for the teller locations correspond to the teller microphone 40 connection, with the preamplifier 41 and the teller speaker connections 129 and 130 corresponding to the speaker connection to point 36.

To permit the tellers and customers to communicate with each other, a switching network 131 is provided for connecting the two-way customer speakers with the amplifier and associated control circuit 124 for the assisting teller. The switching network may take the form of a rotary stepping switch at each teller location. The teller simply sets the switch to a position corresponding to the customer location to which the teller desires to communicate and the desired customer two-way speaker is connected to the amplifier and associated controls 124. Once the communication path is established by setting the switching network as desired, the communication between the teller and the customer will proceed as described earlier for the system in FIG. 1.

A simple switching network such as described above has a serious drawback because more than one teller could attempt to communicate with the same customer location, a condition which would cause confusion. To obviate this possibility, a switching network like that in FIG. 5 may be provided which, for example, is for a system with three teller and six customer locations. The network shown in FIG. 5 is associated with the second of the three teller locations and identical networks must be provided for each of the other two teller locations. The network shown in FIG. 5 is operative to prevent more than one teller from attempting to communicate with the same customer location at the same time.

The circuitry of FIG. 5 is best described by way of example. Each teller location is provided with a plurality of customer selection switches 150, each switch comprising a plurality of single-pole, single-throw (SPST) switches ganged together and all ganged switches being simultaneously closed or opened. Each customer switch has as many SPST switches as there are teller locations in the system. Each of the switches has one contact grounded and the other contact connected to a wire labeled, for example, 2B. This labeling represents the teller No. 2 and the customer number (B). Whenever a teller attempts to communicate with a customer location, each of the ganged SPST switches associated with a given customer and a O signal will be placed on each of the connected lines, such as line 2B.

Assuming teller No. 2 wishes to communicate with customer B, teller No. 2 will close the switch 151 placing a ground or 0 level on the wire labeled 2B. The inverter 153 will produce a 1 level output when the input is a 0. The wire 2B is also connected to the NAND circuit 154 which produces a 1 level output whenever any input becomes a 0. The output of NAND 154 is one input to NAND 155 and will remain at the 1 level as long as teller No. 2 has one of his customer selector switches closed.

The select B signal appearing as a 1 level at the output of inverter 153 is applied to one input of the NAND circuit 156 which serves as a driver circuit for the relay coil K1. The select B signal is also applied to one input of NAND circuit 152. NAND circuit 152 produces a 0 output when teller No. 2 wishes to select customer B and the other two tellers are not selecting customer B, the latter condition is indicated by 1 level signals on lines 160 and 161 which connect to the B customer switches at the other two teller locations.

The output of NAND 152 is applied to one input of NAND 157 which produces a 1 level output whenever any of the inputs is a 0. The output of NAND 157 is applied to an input of NAND 155 which combines with the 1 level signal from NAND 154 to produce a 0 level output as long as teller No. 2 has switch 151 closed. This 0 level signal from NAND 155 is applied to one of the inputs to NAND 157 and is operative to form a latch circuit which will remain set until switch is opened. This latch circuit is necessary because the 0 signal at the output of NAND 152 would become a 1

level signal if any of the other tellers subsequently attempts to communicate with customer B, causing the NAND **152** output to switch to the 1 level.

The output of NAND **157** is also applied to a second input to NAND **156.** When both inputs to NAND circuit **156** are a 1, the output will be the 0 which causes current to flow through the K1 relay coil. Activating the K1 relay causes the K1 relay contact to close which then connects the amplifier and associated controls for teller No. **2** with the two-way speaker at the customer B location. Consequently, when a teller attempts to assist a given customer location, the switching network first determines whether that customer location is being assisted by another teller. If this condition does not exist, then the teller selecting the specific customer location is connected to the selected customer two-way speaker. Communication between the teller and the selected customer location will continue until the teller changes his selector switch. For example, when teller No. **2** opens switch **151,** a 1 level signal will appear on line **149.** Consequently, the output of NAND circuit **154** will become a 0 which operates to reset the latch circuit comprised of NAND circuit **155** and NAND circuit **157.** The 1 level signal on line **149** is applied to inverter circuit **153** and produces a 0 level signal at the output. This **0** level signal is operative to produce a 1 level signal output for NAND circuit **156** which causes the K1 relay to open, thus disconnecting teller No. **2** from the customer B two-way speaker. While the above description has described the teller No. **2** selection of customer location B, the circuit operates in an identical manner when teller No. **2** attempts to select other customer locations. Similarly, the identical networks of FIG. **5** for the other teller locations function as described for the teller No. **2** location and all the switching networks combined provide the desired switching system for connecting several tellers with several customer locations while preventing more than one teller from simultaneously communicating with the same customer.

While the foregoing description of the intercom system and the different switching networks has been made with particular emphasis upon the preferred embodiments therefor, it will be clear to those of skill in the art that numerous changes in form only can easily be made without departing the spirit of this invention. Specifically, the exact circuitry for the controls and the audio amplifiers may be modified according to generally known engineering techniques without changing the fundamental operation of the system. Additionally, the logical diagram of FIG. **5** which performs the desired network switching function can take on various other forms if different logical circuits are selected. Such modifications in form only can readily be made by those of skill in the art without departing from the spirit and scope of this invention as defined in the following claims.

What is claimed:

1. An intercommunication system for a remote banking installation comprising:

speech transducing and sound reproduction means located at a customer location;

a microphone and a speaker located at a teller location, said microphone and speaker being separate electrical components;

an amplifier means with an input and an output; and

a switching means responsive to teller signals at a first nonzero level output from said microphone produced by speech input to said microphone at a first acoustic loudness to establish a first switching configuration and responsive to teller signals from said microphone at a second nonzero level less than said first level produced by speech input to said microphone at a second acoustic loudness less than said first acoustic loudness to establish a second switching configuration, said second nonzero signal level being sufficient in magnitude to permit, upon amplification by said amplifier means, audible reproduction thereof by said customer sound reproduction means, said first switching configuration providing an electrical connection from the output of said amplifier to said customer sound reproduction means and an electrical connection from said microphone to the input of said amplifier to permit the teller to talk to the customer and said second switching configuration providing an electrical connection from the output of said amplifier to said teller speaker and an electrical connection from said customer speech transducing means to the input of said amplifier to permit the customer to talk to the teller, said switching means being unresponsive to a decrease in teller speech signals to a level below said first level, but in excess of said second level, to permit the teller speech signals output from the microphone to drop below said first level to a level exceeding said second level without changing said switching configuration,

said switching means being operative normally in said second switching configuration to facilitate communication from said customer to said teller without the switching of said switch means.

2. The interconnection system in claim **1** wherein said switching means includes sequential switching means for disconnecting said speaker from said output and disconnecting said speech transducing and sound reproducing means from said input followed by the delayed connection of said speech transducing and sound reproducing means to said output and the connection of said microphone to said input when the electrical configuration is switched from said second to said first configuration and for disconnecting said speech transducing and sound reproducing means from said output and disconnecting said microphone from said input followed by the delayed connection of said speech transducing and sound reproducing means to said input and the delayed connection of said speaker to said amplifier output when the electrical configuration is switched from said first to said second configuration.

3. The intercommunication system of claim **1** wherein said second level is at least 6 decibels lower than said first level.

4. The intercommunication system of claim **1** additionally including:

a microphone sensitivity control means connected between said microphone and said switching means for reducing said microphone signals when the output from said speaker increases said sensitivity control operative to prevent customer signals reproduced by said speaker from changing said switching configuration from said second to said first switching configuration.

5. The intercommunication system in claim **4** wherein said sensitivity control means additionally in-

cludes an ambient noise control means to reduce the microphone sensitivity to ambient noise levels at said microphone.

6. An intercommunication system for a remote banking installation comprising in combination:

a two-way speaker means at a customer location;

a microphone and a speaker at a teller location, said microphone and speaker being separate electrical components;

an amplifier means with an input and an output for amplifying audio signals;

a customer preamplifier including a volume control means located at the teller location, an input and an output;

a switching network means for electrically connecting in a first switching mode said two-way speaker to said customer preamplifier input, said customer preamplifier output to said amplifier input and said amplifier output to said speaker permitting a customer to speak to a teller, and for electrically connecting in a second switching mode said microphone to said amplifier input and said amplifier output to said two-way speaker permitting a teller to speak to a customer;

a teller voice amplitude-sensing means for sensing the amplitude of signals produced by said microphone and producing a first output control signal whenever the signals produced by said microphone, in response to speech input thereto at a first acoustic loudness, exceed a first predetermined nonzero level and producing a second output control signal whenever the signals produced by said microphone, in response to speech input thereto at a second acoustic loudness less than said first acoustic loudness, fall below a second predetermined nonzero level, said second predetermined nonzero level being less than said first predetermined nonzero level, but sufficient in magnitude to permit, upon amplification, audible reproduction thereof by said customer two-way speaker, and

control means responsive to said voice amplitude-sensing means to connect said switching network to its second mode in response to said first output control signal and to connect said switching network to its first mode in response to said second output control signal, permitting the teller's voice level to fall to said second predetermined nonzero level, lower than said first predetermined nonzero level, without causing said switching mode to switch from said second to said first switching mode,

said control means being operative to normally connect said switching network to its first mode to facilitate communication from said customer to said teller without switching said switch network.

7. The intercommunication system of claim 6 wherein said switching network includes a sequence switching control means producing a first switching signal for sequentially switching said speaker from said amplifier output and said customer preamplifier output from said amplifier input followed by a second switching signal to connect said two-way speaker to said amplifier output and said microphone to said amplifier input when said network switches from said first mode to said second mode and for producing a third switching signal for switching said microphone from said amplifier input and said two-way speaker from said amplifier output to said customer preamplifier input followed by a fourth switching signal switching said customer preamplifier output to said amplifier input and said amplifier output to said speaker when said network switches from its second mode to its first mode.

8. The intercommunication system in claim 6 wherein said control means includes a sequential switching network comprising means responsive to said output signal changing from said first to said second level for connecting said two-way speaker to said customer preamplifier input and disconnecting said microphone from said amplifier input followed by connecting said speaker to said amplifier output and connecting said preamplifier output to said amplifier input, said sequential switching means responsive to said output level changing from said second to said first level for disconnecting said speaker from said amplifier output and disconnecting said preamplifier output from said amplifier input followed by connecting said microphone to said amplifier input and connecting said two-way speaker to said amplifier output.

9. An intercommunication system for a remote banking installation comprising in combination:

a two-way speaker means at a customer location;

a microphone and a speaker at a teller location, said microphone and speaker being separate electrical components;

an amplifier means with an input and an output for amplifying audio signals;

a customer preamplifier including a volume control means located at the teller location, an input and an output;

a switching network means for electrically connecting in a first switching mode said two-way speaker to said customer preamplifier input, said customer preamplifier output to said amplifier input and said amplifier output to said speaker permitting a customer to speak to a teller, and for electrically connecting in a second switching mode said microphone to said amplifier input and said amplifier output to said two-way speaker permitting a teller to speak to a customer;

a teller voice amplitude-sensing means for sensing the amplitude of signals produced by said microphone and producing a first output control signal whenever the signals produced by said microphone, in response to speech input thereto at a first acoustic loudness, exceed a first predetermined nonzero level and producing a second output control signal whenever the signals produced by said microphone, in response to speech input thereto at a second acoustic loudness less than said first acoustic loudness, fall below a second predetermined nonzero level, said second predetermined nonzero level being less than said first predetermined nonzero level, but sufficient in magnitude to permit, upon amplification, audible reproduction thereof by said customer two-way speaker,

control means responsive to said voice amplitude-sensing means to connect said switching network to its second mode in response to said first output control signal and to connect said switching network to its first mode in response to said second output control signal, permitting the teller's voice level to fall to said second predetermined nonzero level, lower than said first predetermined nonzero level, without causing said switching mode to

switch from said second to said first switching mode, said control means comprising:

a delay means connected to the output of said voice amplitude-sensing means for producing at its output delayed signals from said amplitude-sensing means;

a NOR circuit having two inputs and one output, one said NOR input being connected to said voice amplitude-sensing means output and said other NOR input being connected to said delay output, said NOR output producing a first switching signal when said voice amplitude-sensing means output or said delay output is at said first level and said NOR output producing a second switching signal when said voice amplitude-sensing means output and said delay output are at said second level; and

an AND circuit with two inputs and one output, one input to said AND circuit being connected to said delay means output and said other AND input being connected to the output of said voice amplitude-sensing means, said AND circuit output producing a third switching signal when said voice amplitude-sensing means output is at its first level and said delay output is also at said first level, said AND circuit output producing a fourth switching signal when either input is at said second level of said voice amplitude-sensing means output, said first switching signal operative to disconnect said speaker from said amplifier output and to disconnect said preamplifier output from said amplifier input said second switching signal operative to connect said microphone to said amplifier input and said two-way speaker to said amplifier output, said third switching signal operative to connect said two-way speaker to said preamplifier input and disconnect said microphone from said amplifier input and said fourth switching signal operative to connect said speaker to said amplifier output and said preamplifier output to said amplifier input.

10. The intercommunication system in claim **6** additionally including:

a microphone gain control means for controlling the amplitude of the signals produced by said microphone and applied to the input of said voice amplitude-sensing means; and

means for reducing the gain of said microphone gain control means in response to increased amplitude signals at said amplifier output when said switching network is in said first mode preventing the customer's voice reproduced by said speaker from causing said switching network from changing from said first mode to said second mode.

11. The intercommunication system in claim **10** additionally including an impedance connected between said amplifier output and said gain reducing means when said switching network is in said second mode for providing an automatic volume control for the teller's communications to the customer.

12. The intercommunication system in claim **10** additionally including an adjustable microphone gain control means to set the maximum microphone gain for preventing ambient noise at the microphone from switching said switching network from said first mode to said second mode.

13. The intercommunication system of claim **6** additionally including:

a muting means for disconnecting said speaker from said amplifier output when said switching network is in said first mode, said muting means being responsive to a mute signal generated by a system associated noise producing apparatus at the customer location.

14. The intercommunication system of claim **6** additionally including:

at least one other two-way speaker located at one other customer location; and

a speaker switch means for electrically connecting only one two-way speaker to said switching network means.

15. The intercommunication system of claim **6** additionally including:

at least one other two-way speaker at another customer location;

at least one other intercommunication system as defined in claim **6**; and

a second switching network means between each said two-way speaker and each said switching network operative to connect only one two-way speaker to only one switching network, permitting each teller to communicate with one customer at a time.

16. The intercommunication system of claim **15** additionally including at least one additional two-way speaker means connected to said second switching network.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,849,603 Dated November 19, 1974

Inventor(s) Steve Proios

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 54, change "amplififer" to --amplifier--.

Column 5, line 18, change "input 32" to --output 32--.

Column 6, line 20, insert the word "circuit" between the words "pause" and "rectifies".

Colum 7, line 24, delete the word "charging", second occurrence.

Signed and sealed this 4th day of March 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

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