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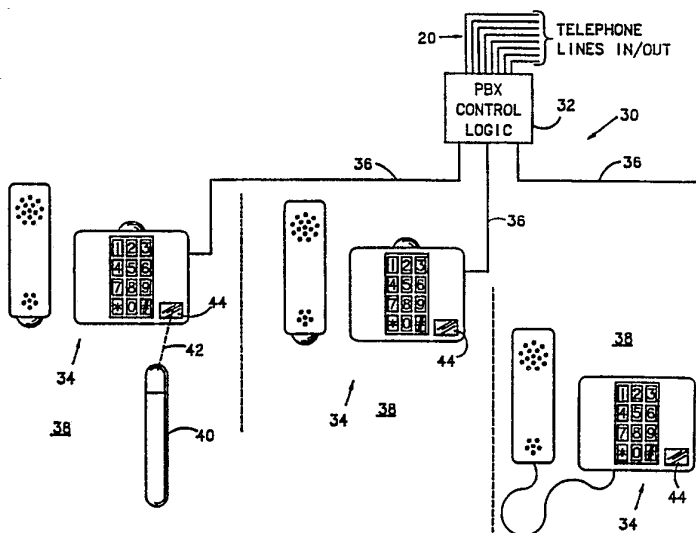
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(57) Abstract

Personal locator apparatus for advising central control and switching logic of present locations of respective ones of a plurality of users. The apparatus can be used to provide automatic recipient location switching in PBX type telephone systems (32), cellular telephone systems, and wide area computer networks. It also provides personnel location information. Each user-carried device may be a transmitting IR beacon, a passive reflecting IR beacon, or a readable device which must be inserted into a reader to register the user's location. The user-carried devices can also incorporate silent paging apparatus and can be used to advise a user of incoming cellular telephone calls so as to extend the in-use battery life of cellular telephones (40).

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5 PERSONAL LOCATOR AND CALL FORWARDING

BACKGROUND OF THE INVENTION:

10 This application is a continuation-in-part of application serial no. 795,887, filed 20 November 1991, now abandoned.

This invention relates to PBX type telephone systems and, more particularly, in a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected to a central control and switching logic by connecting wires, to the improvement to provide automatic call forwarding and personnel location information for access on request throughout the associated locations comprising, a plurality of personnel identifiers carried by individuals throughout the associated locations, each of the plurality of personnel identifiers having a unique readable identification code associated therewith; a plurality of code reading means associated with respective ones of the plurality of telephone extensions for reading the readable identification code of ones of the plurality of personnel identifiers; a plurality of detector logic means associated with and connected to respective ones of the plurality of code reading means and connected to a central control and switching logic through the connecting wires for obtaining the readable identification code of ones of the plurality of personnel identifiers from an associated one of the plurality of detector logic means and for forwarding an obtained the readable identification code to the central control and switching logic through the connecting wires; beacon logic table means associated with the central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of the plurality of personnel identifiers; and, beacon logic means

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associated with the central control and switching logic for receiving the readable identification code from associated ones of the plurality of detector logic means, for storing present ones of the associated locations where respective ones of the plurality of personnel identifiers are presently located in the beacon logic table means, and for causing calls for selected ones of the plurality of telephone extensions to be forwarded automatically to a present one of the associated locations where ones of the plurality of personnel identifiers associated with the selected ones of the plurality of telephone extensions are presently located.

Within business complexes requiring a number of telephones for individuals within a common organization, it is common to employ what can be broadly referred to as a PBX system. In such a system, the outside telephone lines come into a central distribution location. The central distribution location, in turn, is connected to telephone "extensions" throughout the complex. Many years ago, the connections between the incoming lines and the extensions were made by an operator employing plugs and jacks at a "PBX board". The PBX operators, when employed, now only have to push buttons to cause the calls to be routed to their proper destinations. In many installations, the PBX operator has been replaced by a voice response unit and the caller can route calls by inputting extension designations through a Touch Tone dialing pad.

While the two wires comprising the Tip and Ring of the telephone line used to be switchably connected from an incoming call to the called extension, the wire pairs running from each telephone extension to the PBX central computer now serve multiple functions. When a caller picks up the handset, the wire pair acts first as a data transmission line to the PBX central computer whereby the user can dial a number or accomplish a number of system parameters including resetting the system clock (such as at the change to and from Daylight

Savings Time) and the like. When a call is placed or received, the Tip and Ring of the outside line are connected to the telephone extension through the wire pair in the normal manner.

5 Within the telephone environment in general, so-called "wireless" telephones (i.e. without a cord to the handset) have become quite popular because the user is free to move about the work area while talking and is not limited by a connecting cord. Early wireless telephones employed a radio frequency
10 (RF) link between the user's telephone and the base portion connected to the telephone line. RF is subject to interference, however, particularly from fluorescent lighting fixtures which, unfortunately, is the most commonly used form of lighting in large installations. Personal computers and other electronic
15 apparatus which are common in most workplaces today can also cause interference with the operation of an RF wireless telephone. More recently, infrared (IR) linked telephones have become available, even with commercial PBX type systems. As depicted in Figure 1, the base IR link 10 which can be located
20 on the ceiling 12 and is connected to the telephone line (not shown) is linked to the user's telephone 14 by IR light beams 16 emitted from and detected by the user's telephone IR link 18.

One prior art PBX type telephone system employing IR linked telephones as developed by Bell Telephone Laboratories
25 is disclosed in the 1984 patent of Baker et al. (4,456,793). The basic approach of Baker et al. is shown in Figure 2. The outside telephone lines 20 come into a central office logic 22. The central office logic 22 includes a switching matrix (not shown) connecting it to a plurality of IR emitter/detector heads 24
30 located in zones throughout the building. As a user telephone 14 is moved from one zone to another, its location by zone is detected and an active call on an incoming telephone line is switched, as necessary, to the IR emitter/detector head 24 located in the zone where the telephone is presently located.

Another prior art approach to a PBX type telephone system employing IR linked telephones according to techniques of the inventors of this application is shown in Figure 3. The outside telephone lines 20 again come into a central office logic 22. In this case, however, the central office logic 22 is connected in parallel to a plurality of IR emitter/detector heads 24 located in rooms and hallways throughout the building. Self-contained repeaters can also be used to pass the light signals around corners and through walls. As a user telephone 14 is moved from one area to another, it is always directly or indirectly within line of sight of one of the IR emitter/detector heads 24. Signals are multiplexed through the IR emitter/detector heads 24 so that more than one user telephone 14 at a time can be connected to its own telephone line through the system of parallel IR emitter/detector heads 24.

As depicted in Figure 4, IR links are also employed to connect a handset 26 to its associated telephone instrument 28. In this case, the handset 26 contains only the microphone and earpiece speaker portions while the telephone instrument 28 contains the dial pad, ringer, etc. and is connected to the telephone line 20. According to other techniques of the inventors of this application, cellular telephone handsets (both active and passive) are also linked to their transceiver portions through an IR link.

As far as other features provided by many modern computer-controlled PBX type telephone systems, there is voice mail wherein a user can put his or her extension in an answer mode (using the dial pad as mentioned earlier) whereby a caller can leave voice messages which the user can retrieve from remote locations. Some systems allow a user to "call forward" incoming calls to another extension. Paging is usually accomplished by the users carrying a standard RF "beeper" or alpha-numeric pager which is operated by apparatus separate from the telephone system or by an amplified speaker system

(also separate from the telephone system) throughout the building. Speaker systems are typically loud and obnoxious and, therefore, are only employed where paging is necessary and the use of virtually silent paging through individually-carried pagers is impossible or impractical.

Except for exotic systems as used for taxicabs, police vehicles, buses, and the like, there is no simple way of knowing the location of individuals within a building or the like. This capability, of course, would be particularly useful in hospitals and similar situations where it is important to know where key personnel are at all times.

Wherefore, it is an object of this invention to provide an improvement to PBX type telephone systems wherein user calls are automatically forwarded to a location where the user is presently located.

It is another object of this invention to provide an improvement to PBX type telephone systems wherein key locations can lock out the forwarding of calls from other locations thereto.

It is still another object of this invention to provide an improvement to PBX type telephone systems wherein the telephone system keeps track of everyone's location for instant retrieval.

It is yet another object of this invention to provide an improvement to PBX type telephone systems wherein the telephone system can advise each user of the number of voice mail messages presently stored for that user's extension.

It is a further object of this invention to provide an improvement to PBX type telephone systems wherein the telephone system can silently page users.

It is an ultimate object of this invention to provide an improvement to PBX type telephone systems employing IR-linking for multiple benefits, added features, and improved performance.

Other objects and benefits of the invention will become apparent from the detailed description which follows hereinafter when taken in conjunction with the drawing figures which accompany it.

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RELEVANT PRIOR ART:

Examples of prior art of relevance to the present invention can be found in the following U.S. patents:

10 4,275,385 (White) - which describes a IR transmitting beacon personnel locator system which can be used to provide location information to a telephone switching network.

15 4,990,892 (Guest et al.) - which describes a IR transmitting beacon personnel locator system which identifies individuals by the frequency of transmitted pulse bursts.

2,499,475 (Ericsson et al.) - which describes a personnel locator system employing a cross-bar switching circuit activated by personnel inputs of identification codes at pre-established locations.

20 4,399,330 (Kuenzel) - which describes a mobile telephone system which transmits to fixed stations and charges according to user identification code numbers.

25 4,225,953 (Simon et al.) - which describes an RF or ultrasonic transmitting beacon personnel locator system which identifies individuals by the preprogrammed timing sequence of transmitted signals.

30 4,752,951 (Konneker) - which describes a system in which personnel locator system location information is provided to a telephone switching network for switching incoming calls to a destination associated with the present location of a subscriber. Reference is also made to patent 4,209,787 (Freeny) as to the preferred type of personnel locator system to be used.

4,225,953 (Simon et al.) - which describes an RF transmitting beacon personnel locator system for use with a telephone switching network which identifies individuals by a bi-directional polling sequence in which the personal beacons respond to polling signals from the local transmitters.

SUMMARY:

The foregoing objects have been attained in a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected to a central control and switching logic by connecting wires, by the improvement of the present invention to provide automatic call forwarding and personnel location information for access on request throughout the associated locations comprising, a plurality of personnel identifiers carried by individuals throughout the associated locations, each of the plurality of personnel identifiers having a unique readable identification code associated therewith; a plurality of code reading means associated with respective ones of the plurality of telephone extensions for reading the readable identification code of ones of the plurality of personnel identifiers; a plurality of detector logic means associated with and connected to respective ones of the plurality of code reading means and connected to a central control and switching logic through the connecting wires for obtaining the readable identification code of ones of the plurality of personnel identifiers from an associated one of the plurality of detector logic means and for forwarding an obtained the readable identification code to the central control and switching logic through the connecting wires; beacon logic table means associated with the central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of the plurality of personnel identifiers; and, beacon logic means

associated with the central control and switching logic for receiving the readable identification code from associated ones of the plurality of detector logic means, for storing present ones of the associated locations where respective ones of the plurality of personnel identifiers are presently located in the beacon logic table means, and for causing calls for selected ones of the plurality of telephone extensions to be forwarded automatically to a present one of the associated locations where ones of the plurality of personnel identifiers associated with the selected ones of the plurality of telephone extensions are presently located.

In one embodiment, the plurality of personnel identifiers comprises a plurality of transmitting beacons carried by individuals throughout the associated locations, each of the plurality of transmitting beacons comprising, a case, an identifier carried by the case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions, a battery carried by the case and connected to supply power to components of an associated transmitting beacon, a signal-emitting element carried by the case, and beacon logic carried by the case for causing the signal-emitting element to periodically transmit a signal including the unique binary number; and additionally, the plurality of code reading means comprises a plurality of signal detectors associated with respective ones of the plurality of telephone extensions.

Preferably in this embodiment, the signal-emitting element of each of the plurality of transmitting beacons comprises an infrared light-emitting element and each of the plurality of signal detectors comprises an infrared light detector outputting an electrical signal. Also, the beacon logic table means includes a present location table containing a last reported location for each of the plurality of personnel identifiers. Additionally, the beacon logic means includes logic for not forwarding calls to a

new location reported by one of the plurality of transmitting beacons until the new location has been reported twice whereby calls are not forwarded to locations reported during movement of ones of the plurality of transmitting beacons and only
5 forwarded to locations where ones of the plurality of transmitting beacons have remained for a period of time. The beacon logic table means may also include a forwardable-to table designating ones of the plurality of telephone extensions which can be forwarded to and ones which cannot and the
10 beacon logic means may include logic for not forwarding calls to a new location designated in the forwardable-to table as one which cannot have calls forwarded thereto. The beacon logic table means may also include an extensions status table designating ones of the plurality of telephone extensions for
15 which calls can be forwarded from and ones which cannot and the beacon logic means may include logic for not forwarding calls for ones of the plurality of telephone extensions designated in the extensions status table as ones which cannot have calls forwarded therefrom.

20 An additional improvement to the personnel identifiers comprises, receiver means for receiving transmitted multiplexed signals; annunciator means for advising a user of a signal receipt; and, paging logic means for recognizing received multiplexed signals received by the receiver means intended for
25 an associated one of the plurality of personnel identifiers and for activating the annunciator means in response thereto. Preferably, the receiver means is an infrared light detector outputting an electrical signal; the annunciator means comprises an alpha-numeric display; and, the paging logic means includes
30 logic means for retrieving alpha-numeric data from the received multiplexed signals and for displaying the alpha-numeric data on the alpha-numeric display.

In a second embodiment, the plurality of personnel identifiers comprises a plurality of passive reflecting beacons

carried by individuals throughout the associated locations, each of the plurality of passive reflecting beacons comprising, a case, an identifier carried by the case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions, a battery carried by the case and connected to supply power to components requiring power, a spatial light-modulating element carried by the case, reflector means for receiving incoming light beams, for directing the incoming light beams through the spatial light-modulating element, and for re-directing light beams modulated by the spatial light-modulating element back towards a source of the incoming light beams, and beacon logic carried by the case for causing the spatial light-modulating element to modulate light beams passing therethrough with the unique binary number; and wherein additionally, the plurality of code reading means comprises a plurality of light beam emitters and a plurality of signal detectors associated with respective ones of the plurality of telephone extensions. A light amplifier can also be employed to boost the strength of the modulated light signal returned to the source of the incoming light beams.

In a third embodiment, the plurality of personnel identifiers comprises a plurality of readable smart badges carried by individuals throughout the associated locations, each of the plurality of readable smart badges having a unique readable identification code; and, the plurality of code reading means comprises a plurality of readers including means for reading the unique readable identification code associated with respective ones of the plurality of telephone extensions.

The objects of the invention have also been attained by beacon apparatus for advising central control and switching logic of a cellular telephone system central control and switching site of present locations of respective ones of a plurality of users comprising, a plurality of transmitting beacons carried by respective ones of the plurality of users, each of the plurality of

transmitting beacons comprising, a case, an identifier carried by the case and including a binary number being an identification number of an associated user, a battery carried by the case and connected to supply power to components of an associated transmitting beacon, a signal-emitting element carried by the case, and beacon logic carried by the case for causing the signal-emitting element to periodically transmit a signal including the unique binary number; and, a plurality of detector/transmitters located at various known locations, each of the plurality of detector/transmitters comprising, a signal detector, detector logic means connected to the signal detector for detecting signals from ones of the plurality of transmitting beacons, and transmitter logic means connected to the detector logic means for receiving detected signals and for transmitting to the central control and switching logic the present location of users associated with identification numbers contained within the detected signals; wherein, the identification number is an electronic serial number of a cellular telephone of the associated user; the signal-emitting element is a cellular transmitter; and, each of the plurality of transmitting beacons additionally comprises, receiver means carried by the case for receiving transmitted cellular signals, annunciator means for advising a user of a signal receipt, and paging logic means for recognizing received cellular signals received by the receiver means intended for the cellular telephone of the associated user and for activating the annunciator means in response thereto.

The objects of the invention have additionally been attained by beacon apparatus for advising central control and switching logic of a wide area computer network central control site of present locations of respective ones of a plurality of users comprising, a plurality of transmitting beacons carried by respective ones of the plurality of users, each of the plurality of transmitting beacons comprising, a case, an identifier carried by the case and including a binary number being an identification

number of an associated user, a battery carried by the case and connected to supply power to components of an associated transmitting beacon, a signal-emitting element carried by the case, and beacon logic carried by the case for causing the signal-emitting element to periodically transmit a signal including the
5 unique binary number; and, a plurality of detector/transmitters located at various known locations, each of the plurality of detector/transmitters comprising, a signal detector, detector logic means connected to the signal detector for detecting
10 signals from ones of the plurality of transmitting beacons, and transmitter logic means connected to the detector logic means for receiving detected signals and for transmitting to the central control and switching logic the present location of users associated with identification numbers contained within the
15 detected signals; wherein, the identification number is a personal identification number of an associated user; and, the transmitter logic means includes logic for transmitting to the wide area computer network central control site the present one of the various known locations associated with a user's personal
20 identification number contained within the detected signals. The passive reflective beacons and the smart badges can also be used as the personal identification input devices in this application of the present invention.

25 DESCRIPTION OF THE DRAWINGS:

Figure 1 is a simplified drawing of a prior art approach to linking a telephone to the telephone lines by using an infrared link.

30 Figure 2 is a simplified drawing of a prior art approach to linking a telephone to a telephone line by using an infrared link wherein the location of the phone is sensed and the telephone line is switched to be connected to an emitter/detector head in the zone where the telephone is located.

Figure 3 is a simplified drawing of a prior art approach to linking a telephone to a telephone line by using an infrared link wherein a plurality of duplicate emitter/detector heads are in located throughout an area of service and the telephone uses
5 the emitter/detector head where it is presently located.

Figure 4 is a simplified drawing of a prior art approach to linking a telephone handset to the telephone instrument itself by using an infrared link so as to only replace the connecting cord.

Figure 5 is a simplified drawing of a PBX installation
10 according to the present invention in a basic embodiment wherein a transmitting coded beacon carried by each user is sensed by telephone instruments in various locations so that the user's calls can be forwarded automatically to the telephone instrument at the user's present location.

15 Figure 6 is a functional block diagram cross section of a beacon as can be used in the system of Figure 5.

Figure 7 is a functional block diagram of a telephone instrument as can be used in the system of Figure 5.

Figure 8 is a simplified flowchart of logic implemented in
20 the beacon of Figure 6.

Figure 9 is a functional block diagram of the PBX control logic of the system of Figure 5.

Figure 10 is a functional block diagram of the beacon logic tables of the system of Figure 5 including support for optional
25 features.

Figure 11 is a simplified flowchart of beacon logic implemented in the system of Figure 5.

Figure 12 is a functional block diagram cross section of a beacon as can be used for bidirectional information flow in the
30 system of Figure 5 as upgraded to provide optional additional features.

Figure 13 is a functional block diagram of a telephone instrument as can be used with the beacon of Figure 12.

Figure 14 is a functional block diagram of retrofit apparatus which can be employed with a standard telephone instrument to be used with the beacons of the present invention.

Figure 15 is a drawing of a wide area communications system with automated user location advisement employing the IR beacons of the present invention.

Figure 16 is a functional block diagram cross section of a passive, reflecting beacon as can be used in a first alternate approach to the preferred infrared transmitting beacon.

Figure 17 is a functional block diagram of a telephone instrument as can be used with the passive beacon of Figure 16.

Figure 18 is a functional block diagram of a telephone instrument as can be used with a registration approach to the present invention.

Figure 19 is a functional block diagram cross section of a passive, reflecting beacon as can be used in the first alternate approach to the preferred infrared transmitting beacon with the addition of an optical signal amplifier.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

A PBX type telephone system 30 according to the present invention is shown in simplified form in Figure 5. The system includes PBX control logic 32 into which the outside telephone lines 20 are connected. The PBX control logic 32 is connected to a plurality of extension telephones 34 by individual wire-pairs 36. As those skilled in the art will readily recognize and appreciate, the wire-pairs 36 could be replaced by optic fibers or an RF or IR link. Since the manner of connecting the individual extension telephones 34 to the PBX control logic 32 is not a point of novelty of this invention per se, the wire-pairs 36 are being employed because of their simplicity and to avoid detracting from the points of novelty being described herein. Also, it should be noted that the present invention can be employed with extension telephones 34 which are of the

standard cord-connected variety or of the wireless variety employing IR or RF linking. IR-linked extension telephones 34 according to the techniques of the inventors of this application are preferred as they give superior performance and flexibility.

5 IR, of course, is not subject to the various interference problems of a workplace that can effect RF wireless telephones, as mentioned above. By employing an active IR handset (i.e. one having the dialing capability therein) which includes features like stored pre-set numbers, etc., a user can carry the handset

10 from place to place and use those features whenever calls are made. The active IR-linked handset can also be used as a "universal" and personal handset into any IR-linked telephone system including public telephone access systems, private cellular, cellular boosting, and vehicular telephone system

15 (including in-flight systems). As will be appreciated from the description which follows hereinafter, IR-linking, by its unique line-of-sight performance characteristics, allows one to accomplish results not attainable using RF.

As depicted in Figure 5 by the dashed lines, each

20 extension telephone 34 is located in its own area 38. To accomplish the objects of the invention, each extension telephone 34 has an associated IR beacon 40 which is carried by a person or persons associated with the extension telephone 34. If desired, the IR beacon 40 can be made part of a badge or

25 other employee recognition system. As will be addressed in greater detail shortly, as a user wearing an IR beacon 40 moves from area 38 to area 38, the IR beacon 40 periodically sends out a coded IR beam 42 which is detected by an IR detector 44 on the closest extension telephone 34 and transmitted to the PBX

30 control logic 32. Thus, the PBX control logic 32 knows the present location of each person wearing an IR beacon 40. From this information, the PBX control logic 32 can automatically forward calls to the extension telephone 34 where each user is presently located and, additionally, can advise authorized

requestors as to anyone's location on request. The manner in which location information is requested and provided is a matter of choice and can be accomplished by any of a number of ways well known in the computer art. A preferred way would be for the requestor to input the desired person's employee ID or telephone extension number through the Touch Tone pad of any extension telephone 34 and for the PBX control logic 32 to then employ a voice response unit to advise the caller of that person's present location. If more than one person shares a particular extension telephone 34, the IR beacon 40 would have to transmit the person's employee ID number in each case for location purposes. The PBX control logic 32 can, of course, include a cross-reference table associating each employee ID number with an associated extension telephone 34. Only one employee (if any) could be associated with call forwarding in such case, however, or there would be confusion to callers. Where automatic call forwarding is desired, it is preferable to associate an extension telephone 34 with each individual who is to have calls forwarded.

One possible configuration for the IR beacon 40 is shown in Figure 6. The IR beacon 40 is housed in a pen-sized case 46 having a clip 48 thereon for securing the IR beacon to the user's pocket or clothing. The IR beacon 40 is powered by one or more batteries 50 which are preferably of the rechargeable type. The batteries 50 can be recharged by placing them in a recharging receptacle (not shown) provided for the purpose in the users extension telephone 34. There is also a set of so-called DIP switches 52 for setting the extension (or other) number associated with the IR beacon 40. Other number setting apparatus or methods known in the art (such as an EPROM for a large number of extensions) could also be employed. Connected to the DIP switches 52 is logic 54 which, in turn, is connected to drive an IR emitter such as a light emitting diode (LED) 56. The top 58 of the case 46 is preferably of an IR

transmissive plastic so as to protect the LED 56 while letting emitted IR beams 42 to pass therethrough. The logic 54 is relatively simple. A timer in the logic 54 periodically reads the DIP switches 52 and causes the LED 56 to output a binary
5 number sequence on the IR beams 42 representing the number sequence set into the DIP switches. To extend battery life and prevent false readings during user movement from place to place, the timer should only cause transmission every thirty seconds or so -- or even less frequently if desired. With modern
10 computer and support technology, it would be a simple matter to provide a voice response message to a caller advising that the called party is presently away from his/her extension, not yet at a forwardable location, and for the caller to call back shortly or, optionally, leave a voice mail message. As will be seen from the
15 description which follows hereinafter, with the preferred embodiment of the present invention, the caller can also be given the option of silently paging the called party.

An extension telephone 34 to be employed with the IR beacon 40 is shown in functional block diagram form in Figure
20 7. There is logic 62 connected to the wire-pair 36 for the extension as well as to the handset 26, the dial pad 64, memory 65, and the IR detector 44. The logic 62 is also simple and operates as depicted in Figure 8. If the IR detector 44 is separately wired to the PBX control logic 32, the logic 62 is
25 unnecessary. In most instances, however, the wire-pairs 36 will be the only connection available to the extension telephones 34. Any inputs from an IR beacon 40 are always stored by the logic 62 into the memory 65. Preferably, the memory 65 will hold several numbers for the case when several people are in a
30 forwardable office at one time for a meeting or the like. In such case, the storage portion of the logic 62 will have to check the incoming numbers and store different numbers in different locations of the memory 65. After that, the logic 62 checks to see if the extension telephone 34 is off hook (i.e. in the process

of using the associated wire-pair 36 for a call in progress. If it is, the handset 26 and dial pad 64 are connected to the associated wire-pair 36. If not, the handset 26 and dial pad 64 are disconnected from the associated wire-pair 36. The "ringing" portion of the extension telephone 34 is always connected to the wire-pair 36 so that the extension telephone 34 can be called by the PBX control logic 32. When the handset 26 and dial pad 64 are disconnected from the associated wire-pair 36, the logic 62 watches for a query signal from the PBX control logic 32. When a query signal is received over the wire-pair 36, the logic 62 transmits the contents of the memory 65 to the PBX control logic 32 and then clears the memory 65.

The PBX control logic 32 is depicted in functional block diagram form in Figure 9. It goes without saying that as with virtually all contemporary telephone systems, all control and switching logic is binary in nature under the control of one or more microprocessors as well known and understood by those skilled in the art. The outside telephone lines 20 are connected into telephone logic 66 which is substantially the normal switching and control logic employed in conventional computer-controlled PBX telephone systems. The telephone logic 66 is, of course, modified as necessary to interface with the capabilities provided by the present invention. The necessary modifications to the telephone logic 66 to effect such interface will be apparent to those skilled in the art and will depend in each case upon the configuration of the telephone logic 66. No attempt will be made to address the modifications to the telephone logic 66 herein therefore. The telephone logic 66 is also connected to the wire-pairs 36 leading to the extension telephones 34 in the usual manner. To effect the objects and features of the present invention, beacon logic 68 is connected in parallel to the wire-pairs 36 to receive the incoming signals from the IR beacons 42. The beacon logic 68 is connected to a memory containing the beacon logic tables 70. There is also a data/control transfer

connection 72 connecting the beacon logic 68 to the telephone logic 66 over which the beacon logic 68 can advise the telephone logic 66 of call forwarding changes and the like which are actually accomplished by the telephone logic 66. The telephone logic 66 can also query the beacon logic 68 before taking any action over the data/control transfer connection 72. In other words, call forwarding by a user from his/her telephone instrument using the Touch Tone keypad is known in the art (and, therefore, a prior art part of the telephone logic 66). To effect automatic call forwarding, therefore, the beacon logic 68 only has to send a signal over the data/control transfer connection 72 which is received and interpreted by the telephone logic 66 as a call forwarding request from the particular extension being forwarded by the beacon logic 68. Similarly, the telephone logic 66 could check with the beacon logic 68 before ringing any incoming calls to allow the beacon logic 68 to make any last minute changes effecting the incoming call. Such techniques would be trivial to those skilled in the art and could be accomplished without undue experimentation.

Typical contents of the beacon logic tables 70 are depicted in Figure 10. If the IR beacons 40 transmit employee ID numbers, the beacon logic tables 70 would include the cross-reference table (not shown) mentioned above. To effect some of the features to be discussed hereinafter, the beacon logic tables 70 might include a present location table 74, an extensions forwardable to table 76, an extensions status table 78, and a voicemail received table 80. These various tables will be referred to in the descriptions which follow.

A possible implementation for the call forwarding portion of the beacon logic 68 is depicted in flowchart form in Figure 11. At block 11.01, the logic 68 starts at extension number 1 (i.e. the first extension telephone 34 in the scanning sequence). At query block 11.02 it checks to see if that extension telephone 34 is "on hook" (i.e. not being used). If it is not in use, the logic 68

sends a query signal down the wire-pair 36 to that extension telephone 34 at block 11.03. At query block 11.04, the logic 68 looks for a beacon input response from the memory 65 of the extension telephone 34. If there were stored numbers in the memory 65 of the queried extension telephone 34, at block 11.05 the logic 68 goes to the present location table 74 and obtains the last known and stored present location of each extension number transmitted from the queried extension telephone 34 (i.e. each IR beacon 40 presently in the area of that extension telephone 34). At block 11.06, the logic 68 stores the present locations into the present location table 74 and flags those locations which are a repeat. Without the flagging, a person walking down the hall could have his/her location falsely reported if picked up by an extension telephone 34 that is passed as the IR beacon 40 transmits its IR signal. The personnel location logic, of course, can report a passed location as the last known location; but, calls should not be forwarded except to a stable new location. Thus, by requiring that the IR beacon 40 broadcast twice from a given extension telephone 34 before calls are forwarded thereto, this is automatically taken care of because of the time delay between IR transmissions from the IR beacons 40. Having updated the present location table 74 with respect to this queried extension telephone 34, the logic 68 at query block 11.07 then determines if the last extension telephone 34 has been queried. If it has, the logic 68 proceeds to block 11.08. If not, it goes to block 11.09 to set up to query the next extension in the query sequence and then returns to query block 11.02. If the logic 68 at query block 11.02 finds that the extension telephone 34 to be queried is off hook (i.e. using the wire-pair 36 in an active call), it proceeds to query block 11.07 and skips the extension telephone 34 this query sequence. If the logic 68 at query block 11.04 gets no response from a queried extension telephone 34 (i.e. there is no IR

beacon 40 transmitting at that location), it again proceeds to query block 11.07.

Once the above-described query sequence has been accomplished by the beacon logic 68, the beacon logic 68 begins its forwarding update sequence at block 11.08 by starting at extension number 1 which, in this case, is the first entry of the present location table 74. At block 11.10, the logic 68 gets the present location of the extension telephone 34. At query block 11.11, it checks to see if the IR beacon 40 for that extension telephone 34 has reported in from a location other than the location of the extension telephone 34 (i.e. the user is "away" from the extension telephone 34). If yes, at query block 11.12 the logic 68 checks to see if the present location is flagged as described above (indicating a non-transient situation). If yes, the logic 68 at block 11.13 then checks the extensions status table 78 to see if this extension telephone 34 can have its calls forwarded. In this regard, as those skilled in the art will recognize and appreciate, several features can be implemented in association with the extensions status table 78. Also, the entries of the extensions status table 78 can be updated automatically by the system logic or by user inputs from a Touch Tone pad according to techniques well known in the art. Thus, users who do not want calls forwarded automatically can set that status either permanently or temporarily when desired. In any event, if calls are being forwarded for this extension telephone 34 at this time, the logic 68 then goes to query block 11.14 to see if the present location is a forwardable location. To do this, the logic 68 checks the forwardable to table 76 (which is also updateable and settable by the user of that extension telephone 34 through the Touch Tone pad thereof). Key executives, for example, may not want to have the calls of others forwarded to their office. Likewise, conference rooms with multiple people in attendance may be locked out from annoying interruptions from multiple calls being forwarded for the duration of a meeting. If

this is a forwardable location, at block 11.15 the logic 68 forwards the call to the new location. As mentioned above, this can be accomplished by the logic 68 sending an appropriate signal on the data/control transfer connection 72 to "fool" the telephone logic 66 into thinking that the user of that extension telephone 34 is implementing call forwarding through the Touch Tone pad thereof. The logic 68 then proceeds to query block 11.16. The logic 68 also proceeds to query block 11.16 in the event of a NO answer from any of the query blocks 11.11, 11.12, 11.13, or 11.14. At query block 11.16, the logic 68 exits if the last extension telephone 34 in the present location table 74 has been updated. If not, the logic 68 moves to block 11.17 to move to the next entry in the present location table 74 and then returns to block 11.10.

To close the loop with respect to call forwarding and personnel locating, the sensing aspects of extension telephones 34 should be placed at entrances and exits. Thus, as employees and other authorized users leave the controlled environment with their IR beacons 40, the fact that they are gone will be known for locating purposes and calls will no longer be forwarded or run through. The most practical implementation would be to have the beacon logic 68 automatically place the extension telephone 34 of a departing user in the voice mail answering mode by an appropriate signal to the telephone logic 66 over the data/control transfer connection 72 as described above to implement call forwarding.

As those skilled in the art will appreciate, the present location table 74 provides the last known location of each IR beacon 40. Conventional techniques well known in the computer can be used to access this information and provide it to a requestor. All these techniques form no part of the novelty of this invention and, therefore, will not be addressed herein.

The additional objectives of this invention are accomplished by making the IR link between the IR beacon 40

and the extension telephones 34 bi-directional. An IR beacon 40' for such use is shown in Figure 12. The components of the basic IR beacon 40 of Figure 6 are the same. In addition, however, there is also an IR detector 82 (such as a phototransistor), a liquid crystal display (LCD) 84, and a buzzer 86 connected to the logic 54'. Broadcast information from the PBX control logic 32 received by the IR detector 82 can be employed by the logic 54' to create an appropriate display on the LCD 84 or sound the buzzer 86. For example, the contents of the voicemail received table 80 could be broadcast periodically to those IR beacons 40' having waiting voicemail and the number displayed on the LCD 84 for periodic checking by the wearer. Broadcast information from the PBX control logic 32 to the IR beacons 40' would, of course, have to be transmitted in parallel to all emitting sites and employ multiplexing techniques well known to those skilled in the art which form no part of the points of novelty of this invention. Similarly, a user could be paged by simply sending a multiplexed signal recognized by the logic 54' causing the logic 54' to sound the buzzer 86. In such case, as with RF pagers, the user would have to know who to call when the buzzer 86 is activated (typically the local operator). The IR beacon 40' could also be operated as an alpha-numeric pager by having the extension number of a calling/paging extension telephone 34 be sent as part of the multiplexed signal from the PBX control logic 32 so that the logic 54' in the receiving IR beacon 40' can display the caller's extension number on the LCD 84. Thus, as mentioned earlier herein and as stated as a object of the invention, the present invention can provide both virtually silent paging (both advisory and alpha-numeric) and voicemail status information to users away from their base location as part of an overall IR-linked PBX telephone system.

An extension telephone 34 configured for bi-directional communications with the IR beacons 40' is depicted in Figure

13. In addition to the elements of the receive and forward only extension telephone 34 of Figure 7 comprises an IR emitting LED 56'. As those skilled in the art will undoubtedly recognize and appreciate, the IR emitting LEDs 56' could also be
5 connected in parallel to a single wire pair running through the building(s) and connected back to the PBX control logic 32.

While it is preferred that the present invention be implemented as part of a total IR-linked, PBX type telephone system for the total benefits and improvement in performance
10 such equipment can provide, it is understandable that companies and other organizations having recently-installed, computer-controlled PBX type telephone system would not want to replace them to obtain the benefits of the present invention. For these purposes, retrofit apparatus for converting
15 existing telephone systems to operate according to the present invention as depicted in Figure 14 will now be described. In a standard computer-controlled PBX type telephone system to which the features of the present invention are to be added, there is a standard telephone 14 having an RJ-11 jack 88 into
20 which its wire-pair 36 is plugged using an RJ-11 plug 90. To add the above-described features of the present invention, an interface unit 92 is associated with each telephone 14. While the above-described integral implementations most likely derive their power from the telephone system power source, the
25 interface unit 92 can be powered by one of the plug-in transformer type power supplies commonly used with transistorized electronics devices. A convenient implementation for the interface unit 92 would be to make it of a size so as to provide a base upon which the telephone 14 can sit as shown in
30 Figure 14. While a bi-directional interface unit 92 will be described, a detect and forward only implementation could, of course, be employed if only the automatic call forwarding and personnel locating benefits were desired. To retrofit an existing computer-controlled PBX type telephone system, the beacon

logic 68 aspects of the invention as described above would have to be connected to the existing telephone logic 66. Since this principally involves paralleling each wire-pair 36 into the beacon logic 68 and providing a data/control transfer connection 72 by which to "fool" the telephone logic 66, that aspect could be accomplished by those skilled in the art without undue experimentation. Other than that, the interface units 92 would have to be installed -- which is a matter of plug-exchange as when installing an answering machine to a telephone. Thus, the RJ-11 plug 90 connected to the wire-pair 36 of the telephone 14 is removed from the telephone 14 and plugged into the INPUT RJ-11 jack 88 of the interface unit 92 and a jumper wire pair 94 plug-connected between the OUTPUT RJ-11 jack 88 of the interface unit 92 and the RJ-11 jack 88 of the telephone 14. Functionally, the interface unit 92 operates like the telephones of Figures 7 and 13. Since the interface unit 92 controls the connection of the wire-pair 36 to the telephone (and not just the connection to the handset 26 and dial pad 64) the interface unit 92 should include a ringer 96 to signal an incoming call. The logic 62, on the other hand, can detect the on/off status of the telephone 14 through the jumper wire pair 94.

As those skilled in the art will appreciate, the interface unit 92 as shown in Figure 14 including the IR detector 82 connected to the logic 62 can also be employed to add other IR-linked telephone features to the existing computer-controlled PBX type telephone system and/or the standard telephones 14. For example, any IR-linked telephone apparatus could be connected to the wire-pair 36 through the interface unit 92. This could include IR-linked handsets, telephones, cellular telephones, "universal" handsets, facsimile devices, and computer modems. All that would be required is minor modification to the logic 62 so that the telephone 14 and the interface unit 92 could be selectively connected in parallel to the wire-pair 36 for such uses rather than as in the above-described

purposes wherein the use of the wire-pairs 36 is, by necessity, mutually exclusive.

As those skilled in the art will further appreciate, the use of IR for the transmitting aspects of the IR beacons 40 is preferred because the line-of-sight characteristics of light transmission limits detection of signals emitted from the IR beacons 40 to locations (such as rooms) where they are located whereas an RF transmitter in the beacon could transmit through walls and lead to confusion unless complex and costly specialized shielding and/or directional antennas were employed. IR is also preferred for the transmission of the paging and voicemail signals as well so as to completely eliminate any RF transmissions being required; however, if desired RF could be used for such purposes within the scope and spirit of the present invention since the multiplexed signals with that data are being broadcast in general throughout the entire area of telephone service.

Finally, as those skilled in the art will also recognize and appreciate, the transmitting IR beacon 40 could be employed outside of a localized PBX to provide the same personnel locating and tracking capabilities on a large scale -- i.e. even nationally and internationally. Such a system is depicted in simplified form in Figure 15. Presently, there is much planning and development taking place aimed at a true universal communication system. In particular, next generation computers and computer systems are being designed which will include intra-computer networks wherein telephonic transmissions will be just another form of digital data transmission along with packetized computer data and messages. In such systems, each user is assigned a unique identification code. By logging onto the network and telling the network where he/she is (or will be), all messages to the user will be routed automatically to his/her location.

This, of course, is similar to the approach employed by cellular telephones in their roaming mode wherein the cellular telephone when turned on periodically transmits its electronic serial number (ESN) to the nearest cell site from which it is entered into the computer switching network logic. Thus, when the telephone number of the cellular telephone is called, its actual location can be traced by cross reference to its ESN and the call routed to that location. By fitting all communications under the aegis of the computer link as described above, only one user identification number is required; but, the user must log-on and advise the network of changes in location. By providing IR input units 98 at various sites connected by cables 100 to the telephone lines 20 (or connected cables 102, microwave links 104, or the like) and from thence to the central switching and control computer site 106 along with each user carrying one of the small and easily transportable IR beacons 40 of this invention as described above, each user would automatically and periodically advise the large-scale communications network of his/her location so as to receive incoming calls and other data transmissions at the nearest appropriate equipment site to the last reported location. In that case, of course, the IR beacons 40 would each be assigned (and transmit) each user's unique identification code which could then be cross-referenced against any other numbers associated with the user by the central switching and control logic in the manner described above. For such uses, the replacement of the DIP switches with an EPROM for containing the user's unique identification code as mentioned above is a preferred approach.

For example, in the present mode of operation, for a caller to call a party via cellular telephone two things are required -- (1) the caller must know the telephone number (area code + telephone number) of the cellular telephone of the called party and (2) the called party must have his/her cellular telephone on and in a stand-by mode so that the present location of that

cellular telephone is known to the cellular system. This, of course, causes battery drain and loss of in-use transmit time from the periodic transmissions of the cellular telephone for location advisory purposes. To try other calling modes
5 (electronic mail, voice mail, standard telephone, etc.), the caller must know the separate numbers or calling sequences of the called party for those other communications systems. In today's society, it is not uncommon for a party to have a home telephone number, a work telephone number, a car cellular
10 telephone number, a portable cellular telephone number, and an identifier on a computer network. By contrast and as depicted in Figure 15, if each user has a single unique identification code as suggested and each user carries an IR beacon 40 according to the present invention periodically
15 transmitting the user's unique identification code to the network (from a known site), a caller can call the user wherever he/she is by dialing that one unique identification code number associated with the user. Thus, if the caller calls on a cellular telephone, the call can be routed to the nearest home telephone
20 number, work telephone number, car cellular telephone number, or portable cellular telephone number as appropriate. Similarly, even if the caller calls from a public telephone booth employing the called party's unique identification code number, the call can still be routed to any type of communications device
25 designed to handle the call as appropriate to the called party's present location. Thus, the call from the telephone booth may be routed to the called party at a telephonic-compatible computer terminal connected to a wide area network (WAN) and be handled by local digital voice mail if the called party is
30 not there to accept the incoming call in person. The called party can, of course, access his/her voice mail from anywhere according to the same techniques regardless of where it is stored. The passive reflective beacon and the readable smart badge to be described hereinafter can also be used as the

personal identification input device in the above application in place of the transmitting beacon, if desired, within the scope and spirit of the present invention.

Until such time as the above-described universal communications network with single user identification numbers becomes a reality, the IR beacons 40 in combination with the IR input units 98 at various locations can still be put to good use outside of the localized PBX environment described in detail hereinbefore. For one thing, the IR beacons 40 can be set up to periodically transmit several identification numbers associated with the user in the absence of a "universal" identification number. Thus, a work telephone number and extension identifier (or employee ID number) could be transmitted and then be relayed back by an IR input unit 98 (employing a standard telephone line 20 by "dialing" the transmitted telephone number) to a PBX control logic so as to call-forward outside of the building. Of course, personnel presence at remote locations would also be provided by such an implementation. Similarly, the IR beacons 40 can be set to transmit the ESN of a cellular telephone of the user and the logic 62' of the IR input sites 98 adapted to forward the information (directly or indirectly) to the nearest cellular central office site (in place of the central switching and control computer site 106 of Figure 15) just as if the cellular telephone itself were transmitting its location in the stand-by mode. By including an RF paging "beeper" in the IR beacon 40 in the manner described above which is responsive to the transmitted call identifier of the associated cellular telephone, the normal problems of battery drain in the stand-by mode with loss of in-use transmit time can be eliminated (along with the requirement of having the cellular telephone out in the open). Using this approach, the cellular telephone could be left in a briefcase or purse in the off condition while the IR beacon 40 transmitted the ESN and responded to (but did not answer) incoming calls.

When the pager buzzer 86 associated with the cellular telephone sounded to indicate an incoming call, the cellular telephone could be taken out and turned on so as to answer the call in progress in the usual manner. For such cellular advisory and response use, the IR beacons 40 could, of course, be implemented to transmit their ESN signals as RF signals at the cellular frequencies so as to directly advise the nearest cell site of the cellular telephone's presence.

While the use of a transmitting IR beacon as described above as the personnel positional location input device is preferred, other approaches to inputting the location information within the scope and spirit of the present invention can also be employed, as mentioned above. Two such approaches will now be described. The first is the use of a passive reflecting "beacon" and the second is the use of a badge containing readable information which is then read when a user desires to register his or her present location with the system.

Turning first to Figure 16 a passive, reflecting beacon 108 is depicted. The passive, reflecting beacon 108 can operate according to the preferred techniques described in Letters Patent No. 4,916,296 of Donald A. Streck, entitled LIGHT MODULATING SMART CARD, which issued 10 April 1990, the teachings of which are incorporated herein by reference. In this embodiment, the plastic case 46 of the beacon 108 includes a compartment 110 having a transparent front surface. A pair of reflectors 112 are disposed at opposite ends of the compartment 110 at 45° angles to the longitudinal axis of the compartment 110 so as to reflect incoming IR beams 42 striking one reflector 112 along the length of the compartment 110 to strike the other reflector 112 and be reflected back towards the source thereof. Preferably, the reflectors are parabolic-like in shape so as to gather incoming IR beams 42 from various incoming angles and reflect them along the length of the compartment 110 to strike the other reflector 112. A spatial

light modulator 114 as described in the above-referenced '296 patent is disposed within the compartment 110 so as to have IR beams 42 from one reflector 112 to the other reflector 112 pass therethrough. The spatial light modulator 114 is connected to
5 and driven by the logic 54' which, in turn, is connected to the DIP switches 52 designating the extension (or other) number associated with the beacon 108. Thus, the IR beams 42 reflected back to the source are modulated by the spatial light modulator 114 with the identification information supplied to
10 the logic 54' in the manner of the transmitting beacon described earlier herein. By including a light detector in the path along with the spatial light modulator 114, modulated IR beams 42 entering the beacon 108 and containing paging information can be detected and the signal developed therefrom conducted to
15 the logic 54' so as to have the logic 54' activate the buzzer 86 and display 84 substantially as described with respect to the earlier embodiment.

Figure 17 depicts an extension telephone 34 configured to interface with the beacon 108. As will be noticed, the telephone
20 34 of Figure 17 is substantially identical to the telephone 34 of Figure 13. In this case, the detector 44 detects the reflected IR beams 42 which were emitted by the emitter 56' and reflected back by the beacon 108 after modulation. The emitter 56' can also emit paging information for detection by the beacon 108 as
25 described above.

The other alternate approach to the present invention is depicted in Figure 18. In Figure 18, it is shown incorporated into an interfacing unit 92' used with a telephone 14 in the manner of the interfacing unit 92 of Figure 14. As those skilled
30 in the art will readily recognize and appreciate, this embodiment could also be built into a telephone as with the embodiment of Figure 17 and the embodiment of Figure 17 could also be built into an interfacing unit 92. In this "registration" approach, the user must register his or her presence at a location by inserting

the readable smart badge 116 into the reader 118 of the interfacing unit 92'. Again, it is preferred that the readable smart badge 116 and the reader 118 be according to techniques described in the above-referenced '296 patent. Thus, the readable smart badge 116 can comprise a light-modulated smart card which is powered by light (not shown) passing therethrough within the reader 118, which light is also modulated by the smart card. As an alternative, the readable smart badge 116 can include a magnetic strip or punched holes which are read by the reader 118 according to techniques well known in the art. This latter embodiment when employed to initiate call-forwarding does have the advantage that call-forwarding to a new location is only initiated when the user desires it by registering the readable smart badge 116 at the desired location for call-forwarding.

Turning finally to Figure 19 a power-boosted, passive, reflecting beacon 108' is depicted therein. The preferred beacon 108' also operates according to the techniques described in the '296 patent and generally in the manner of the beacon 108 of Figure 16. In the beacon 108', however, the incoming IR beams 42 after passing through the spatial light modulator 114 are then boosted in power by a light amplifier 120 before being directed back towards the emitting source (e.g. the telephone 34) as, by example, by the other reflector 112. Light amplifiers and methods of light amplification are well known to those skilled in the art and, therefore, will not be described in any particular detail herein. For example, the modulated light beam 42' may strike a light detector to create an electrical output which is connected to drive a light-emitting source at a higher power output. In such an approach to the light amplifier 120, the light detector can also be employed to detect modulated IR beams 42 entering the beacon 108' containing paging information as described above used by the logic 54' to activate the buzzer 86 and display 84.

Wherefore, having thus described the present invention in its various embodiments, what is claimed is:

1. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected to a central control and switching logic by connecting wires, the improvement to provide automatic
5 call forwarding and personnel location information for access on request throughout the associated locations comprising:

a) a plurality of personnel identifiers carried by individuals throughout the associated locations, each of said plurality of personnel identifiers having a unique readable
10 identification code associated therewith;

b) a plurality of code reading means associated with respective ones of the plurality of telephone extensions for reading said readable identification code of ones of said plurality of personnel identifiers;

15 c) a plurality of detector logic means associated with and connected to respective ones of said plurality of code reading means and connected to a central control and switching logic through the connecting wires for obtaining said readable identification code of ones of said plurality of personnel
20 identifiers from an associated one of said plurality of detector logic means and for forwarding an obtained said readable identification code to the central control and switching logic through the connecting wires;

d) beacon logic table means associated with the
25 central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of said plurality of personnel identifiers; and,

e) beacon logic means associated with the central control and switching logic for receiving said readable
30 identification code from associated ones of said plurality of detector logic means, for storing present ones of the associated locations where respective ones of said plurality of personnel identifiers are presently located in said beacon logic table means, and for causing calls for selected ones of the plurality of

telephone extensions to be forwarded automatically to a present one of the associated locations where ones of said plurality of personnel identifiers associated with said selected ones of the plurality of telephone extensions are presently located.

5

2. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein:

10 a) said plurality of personnel identifiers comprises a plurality of transmitting beacons carried by individuals throughout the associated locations, each of said plurality of transmitting beacons comprising,

15 a1) a case,
a2) an identifier carried by said case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions,

20 a3) a battery carried by said case and connected to supply power to components of an associated transmitting beacon,

a4) a signal-emitting element carried by said case, and
25 a5) beacon logic carried by said case for causing said signal-emitting element to periodically transmit a signal including said unique binary number; and,

b) said plurality of code reading means comprises a plurality of signal detectors associated with respective ones of the plurality of telephone extensions.

30

3. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 2 wherein:

a) said signal-emitting element of each of said plurality of transmitting beacons comprises an infrared light-emitting element; and,

b) each of said plurality of signal detectors
5 comprises an infrared light detector outputting an electrical signal.

4. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and
10 personnel location information of claim 1 wherein:

said beacon logic table means includes a present location table containing a last reported location for each of said plurality of personnel identifiers.

15 5. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 2 wherein:

said beacon logic means includes logic for not forwarding calls to a new location reported by one of said
20 plurality of transmitting beacons until said new location has been reported twice whereby calls are not forwarded to locations reported during movement of ones of said plurality of transmitting beacons and only forwarded to locations where ones of said plurality of transmitting beacons have remained for
25 a period of time.

6. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein:

30 a) said beacon logic table means includes a forwardable-to table designating ones of the plurality of telephone extensions which can be forwarded to and ones which cannot; and,

b) said beacon logic means includes logic for not forwarding calls to a new location designated in said forwardable-to table as one which cannot have calls forwarded thereto.

5

7. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein:

a) said beacon logic table means includes an extensions status table designating ones of the plurality of telephone extensions for which calls can be forwarded from and ones which cannot; and,

b) said beacon logic means includes logic for not forwarding calls for ones of the plurality of telephone extensions designated in said extensions status table as ones which cannot have calls forwarded therefrom.

8. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein each of said plurality of personnel identifiers additionally comprises:

a) receiver means for receiving transmitted multiplexed signals;

b) annunciator means for advising a user of a signal receipt; and,

c) paging logic means for recognizing received multiplexed signals received by said receiver means intended for an associated one of said plurality of personnel identifiers and for activating said annunciator means in response thereto.

30

9. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 8 wherein:

said receiver means is an infrared light detector outputting an electrical signal.

10. The improvement to a computer-controlled PBX
5 type telephone system to provide automatic call forwarding and personnel location information of claim 8 wherein:

- a) said annunciator means comprises an alpha-numeric display; and,
- b) said paging logic means includes logic means
10 for retrieving alpha-numeric data from said received multiplexed signals and for displaying said alpha-numeric data on said alpha-numeric display.

11. The improvement to a computer-controlled PBX
15 type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein each of said plurality of personnel identifiers additionally comprises:

- a) receiver means for receiving transmitted multiplexed signals;
- b) alpha-numeric display means for displaying
20 alpha-numeric data input thereto; and,
- c) display logic means for recognizing received multiplexed signals received by said receiver means intended for an associated one of said plurality of personnel identifiers and
25 for outputting alpha-numeric data contained therein to said alpha-numeric display means.

12. The improvement to a computer-controlled PBX
type telephone system to provide automatic call forwarding and
30 personnel location information of claim 1 wherein:

- a) said plurality of personnel identifiers comprises a plurality of passive reflecting beacons carried by individuals throughout the associated locations, each of said plurality of passive reflecting beacons comprising,

- a1) a case,
a2) an identifier carried by said case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions,
5 a3) a battery carried by said case and connected to supply power to components requiring power,
a4) a spatial light-modulating element carried
10 by said case,
a5) reflector means for receiving incoming light beams, for directing said incoming light beams through said spatial light-modulating element, and for re-directing light beams modulated by said spatial light-modulating element back towards a source of said
15 incoming light beams, and
a6) beacon logic carried by said case for causing said spatial light-modulating element to modulate light beams passing therethrough with said unique binary
20 number; and,
b) said plurality of code reading means comprises a plurality of light beam emitters and a plurality of signal detectors associated with respective ones of the plurality of telephone extensions.

25

13. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 12 and additionally comprising:

30

light amplification means disposed after said spatial light-modulating element for amplifying said light beams modulated by said spatial light-modulating element before they are re-directed back towards said source of said incoming light beams.

14. The improvement to a computer-controlled PBX type telephone system to provide automatic call forwarding and personnel location information of claim 1 wherein:
- 5 a) said plurality of personnel identifiers comprises a plurality of readable smart badges carried by individuals throughout the associated locations, each of said plurality of readable smart badges having a unique readable identification code; and,
- 10 b) said plurality of code reading means comprises a plurality of readers including means for reading said unique readable identification code associated with respective ones of the plurality of telephone extensions.
- 15 15. Beacon apparatus for advising central control and switching logic of a cellular telephone system central control and switching site of present locations of respective ones of a plurality of users comprising:
- 20 a) a plurality of transmitting beacons carried by respective ones of the plurality of users, each of said plurality of transmitting beacons comprising,
- a1) a case,
- a2) an identifier carried by said case and including a binary number being an identification number of an associated user,
- 25 a3) a battery carried by said case and connected to supply power to components of an associated transmitting beacon,
- a4) a signal-emitting element carried by said case, and
- 30 a5) beacon logic carried by said case for causing said signal-emitting element to periodically transmit a signal including said unique binary number; and,

b) a plurality of detector/transmitters located at various known locations, each of said plurality of detector/transmitters comprising,

b1) a signal detector,

5 b2) detector logic means connected to said signal detector for detecting signals from ones of said plurality of transmitting beacons, and

10 b3) transmitter logic means connected to said detector logic means for receiving detected signals and for transmitting to the central control and switching logic the present location of users associated with identification numbers contained within said detected signals; and wherein,

15 c) said identification number is an electronic serial number of a cellular telephone of said associated user;

d) said signal-emitting element is a cellular transmitter; and,

e) each of said plurality of transmitting beacons additionally comprises,

20 e1) receiver means carried by said case for receiving transmitted cellular signals,

e2) annunciator means for advising a user of a signal receipt, and

25 e3) paging logic means for recognizing received cellular signals received by said receiver means intended for said cellular telephone of said associated user and for activating said annunciator means in response thereto.

30 16. Beacon apparatus for advising central control and switching logic of a wide area computer network central control site of present locations of respective ones of a plurality of users comprising:

a) a plurality of transmitting beacons carried by respective ones of the plurality of users, each of said plurality of transmitting beacons comprising,

- 5 a1) a case,
- a2) an identifier carried by said case and including a binary number being an identification number of an associated user,
- a3) a battery carried by said case and connected to supply power to components of an associated transmitting beacon,
- 10 a4) a signal-emitting element carried by said case, and
- a5) beacon logic carried by said case for causing said signal-emitting element to periodically transmit a signal including said unique binary number;
- 15 and,

b) a plurality of detector/transmitters located at various known locations, each of said plurality of detector/transmitters comprising,

- 20 b1) a signal detector,
- b2) detector logic means connected to said signal detector for detecting signals from ones of said plurality of transmitting beacons, and
- b3) transmitter logic means connected to said detector logic means for receiving detected signals and for transmitting to the central control and switching logic the present location of users associated with identification numbers contained within said detected signals; and
- 25 wherein,

30 c) said identification number is a personal identification number of an associated user; and,

d) said transmitter logic means includes logic for transmitting to the wide area computer network central control site the present one of said various known locations associated

with a user's personal identification number contained within said detected signals.

17. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected by wire-pairs to a central control and switching logic, apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic comprising:
- 10 a) a plurality of transmitting beacons carried by individuals throughout the associated locations, each of said plurality of transmitting beacons comprising,
 - a1) a case,
 - 15 a2) an identifier carried by said case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions,
 - a3) a battery carried by said case and connected to supply power to components of an associated transmitting beacon,
 - 20 a4) a signal-emitting element carried by said case, said signal-emitting element being an infrared light-emitting element, and
 - a5) beacon logic carried by said case for causing said signal-emitting element to periodically transmit an infrared light signal including said unique binary number; and,
 - 25
 - b) a plurality of signal input units associated with respective ones of the plurality of telephone extensions, each of
30 said plurality of signal input units comprising,
 - b1) infrared light detector means for receiving an infrared light signal at an input surface thereof and for outputting an electrical signal reflecting light impinging on said input surface,

- b2) a telephone ringing device, and
b3) control and output logic means having an associated wire-pair connected to an input thereto and an output pair of wires connected to an input of an associated telephone extension for sensing on said output pair of wires when said associated telephone extension is taken off hook and connecting said output pair of wires to said associated wire-pair when said associated telephone extension is off hook and for disconnecting said output pair of wires from said associated wire-pair when said associated telephone extension is on hook, for ringing said telephone ringing device in response to an incoming ring signal on said associated wire-pair when said associated telephone extension is on hook, and for outputting electrical signals from said infrared light detector means on said associated wire-pair when said associated telephone extension is on hook.

18. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 17 wherein each of said plurality of signal input units additionally comprises:

- a) memory means for storing said electrical signals from said infrared light detector means; and wherein,
b) said control and output logic means includes logic for storing received ones of said electrical signals from said infrared light detector means in said memory means when said associated telephone extension is off hook and for then outputting electrical signals from said memory means on said associated wire-pair when said associated telephone extension is back on hook.

19. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 17 and additionally comprising:

- 5 a) beacon logic table means associated with the central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of said plurality of transmitting beacons; and,
- 10 b) beacon logic means associated with the central control and switching logic for receiving said electrical signals from the wire-pairs, for storing present ones of the associated locations where respective ones of said plurality of transmitting beacons are presently located in said beacon logic table means, and for causing calls for selected ones of the plurality of
- 15 telephone extensions to be forwarded automatically to a present one of the associated locations where ones of said plurality of transmitting beacons associated with said selected ones of the plurality of telephone extensions are presently located.

20 20. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected by wire-pairs to a central control and switching logic, apparatus for providing automatic call forwarding and personnel location information to the central

25 control and switching logic comprising:

- a) a plurality of passive reflecting beacons carried by individuals throughout the associated locations, each of said plurality of passive reflecting beacons comprising,
 - 30 a1) a case,
 - a2) an identifier carried by said case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions,

a3) a battery carried by said case and connected to supply power to components requiring power,

a4) a spatial light-modulating element carried by said case,

a5) reflector means for receiving incoming light beams, for directing said incoming light beams through said spatial light-modulating element, and for re-directing light beams modulated by said spatial light-modulating element back towards a source of said incoming light beams, and

a6) beacon logic carried by said case for causing said spatial light-modulating element to modulate light beams passing therethrough with said unique binary number; and,

b) a plurality of signal input units associated with respective ones of the plurality of telephone extensions, each of said plurality of signal input units comprising,

b1) infrared light emitter means for emitting an infrared light beam to be received by said reflector means,

b2) infrared light detector means for receiving said infrared light beam from said reflector means at an input surface thereof and for outputting an electrical signal reflecting light impinging on said input surface,

b3) a telephone ringing device, and

b4) control and output logic means having an associated wire-pair connected to an input thereto and an output pair of wires connected to an input of an associated telephone extension for sensing on said output pair of wires when said associated telephone extension is taken off hook and connecting said output pair of wires to said associated wire-pair when said associated telephone

extension is off hook and for disconnecting said output pair of wires from said associated wire-pair when said associated telephone extension is on hook, for ringing said telephone ringing device in response to an incoming ring signal on said associated wire-pair when said associated telephone extension is on hook, and for outputting electrical signals from said infrared light detector means on said associated wire-pair when said associated telephone extension is on hook.

10

21. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 20 and additionally comprising:

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light amplification means disposed after said spatial light-modulating element for amplifying said light beams modulated by said spatial light-modulating element before they are re-directed back towards said source of said incoming light beams.

20

22. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 20 wherein each of said plurality of signal input units additionally comprises:

25

a) memory means for storing said electrical signals from said infrared light detector means; and wherein,

b) said control and output logic means includes logic for storing received ones of said electrical signals from said infrared light detector means in said memory means when said associated telephone extension is off hook and for then outputting electrical signals from said memory means on said associated wire-pair when said associated telephone extension is back on hook.

30

23. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 20 and additionally comprising:

- 5 a) beacon logic table means associated with the central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of said plurality of passive reflecting beacons; and,
- 10 b) beacon logic means associated with the central control and switching logic for receiving said electrical signals from the wire-pairs, for storing present ones of the associated locations where respective ones of said plurality of passive reflecting beacons are presently located in said beacon logic
- 15 table means, and for causing calls for selected ones of the plurality of telephone extensions to be forwarded automatically to a present one of the associated locations where ones of said plurality of passive reflecting beacons associated with said selected ones of the plurality of telephone extensions are
- 20 presently located.

24. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected by wire-pairs to a central control and switching logic, apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic comprising:

- 25 a) a plurality of readable smart badges carried by individuals throughout the associated locations, each of said plurality of readable smart badges having a unique readable
- 30 identification code; and,
- b) a plurality of signal input units associated with respective ones of the plurality of telephone extensions, each of said plurality of signal input units comprising,

b1) reader means for reading said unique readable identification code on a one of said plurality of readable smart badges and for outputting an electrical signal reflecting said unique readable identification code,

5 b2) a telephone ringing device, and

 b3) control and output logic means having an associated wire-pair connected to an input thereto and an output pair of wires connected to an input of an associated telephone extension for sensing on said output pair of wires when said associated telephone extension is taken
10 off hook and connecting said output pair of wires to said associated wire-pair when said associated telephone extension is off hook and for disconnecting said output pair of wires from said associated wire-pair when said
15 associated telephone extension is on hook, for ringing said telephone ringing device in response to an incoming ring signal on said associated wire-pair when said associated telephone extension is on hook, and for outputting
20 electrical signals from said infrared light detector means on said associated wire-pair when said associated telephone extension is on hook.

25 25. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 24 wherein each of said plurality of signal input units additionally comprises:

 a) memory means for storing said electrical signals from said reader means; and wherein,

30 b) said control and output logic means includes logic for storing received ones of said electrical signals from said infrared light detector means in said memory means when said associated telephone extension is off hook and for then outputting electrical signals from said memory means on said

associated wire-pair when said associated telephone extension is back on hook.

26. The apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic of a computer-controlled PBX type telephone system of claim 24 and additionally comprising:

a) beacon logic table means associated with the central control and switching logic for storing information about the plurality of telephone extensions and locations of respective ones of said plurality of readable smart badges; and,

b) beacon logic means associated with the central control and switching logic for receiving said electrical signals from the wire-pairs, for storing present ones of the associated locations where respective ones of said plurality of readable smart badges are presently located in said beacon logic table means, and for causing calls for selected ones of the plurality of telephone extensions to be forwarded automatically to a present one of the associated locations where ones of said plurality of readable smart badges associated with said selected ones of the plurality of telephone extensions are presently located.

27. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected to a central control and switching logic, apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic comprising:

a) a plurality of passive reflecting beacons carried by individuals throughout the associated locations, each of said plurality of passive reflecting beacons comprising,

a1) a case,

a2) an identifier carried by said case and having a unique binary number associated therewith which

is also associated with one of the plurality of telephone extensions,

a3) a battery carried by said case and connected to supply power to components requiring power,

a4) a spatial light-modulating element carried by said case,

a5) reflector means for receiving incoming light beams, for directing said incoming light beams through said spatial light-modulating element, and for re-directing light beams modulated by said spatial light-modulating element back towards a source of said incoming light beams, and

a6) beacon logic carried by said case for causing said spatial light-modulating element to modulate light beams passing therethrough with said unique binary number; and,

b) a plurality of signal input units associated with respective ones of the plurality of telephone extensions, each of said plurality of signal input units comprising,

b1) infrared light emitter means for emitting an infrared light beam to be received by said reflector means,

b2) infrared light detector means for receiving said infrared light beam from said reflector means at an input surface thereof and for outputting an electrical signal reflecting light impinging on said input surface, and

b3) output logic means for outputting electrical signals from said infrared light detector means to the central control and switching logic.

28. The apparatus for providing automatic call forwarding and personnel location information to the central

control and switching logic of a computer-controlled PBX type telephone system of claim 27 and additionally comprising:

light amplification means disposed after said spatial light-modulating element for amplifying said light beams modulated by said spatial light-modulating element before they are re-directed back towards said source of said incoming light beams.

29. In a computer-controlled PBX type telephone system having a plurality of telephone extensions at associated locations which are connected to a central control and switching logic by wire-pairs, apparatus for providing automatic call forwarding and personnel location information to the central control and switching logic comprising:

a) a plurality of readable smart badges carried by individuals throughout the associated locations, each of said plurality of readable smart badges having a unique readable identification code; and,

b) a plurality of signal input units associated with respective ones of the plurality of telephone extensions, each of said plurality of signal input units comprising,

b1) reader means for reading said unique readable identification code on a one of said plurality of readable smart badges and for outputting an electrical signal reflecting said unique readable identification code, and

b2) output logic means for outputting electrical signals from said reader means to the central control and switching logic over the wire-pairs.

30. Beacon apparatus for advising central control and switching logic of a wide area computer network central control site of present locations of respective ones of a plurality of users comprising:

a) a plurality of passive reflecting beacons carried by individuals throughout associated locations, each of said plurality of passive reflecting beacons comprising,

a1) a case,

5 a2) an identifier carried by said case and having a unique binary number associated therewith which is also associated with one of the plurality of telephone extensions,

10 a3) a battery carried by said case and connected to supply power to components requiring power,

a4) a spatial light-modulating element carried by said case,

15 a5) reflector means for receiving incoming light beams, for directing said incoming light beams through said spatial light-modulating element, and for re-directing light beams modulated by said spatial light-modulating element back towards a source of said incoming light beams, and

20 a6) beacon logic carried by said case for causing said spatial light-modulating element to modulate light beams passing therethrough with said unique binary number; and,

25 b) a plurality of signal input units located at various known locations, each of said plurality of signal input units comprising,

b1) infrared light emitter means for emitting an infrared light beam to be received by said reflector means,

30 b2) infrared light detector means for receiving said infrared light beam from said reflector means at an input surface thereof and for outputting an electrical signal reflecting light impinging on said input surface,

b3) detector logic means connected to said infrared light detector means for detecting signals from ones of said plurality of passive reflecting beacons, and

5 b4) transmitter logic means connected to said detector logic means for receiving detected signals and for transmitting to the central control and switching logic the present location of users associated with identification numbers contained within said detected signals; and wherein,

10 c) said identification number is a personal identification number of an associated user; and,

15 d) said transmitter logic means includes logic for transmitting to the wide area computer network central control site the present one of said various known locations associated with a user's personal identification number contained within said detected signals.

31. The beacon apparatus for advising central control and switching logic of a wide area computer network central control site of present locations of respective ones of a plurality of users of claim 30 and additionally comprising:

20 light amplification means disposed after said spatial light-modulating element for amplifying said light beams modulated by said spatial light-modulating element before they are re-directed back towards said source of said incoming light beams.

32. Apparatus for advising central control and switching logic of a wide area computer network central control site of present locations of respective ones of a plurality of users comprising:

30 a) a plurality of readable smart badges carried by individuals throughout associated locations, each of said

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plurality of readable smart badges having a unique readable identification code; and,

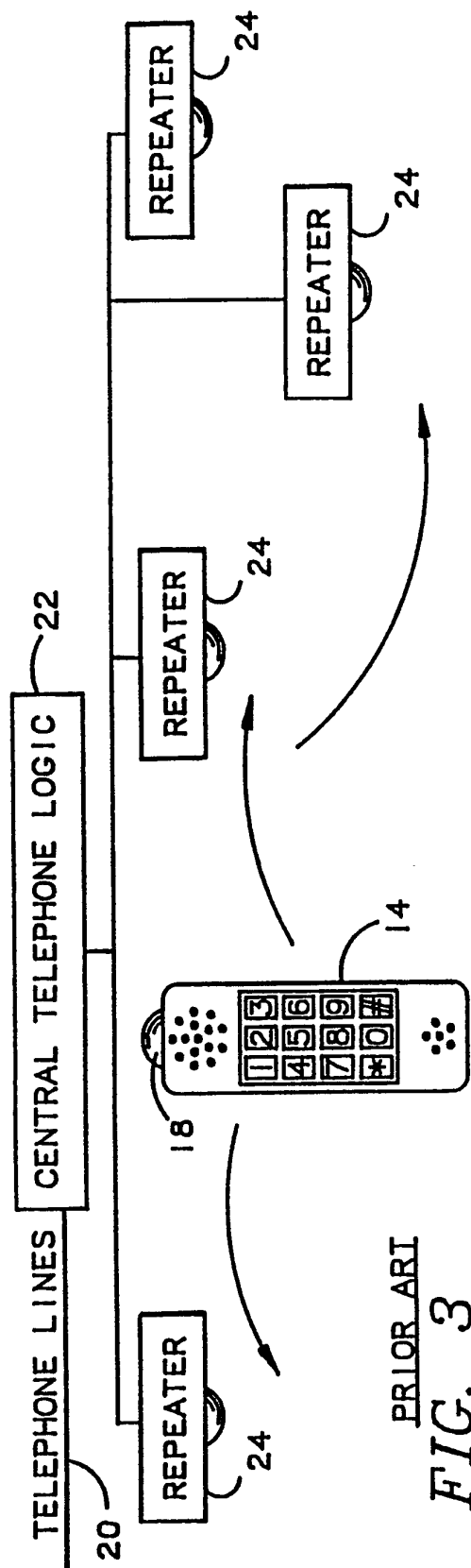
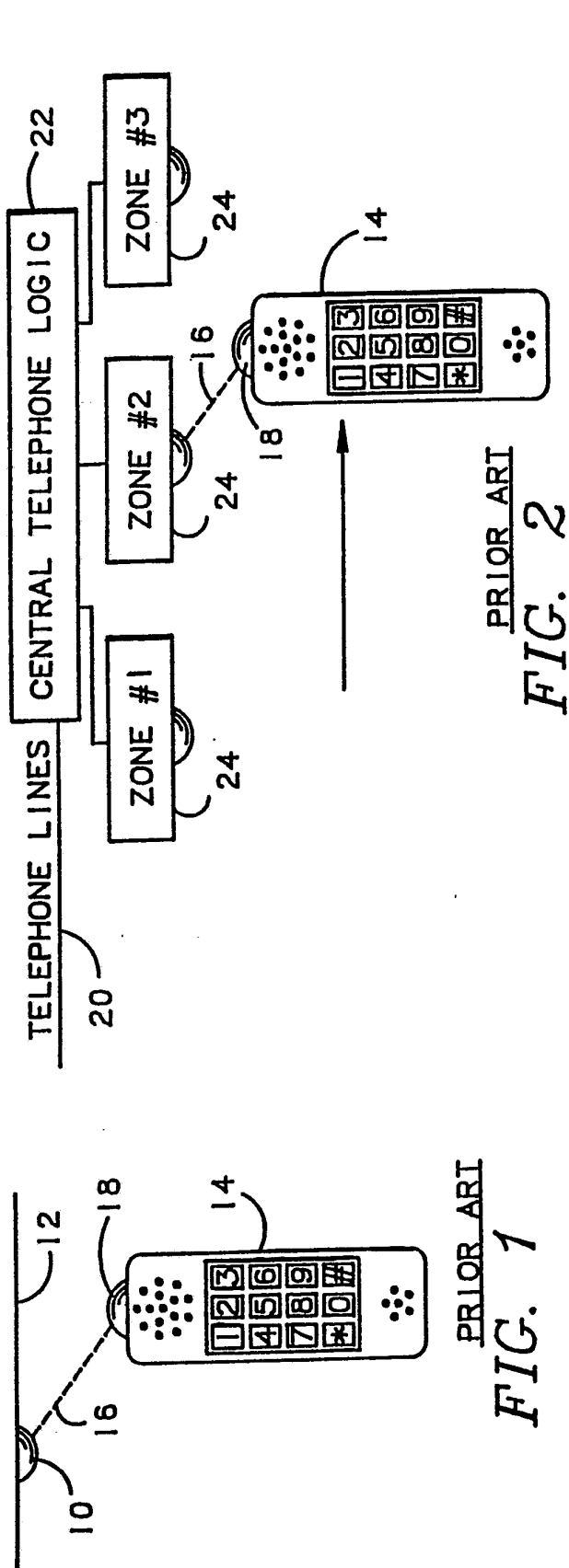
b) a plurality of signal input units located at various known locations, each of said plurality of signal input
5 units comprising,

b1) reader means for reading said unique readable identification code on a one of said plurality of readable smart badges and for outputting an electrical signal reflecting said unique readable identification code,
10 and

b2) transmitter logic means connected to said reader means for receiving signals from said reader means and for transmitting to the central control and switching logic the present location of users associated with
15 identification numbers contained within said signals; and wherein,

c) said identification number is a personal identification number of an associated user; and,

d) said transmitter logic means includes logic for
20 transmitting to the wide area computer network central control site the present one of said various known locations associated with a user's personal identification number contained within said signals.



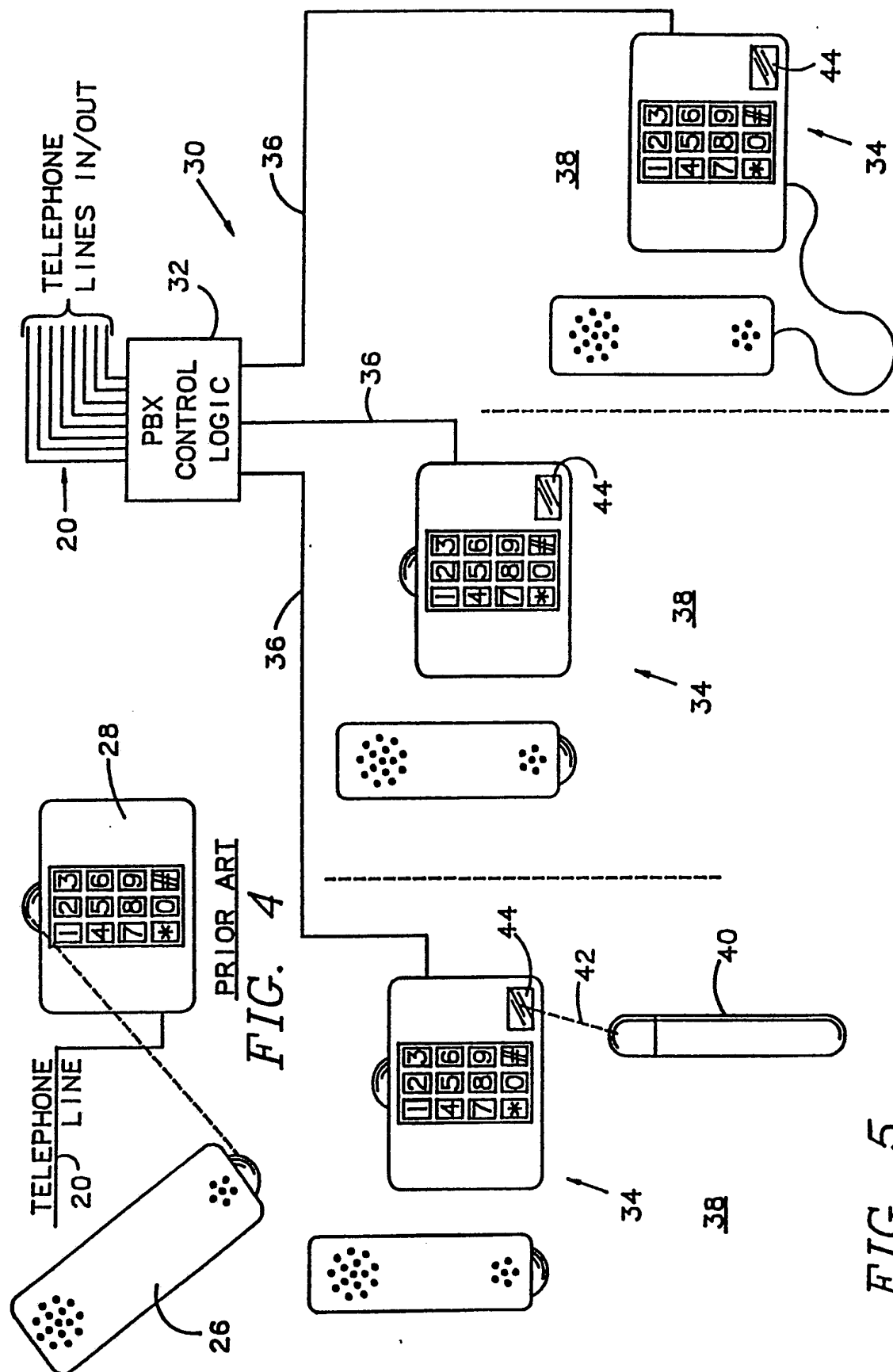


FIG. 5

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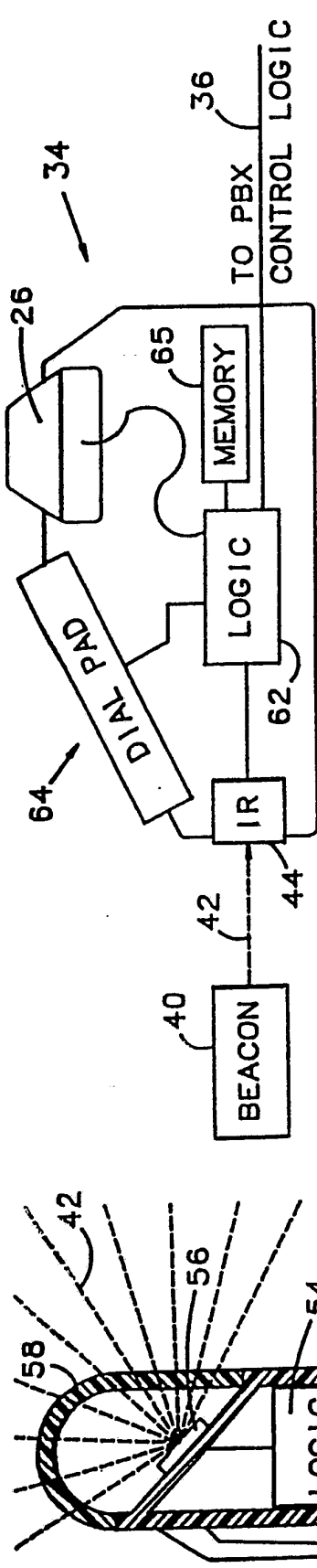


FIG. 6

FIG. 7

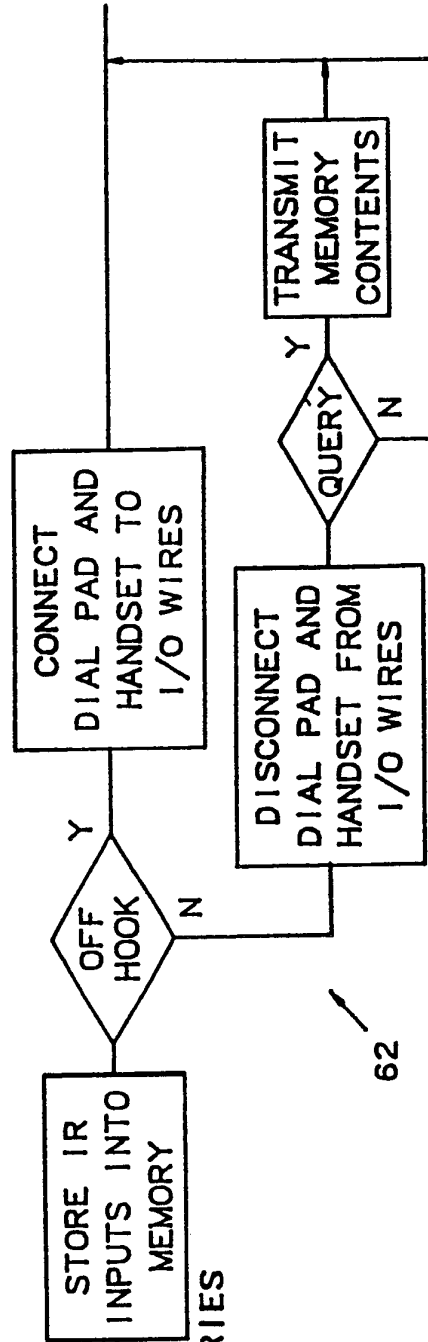
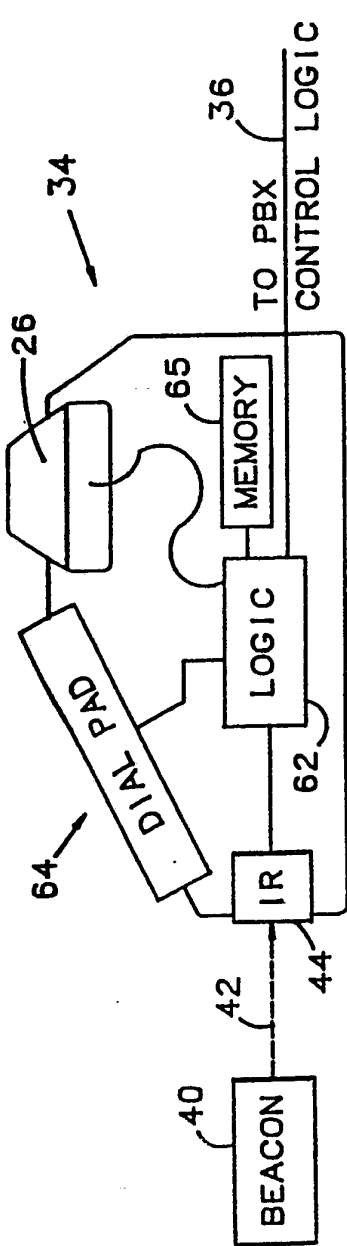


FIG. 8

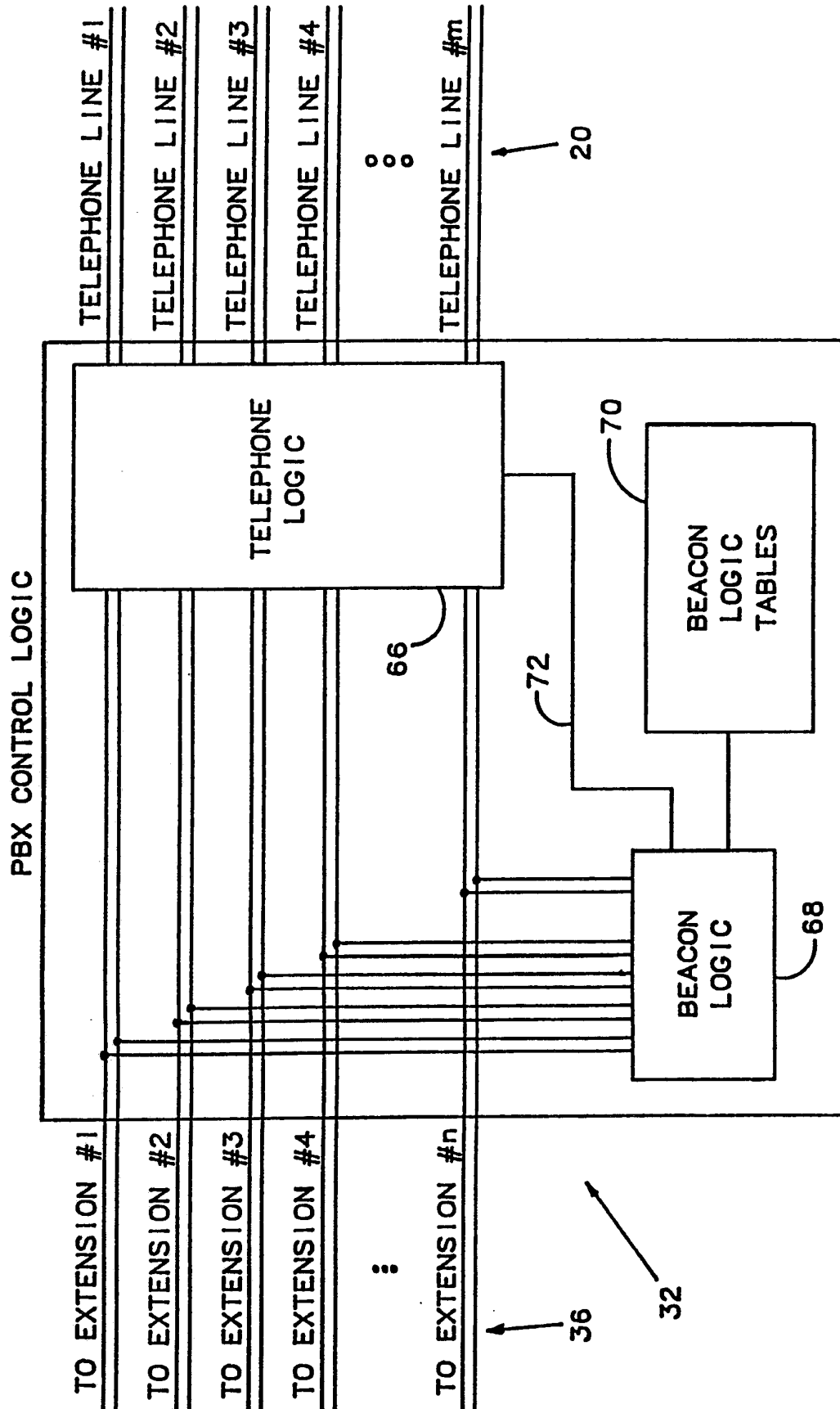


FIG. 9

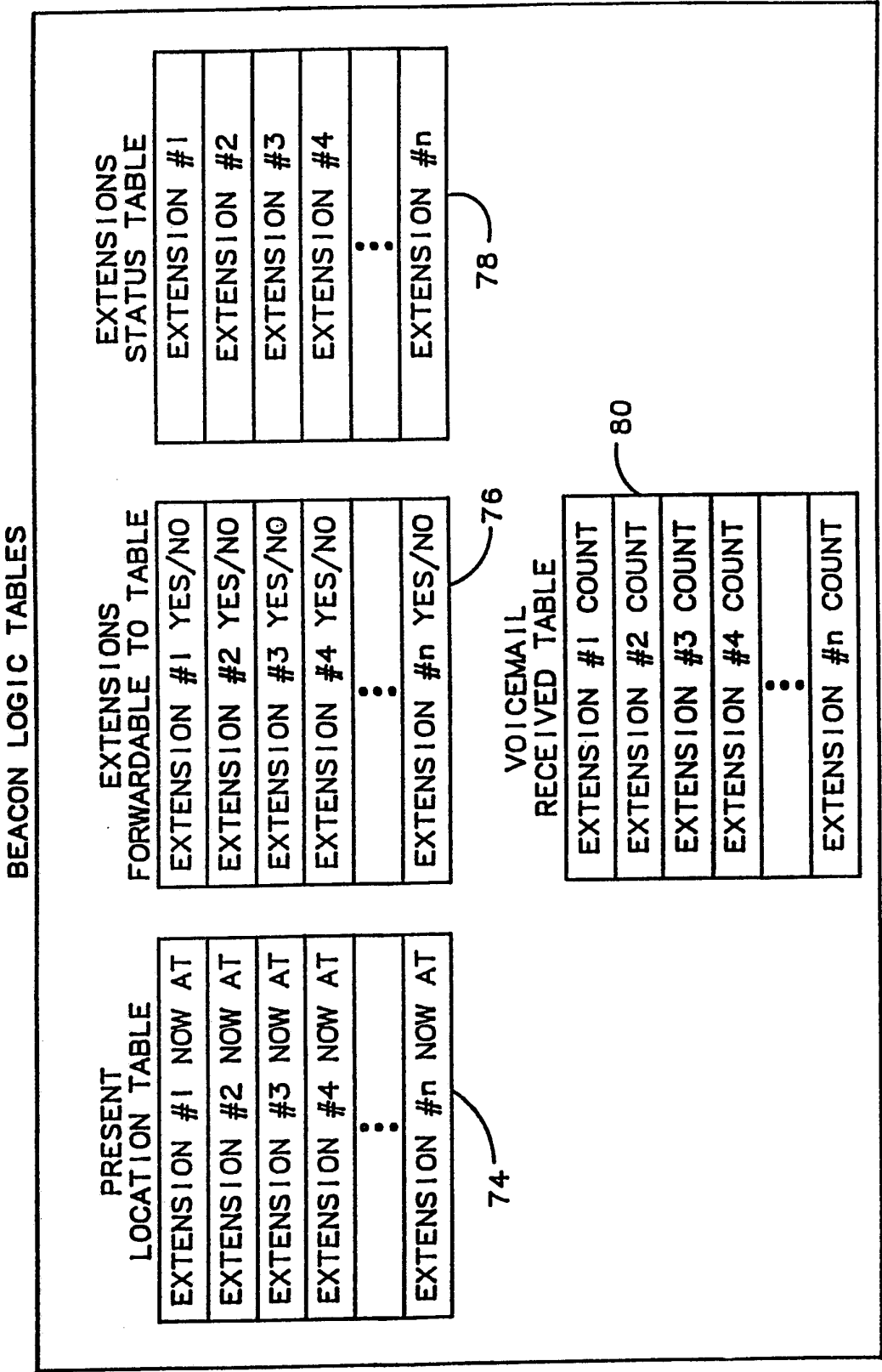


FIG. 10

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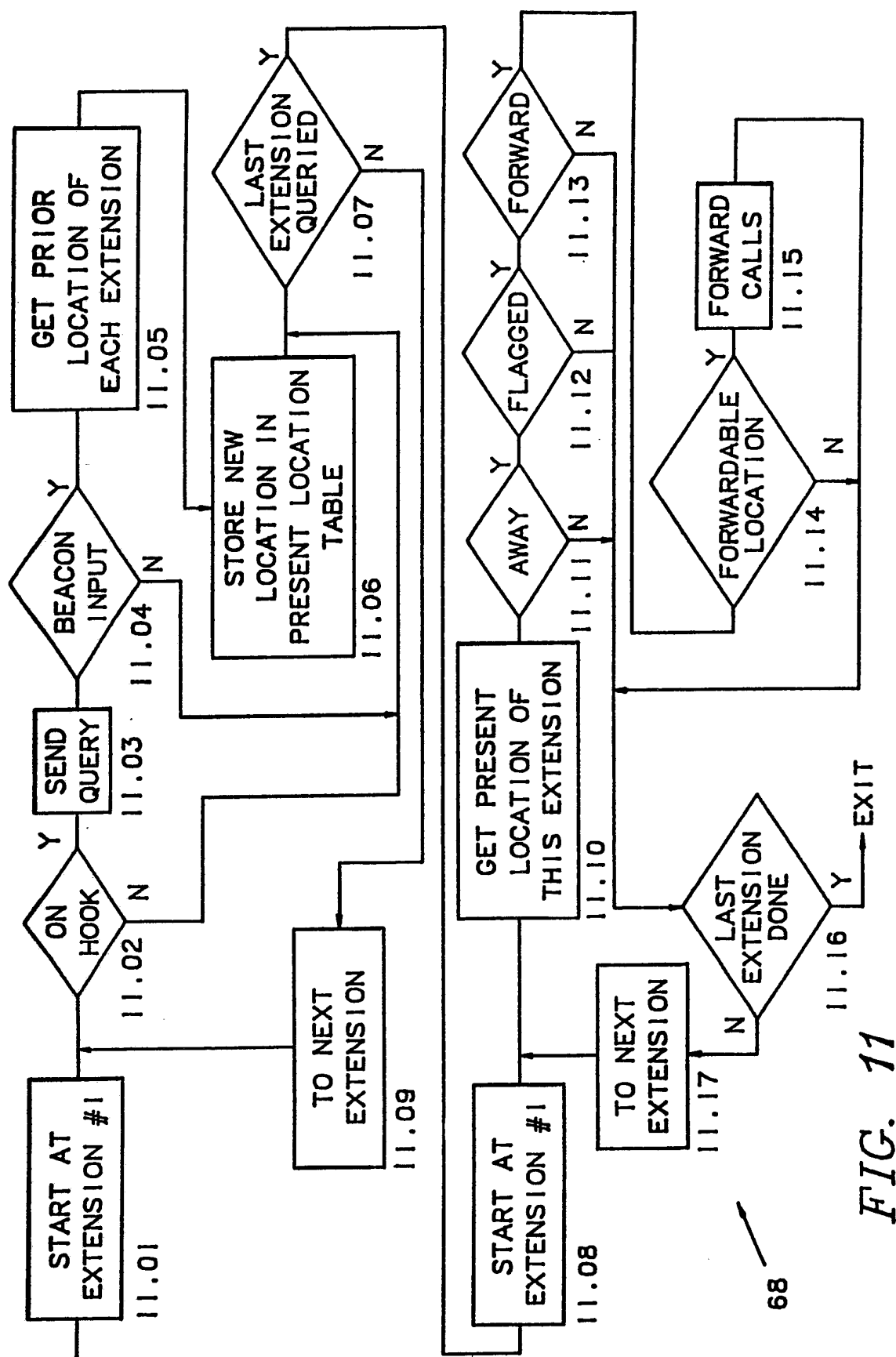


FIG. 11

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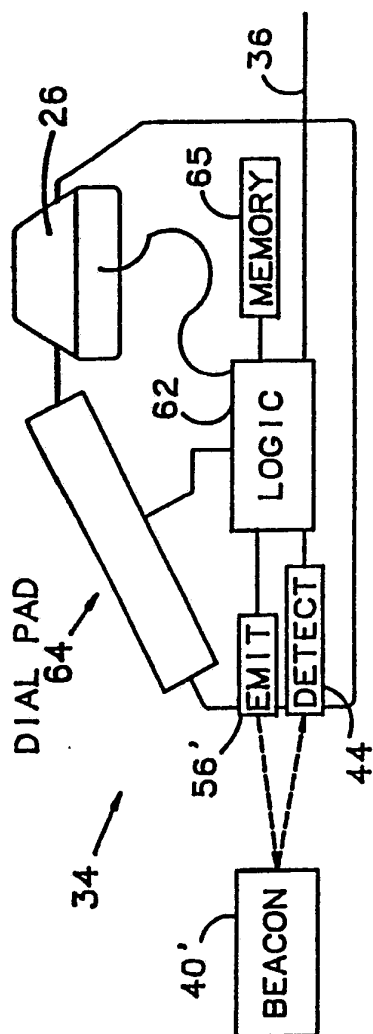


FIG. 13

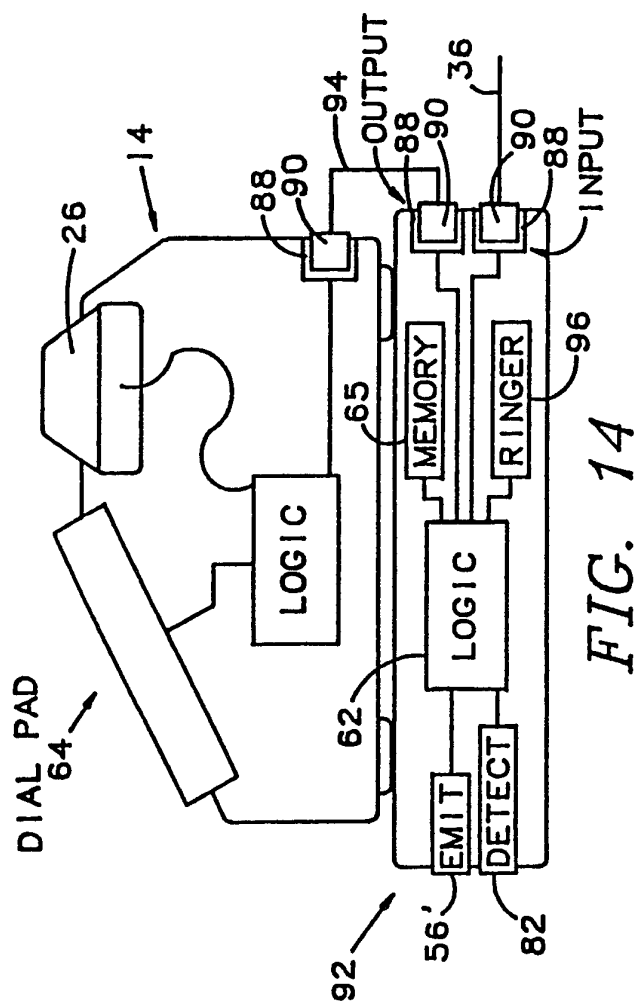


FIG. 14

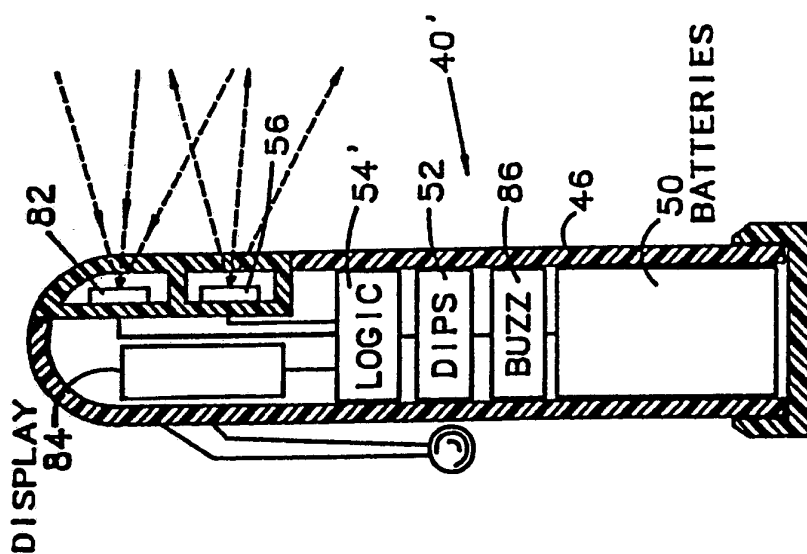


FIG. 12

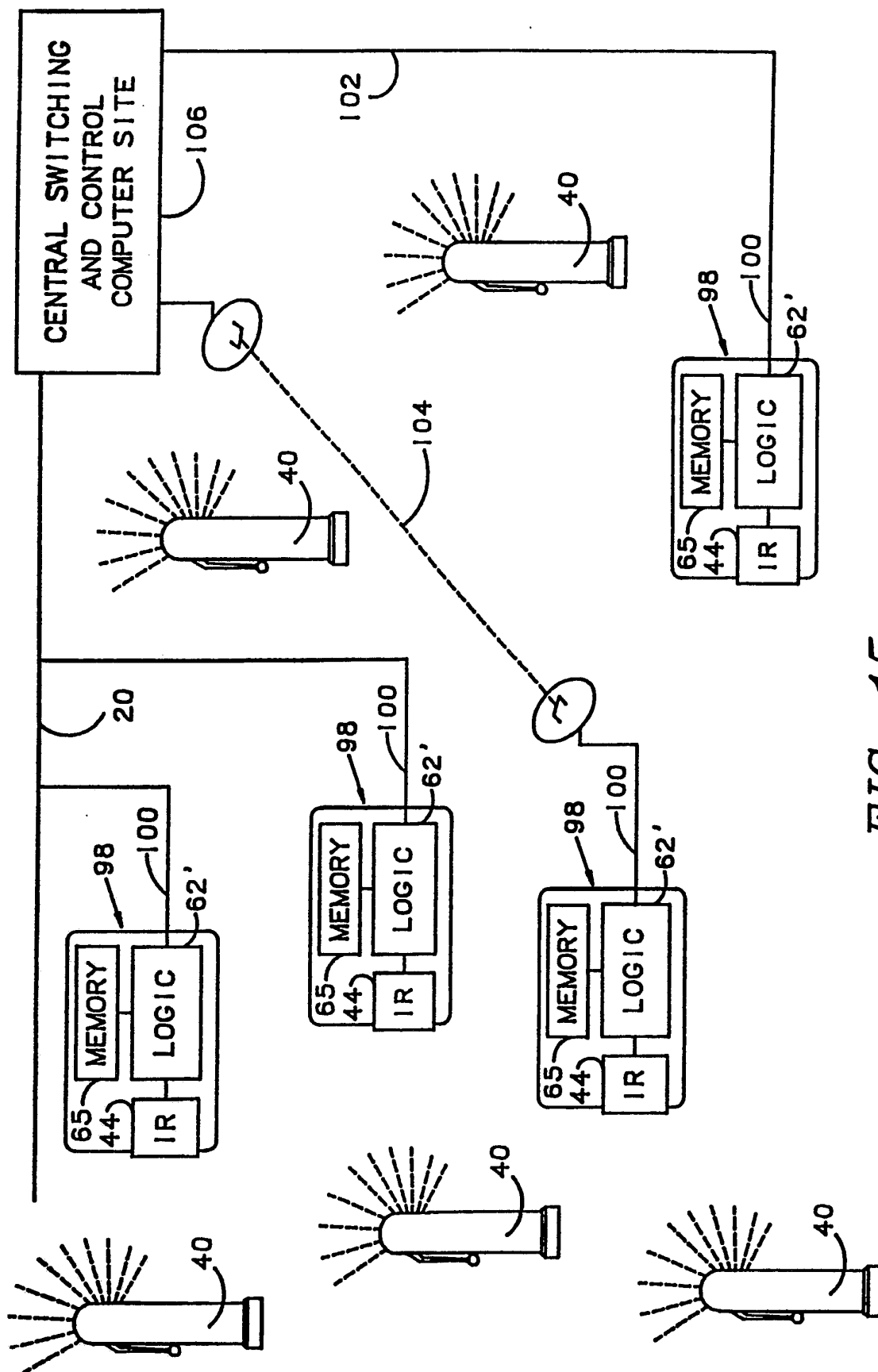


FIG. 15

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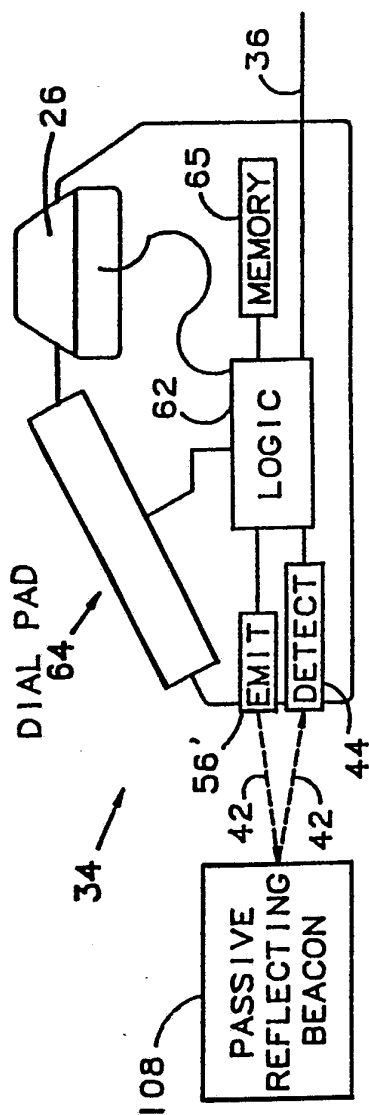


FIG. 17

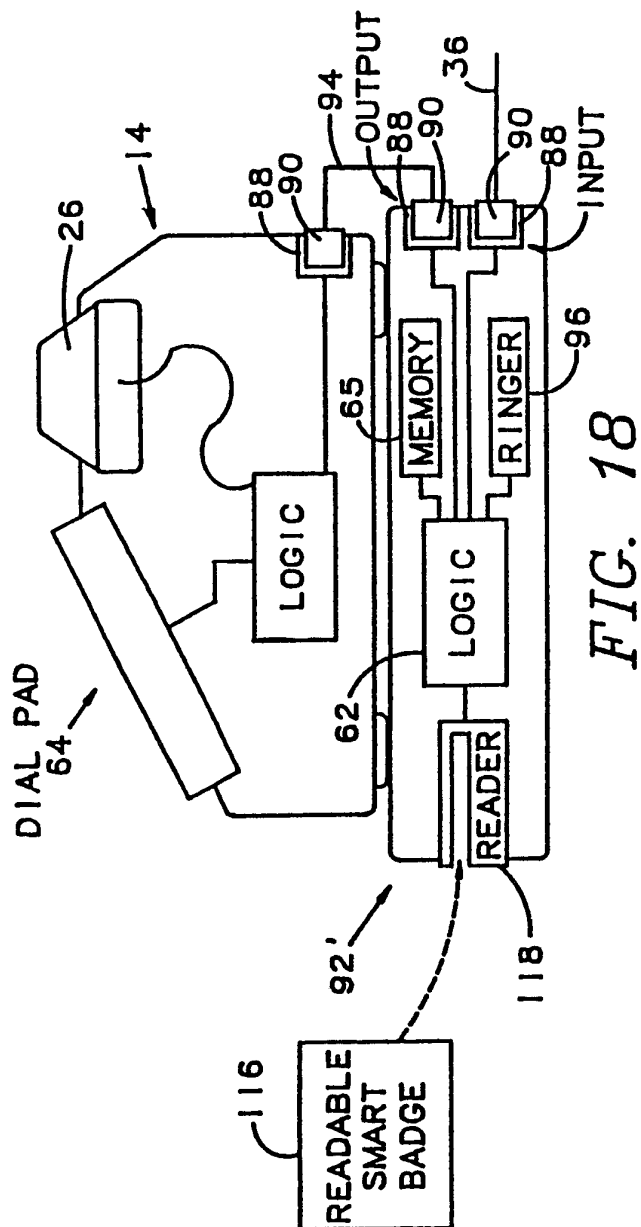


FIG. 18

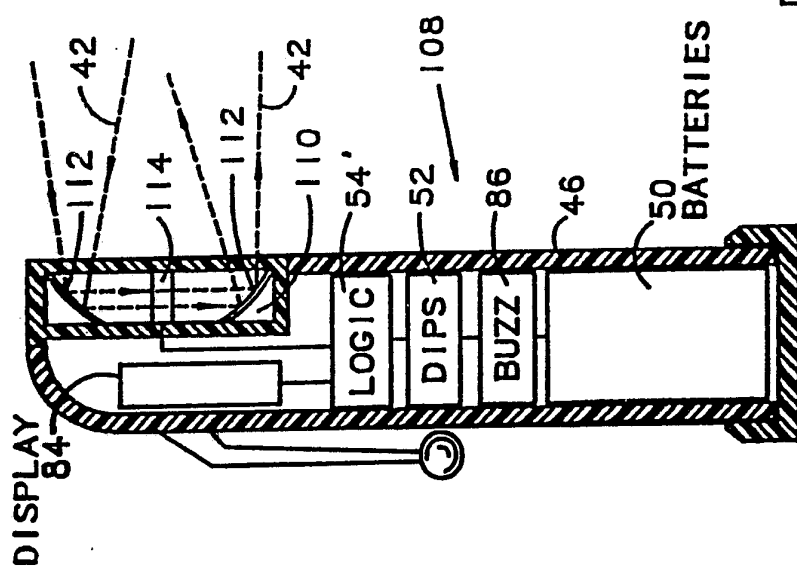


FIG. 16

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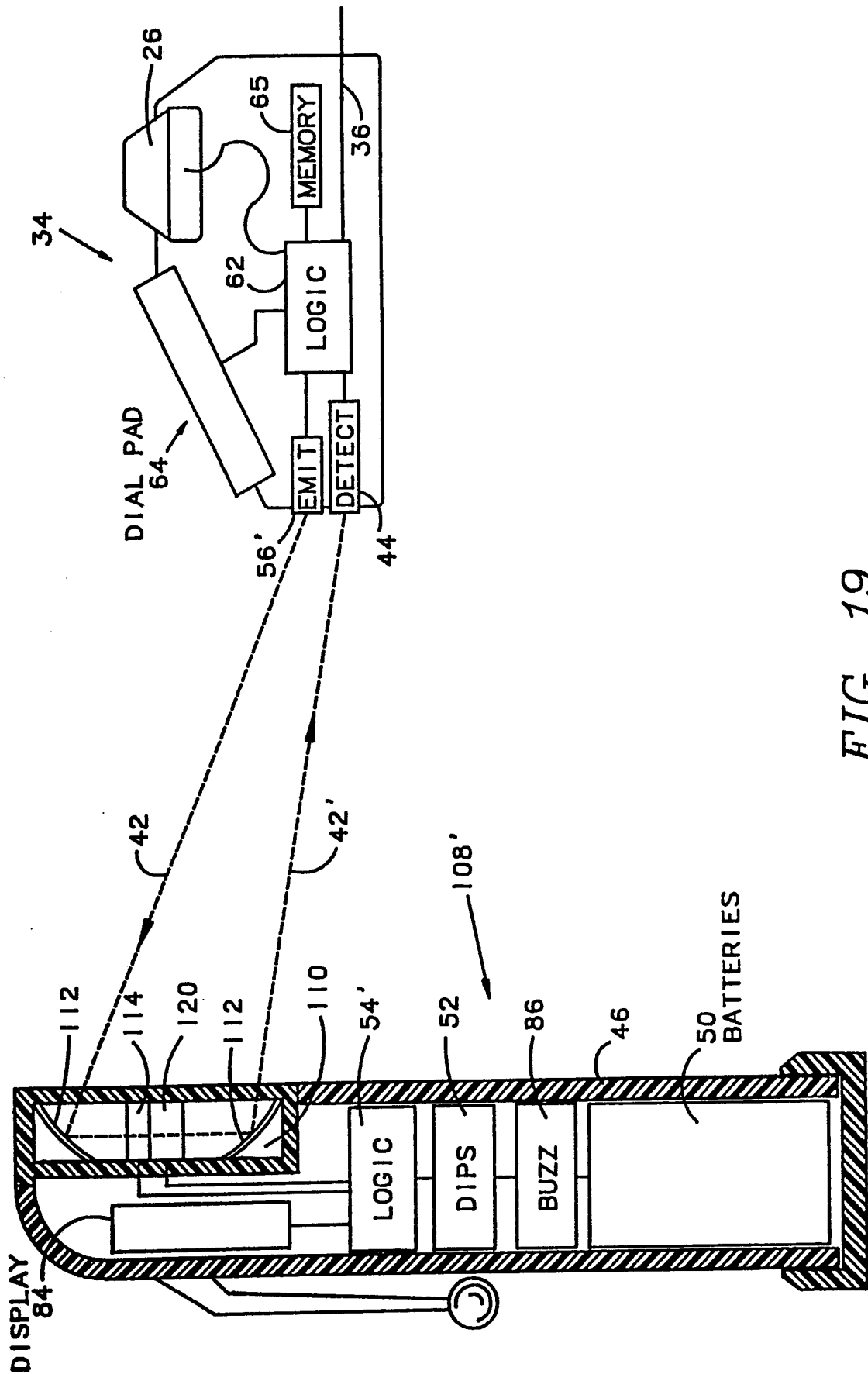


FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/05955

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H04M 11/00

US CL :379/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/69,80,84,88,89,93,94,100,197,198,245,280

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A, 4,580,012 (MATTHEWS ET AL), 01 APRIL 1986, See figures 1,2,4,8.	1-3,14,17-32
Y	US,A, 4,602,129 (MATTHEWS ET AL), 22 JULY 1986, See figure 1,2,4,8.	1-3,14,17-32
Y	US,A, 4,757,525 (MATTHEWS ET AL), 12 JULY 1988, See figures 1,2,4,8	1-3,14,17-32
Y	US,A, 4,761,807 (MATTHEWS ET AL), See figures 1,2,4,8, 02 August 1988.	1-3,14,17-32
Y	US,A, 5,003,583 (IGGULDER ET AL), 26 MARCH 1991, See column 2, line 56- column 3, line 59.	1-3,14,17-31

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 16 SEPTEMBER 1992	Date of mailing of the international search report NOV 1992 NOV 1992
Name and mailing address of the ISA/ Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer <i>H. Cumming</i> WILLIAM D. CUMMING Telephone No. (703) 305-4899

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/05955

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

USPAT APS: PBX, telephone, central control, wires, call forwarding, identifiers, locations, personal identifiers, identification code, code reading telephone extensions, readable identification code, plurality of personnel identifiers.