

- [54] **MACHINE CONTROL BY ACOUSTIC ENERGY**
- [75] **Inventor: Clifford James Hoffman, Oceanport, N.J.**
- [73] **Assignee: Bell Telephone Laboratories, Incorporated, Murray Hill, N.J.**
- [22] **Filed: Dec. 28, 1970**
- [21] **Appl. No.: 101,817**
- [52] **U.S. Cl. 179/90 R, 179/1 VC, 179/1 HF, 179/90 K**
- [51] **Int. Cl. H04m 1/26**
- [58] **Field of Search.....179/1 HF, 1 SA, 1 SB, 90 R, 179/1 VC; 273/138 A; 235/92 ST; 340/324 R, 148, 309.4, 309.5; 200/61.01; 325/22**

- [56]
- References Cited**

UNITED STATES PATENTS

2,700,546	1/1955	Glassen	273/138 A
3,536,836	10/1970	Pfeiffer	179/1 VC
3,612,766	10/1971	Ferguson.....	179/1 HF
2,881,892	4/1959	Ylinen	273/138 A

2,886,758	5/1959	Lehman.....	179/1 VC
3,573,785	4/1971	Miller.....	340/324 R

FOREIGN PATENTS OR APPLICATIONS

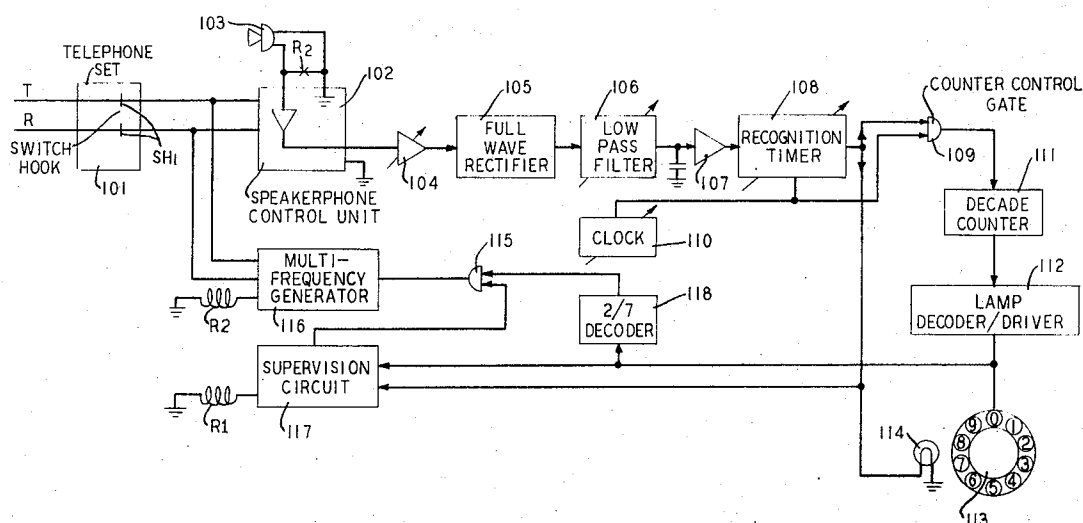
1,178,302	1/1970	Great Britain.....	273/138 A
-----------	--------	--------------------	-----------

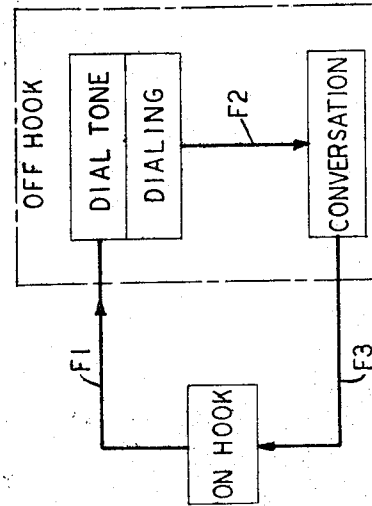
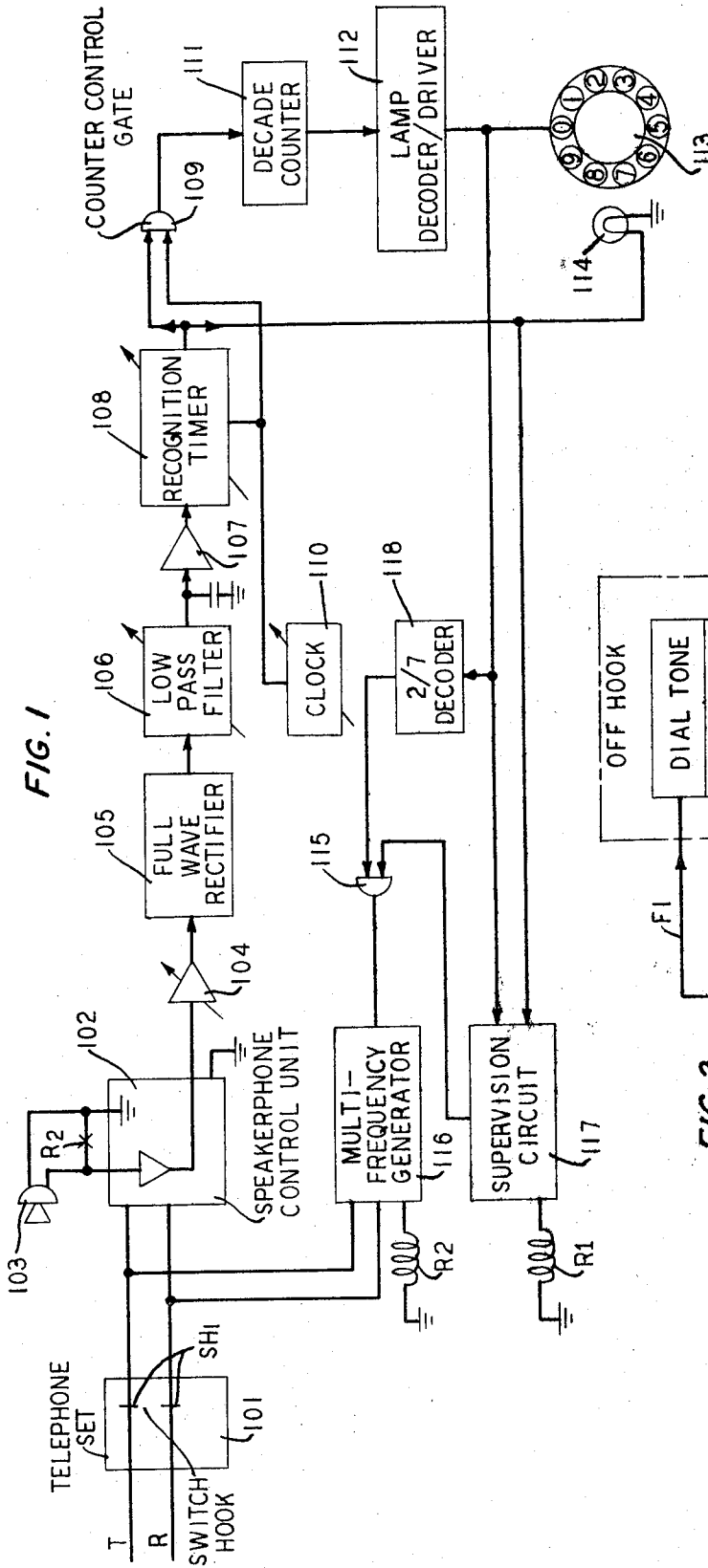
Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Thomas D'Amico
Attorney—R. J. Guenther and Edwin B. Cave

[57] **ABSTRACT**

Machine control is effected by the application of voiced commands or other acoustic energy to a transducer to coincide in time with one of a plurality of indicia being displayed sequentially by a clock-driven indicator. The encoded electrical output achieved thereby is utilized to actuate machine control switching apparatus such as a telephone dial and switchhook. Initiating forces other than acoustic, for example the manual closing of a single switch encoded in terms of time and duration of operation, may alternatively be employed in combination with the clock-driven indicator.

9 Claims, 2 Drawing Figures





INVENTOR
C. J. HOFFMAN
BY *E. J. Oliver*
ATTORNEY

MACHINE CONTROL BY ACOUSTIC ENERGY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to systems and machines, including telephone sets, that are operatively responsive to acoustic power.

2. Description of the Prior Art

In the area of machine control, the use of mechanical translation of voiced commands to effect machine operation is an attractive but elusive goal of long standing. Viewed from the standpoint of pure theory, machine translation of the human voice into written speech or other corresponding mechanical indicia would appear to be well within the reach of the powerful tools provided by modern computers and related electronic technology. Early steps toward machine translation of voiced speech are illustrated by U.S. Pat. No. 2,195,081, issued Mar. 26, 1940, where H. W. Dudley discloses a "sound printing mechanism." By an essentially electromechanical system, voiced speech is translated into electrical signals that are used for the actuation of keys that type out corresponding phonetic symbols. On first consideration, further translation of such symbols into machine commands would appear to be a relatively simple undertaking. This conclusion, however, overlooks the awesome complexities of human speech, including, for example, countless variations among individuals in terms of dialect, accent, pronunciation and speech quality. Nevertheless, additional progress in the field of machine speech translation has been made and currently available systems have the capability of converting a dozen or two different voiced orders into electrical machine control signals. Such systems are unduly complex, however, and their high cost makes them unsuitable for widespread or general purpose use.

SUMMARY OF THE INVENTION

A broad object of the invention is to reduce the cost and complexity of acoustically responsive machine control systems, including systems for the acoustic operation of telephone sets.

The stated object and additional objects are achieved in accordance with the principles of the invention by the translation of uniquely coded bursts of acoustic energy into electrical, switch-actuating signals. The coding of the acoustic bursts is carried out in terms of either inception time or duration or both, and it is this coding which enables the operator to give commands of considerable complexity, even though the capability realized falls far short of machine translation of speech in its strictest sense.

In accordance with one feature of the invention, acoustic-responsive switching means are employed in combination with a coding aid in the form of a visual, clock-driven, numerical display that sequentially indicates digit-designated time slots. By applying acoustic power, either by voicing the particular digit or by generating any suitable acoustic energy burst to coincide with the time slot of the visually designated digit, a numerically identifiable command is registered so that a corresponding machine control can be actuated. In this manner an otherwise conventional telephone dial can be made to generate electrical dial signals in response to voiced digits.

The basic concepts of the invention can be extended to control a variety of functions in addition to telephone dialing. For example, combinations of digits can be used as control codes to effect going on and off-hook. In accordance with a particular feature of the invention, control of the on/off-hook function of a telephone set is accomplished by a detector which senses a selected sequence of digits. During the dialing mode, the code detector is automatically inactivated to preclude inadvertent operation should the special code group occur as part of a telephone number.

An acoustically operated telephone set in accordance with the invention provides an extra dimension of utility in telephone set operation since complete hands-free, across-the-room operation is an extremely convenient capability. In the case of many physically handicapped people, however, acoustic operation becomes a matter of necessity if telephone service is to be made reasonably available to them.

As described, the principles of the invention may be turned to account advantageously by employing acoustic energy to effect encoded signals for machine operation and control. Within the scope of the invention, however, energy sources other than acoustic may be employed successfully in combination with a clock-driven sequentially display of visual indicia. Moreover, the clock-driven indicia may be in the form of an audio display rather than visual.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of a telephone set embodying of the features of the invention; and

FIG. 2 is a partial function block diagram of the telephone set of FIG. 1.

DETAILED DESCRIPTION

In FIG. 1 the telephone set 101 is illustrated by a separate block, although it is to be understood that all of the blocks shown, including the telephone set, may readily be incorporated together on a single chassis as an integrated operating unit. A conventional speakerphone control unit 102, including a microphone 103, is employed as an interface to the telephone line TR. Speakerphones or loudspeaking telephones are well known in the art and are shown, for example, in U.S. Pat. No. 3,075,045, issued Jan. 22, 1963 to W. F. Clemency.

The telephone set 101 is placed off-hook either conventionally by manual operation of the switchhook or in a manner in accordance with the invention to be described below. The speakerphone unit 102 produces an electrical output in response to an acoustic input to the microphone 103. The threshold control unit 104 allows the user to adjust the output of the speakerphone unit 102 to a satisfactory level. After full-wave rectification by the rectifier 105, a low-pass filter 106 allows for the adjustment of the minimum duration acoustic input necessary to effect dialing and switchhook operation. With the low-pass filter 106 set at maximum sensitivity, the system is made more responsive to finger clicks or similar voiced sounds, while at a minimum sensitivity setting, more prolonged inputs are required. A threshold detector 107 is designed to produce a logical "1" at its output whenever its input threshold is exceeded. An output from the threshold detector 107 initiates operation of a recognition timer circuit 108.

The adjustable clock 110 produces conventional clock pulses at a preselected rate which are applied both to the recognition timer 108 and, via a counter control gate 109, to a decade counter 111. The recognition timer 108 performs the function of receiving the output from the threshold detector 107 and by its output to the counter control gate 109 blocks the transmission of further clock pulses to a decade counter 111. As a result, the decade counter 111 is prevented from advancing to its next counting position. A succeeding input to the decade counter 111 is not applied until the recognition timer 108 is permitted to time out. The decade counter 111 is a simple 4-bit binary counter which counts up through repetitive cycles from "0" through "9".

A lamp decoder-driver circuit 112 translates the binary coded decimal output of the counter 111 to a one-out-of-10 code which, in turn, is employed to operate a lamp display unit 113. As shown, the lamp display 113 consists of a circle array of illuminable digits "0" through "9" and when in operation, each digit is lighted sequentially in ascending numerical order for some preselected period such as a half second for example. Insofar as the lamp display 113 is concerned, the effect of an acoustic input to the microphone 103 is to delay the progressive digit lighting action so that the number illuminated at the time of the acoustic input remains illuminated for some extended period, such as an extra half second for example. Additionally, and at the same time, an output from the recognition timer 108 is employed to light a recognition lamp 114 to provide supplementary visual feedback so that it is made evident to the user from the simultaneous lighting of the recognition lamp 114 and the prolonged lighting of one of the display numerals of the lamp display unit 113 that the digit so designated has been registered and is to be converted into a dialing or supervision signal.

The two-out-of-seven decoder 118 receives the one-out-of-10 code from the lamp decoder-driver circuit 112 and converts that signal to the standard two-out-of-seven multifrequency dialing code which is then utilized during the dialing mode to energize the multifrequency dial signal generator 116 by way of gate 115. The supervision circuit 117 continuously registers or keeps track of the mode or operational condition of the set. When the set is in the dialing mode a timed enabling signal is applied from the supervision circuit to the gate 115. Additionally, the supervision circuit 117 operates a relay R2 and its associated contacts R₂ so that the microphone 103 is disabled during dial signal generation. As a result, interference by unwanted acoustic inputs is prevented.

The particular acoustic input which may be employed to effect dialing is a matter of choice for the user. One method which has proved effective is to voice the digit desired at the time of or immediately before the time that the digit is illuminated on the lamp display unit 113. However, a snapping of the fingers, a clapping of the hands or virtually any burst of acoustic energy may be used in lieu of voicing.

The time t_N required to dial N_T digits in a system in accordance with the invention may be expressed as $t_N = N_T (5 + n_f)T$ if all digit sequences are equally probable. In this expression, $5T$ is the average time required to reach each digit; n_f is the number of additional clock periods used for feedback each time a digit is registered

and hence, the minimum mean time required to register a random digit is then $(5 + n_f)T$. It has been determined that most people can easily register digits with a clock period of 0.5 to 0.6 seconds (n_f is normally set equal to one). Accordingly, the minimum time required to dial a seven-digit telephone number is approximately 21 to 25 seconds. Experienced users, however, can register digits successively with a clock period as short as 0.3 seconds which gives a seven-digit dialing time of approximately 13 seconds.

Control of the on/off-hook function, in accordance with the invention, is accomplished by a simple detector (not specifically shown) which forms a part of the supervision circuit 117. The detector senses a selected sequence of digits, typically three digits, irrespective of the time relation between the digits. When the set is on-hook, entry of the code takes it off-hook through the operation of relay R1 and its associated contacts. During the dialing mode the code detector is inactivated in order to prevent inadvertent switchhook operation during dialing in the event that the on/off-hook code happens to occur as a part of a dialed telephone number. Entry into the conversation mode is detected by the supervision circuit 117 in response to any signal that exceeds a preselected duration and the code detector is reactivated thereby. It has been found that a 3-2-1 code for on/off-hook use is particularly effective.

The probability of random occurrences of three speech or noise inputs isolated in time in the same way as these digits is negligibly small. It has also been found, however, that a 1-3-5 code has desirable talk-off properties (resistance to spurious signals) and offers the additional advantage of a significant reduction in code entry time over the 3-2-1 code.

A fuller understanding of on/off-hook action may be had by referring to the mode or status diagram of FIG. 2. As indicated, it is the prevailing status of the system that determines what action is taken as a result of a digit being selected. Thus, for example, during the on-hook mode, no action is taken as a result of a digit being registered unless it is part of the on/off-hook code. A complete on/off-hook code takes the set off-hook, function F1, FIG. 2, and the user then waits for dial tone. Each digit selected thereafter results in a corresponding *m-f* dial signal being generated and applied to the line.

Upon completion of a call (or sooner if the call is to be aborted because of an error, a busy signal or a no-answer for example), the conversation mode is entered by sensing a prolonged energy burst (0.6 seconds for example), indicated by function F2. This action reactivates the on/off-hook code detector and prevents further dial signals from being generated. Upon completion of the conversation, the on/off-hook code is used to return the set to the on-hook state, as shown by the function F3 of FIG. 2. The sequence described is repeated each time a call is placed.

Although the invention has been described in terms of an embodiment employing acoustic initiation of machine control orders, it is evident, as indicated above, that certain principles of the invention are equally applicable to arrangements in which other energy sources, including manual power, may be used to initiate machine control orders. For example, a single switch, irrespective of how it is powered, may be

operated in combination with a visual or audio indicator of sequentially displayed numerals in order to register number encoded orders in the manner taught by the principles of the invention.

It is to be understood that the embodiment described herein is merely illustrative of the principles of the invention. Various modifications thereto may be effected by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. Acoustically operated machine control apparatus comprising, in combination,

first means for indicating sequentially each of a series of time intervals each corresponding to a respective preselected indicia,

second means responsive to an acoustic energy burst for generating a corresponding electrical signal,

third means responsive to a substantially coincident combination between one of said intervals and said signal for generating an encoded signal corresponding to that one of said indicia indicated by said last named interval, and

utilization means uniquely and operatively responsive to each respective one of said encoded signal.

2. Apparatus in accordance with claim 1 wherein said utilization means comprises a telephone set dial and wherein said dial generates dial signals each corresponding to said last named output.

3. Apparatus in accordance with claim 2 wherein said first means comprises a clock pulse generator.

4. Apparatus in accordance with claim 3 wherein said third means comprises a visual indicator sequentially displaying by illumination each of the digits corresponding to a telephone set dial under the control of said clock pulse generator, and means responsive to one of said electrical signals for arresting the operation of said clock generator for some preselected period whereby visual feedback of the registration of one of

said indicia is provided by the prolonged illumination of a corresponding one of said digits.

5. Apparatus in accordance with claim 4 wherein said utilization means further includes means for translating the output of said third means into dial switch actuating means.

6. Apparatus in accordance with claim 4 including means responsive to the registration of a preselected code in terms of a particular combination of digits for placing said telephone in an on or off-hook condition depending on the particular operating mode of said telephone set.

7. An acoustically operated telephone set comprising, in combination,

a clock driven display of sequentially illuminated digits, each being normally illuminated for a preselected period,

means responsive to a burst of acoustic energy coinciding substantially in time with one of said periods for registering an electrical signal indicative of the digit thus designated,

means for translating each of said registered signals into a dial switch actuating signal, and

means for applying each of said actuating signals to operate a dial signal generator.

8. Apparatus in accordance with claim 7 including means responsive to the registration of a preselected combination of said digits through the application of acoustic energy bursts for placing said set in an on-hook or in an off-hook mode dependent upon the existing operational mode of said set.

9. Apparatus in accordance with claim 7 including additional visual feedback means indicative of the registration of one of said digits comprising a signal actuated by one of said bursts exceeding a preselected level, and means for prolonging the illuminated period of any of said digits registered.

* * * * *

40

45

50

55

60

65