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TONE GENERATION CIRCUIT

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This invention relates to an automatic telephone exchange in which the tone generation is at least partly centralised.

According to the invention there is provided
15 an automatic telecommunication exchange, in which speech and tones are conveyed in TDM manner using PCM via a common intelligence bus which interconnects a central unit and a number of terminal interfaces each of which serves one or a small number of subscriber's
20 lines, in which the central unit and the terminal interfaces are also interconnected by a common signalling bus used to convey control information, in which said central unit includes common processing means and a tone generation means, in which said tone
25 generation means produces a plurality of different tones with each said tone conveyed in PCM form on the intelligence bus in a time slot reserved therefor, in which when a tone is needed for any one of the lines served by the two busses, the common processing means
30 sends control signals appropriate to the wanted tone via the common signalling bus to the terminal interface for that one of said lines, in which each said terminal interface includes processing means, digital-to-analogue conversion means for said tones
35 and gating means for said tones, in which the reception of said control signals at a said terminal interface causes the gating means appropriate to the

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required tone or tones to be enabled so that that tone is transmitted to the appropriate one of the subscriber's lines, and in which, dependent on the control signals thus transmitted, one or more of said tones can be sent to the subscriber's line, either continuously or cadenced as appropriate to the information to be notified to that subscriber's line.

An embodiment of the invention will now be described with reference to the accompanying highly schematic block diagram, which shows the centralised portion of a telephone exchange tone generation arrangement embodying the invention.

The tone generation arrangement is described as applied to a telephone exchange of the type described and claimed in our Application No. 8228206. However, the principles of the arrangement described herein can be applied in other forms of telephone exchanges.

The above-mentioned telephone exchange is a small "business-type" telephone exchange, in which calls are set up in TDM manner using PCM to convey speech, and also data if the exchange serves any data terminals. It has
5 subscriber line ports each of which serves two subscriber lines and a smaller number of trunk line ports each of which serves a trunk to a local exchange. Each port has a local processor with, in the case of analogue lines and trunks, analogue-to-digital and digital-to-
10 analogue conversion circuitry. Where a line or trunk is of the digital type, naturally no conversion circuitry is needed. The exchange also has a central processor, with its associated memories.

The ports and the central processor are inter-
15 connected by an intelligence bus and a signalling bus. The central processor and the port processors co-operate in call setting with all communications between the processors over the signalling bus. During operation the central processor polls the ports via the signalling bus
20 for ports needing the services of the central processor and also to pass call control information to those ports.

To set up a call between two lines, or a line and a trunk, two time slots in the TDM cycle are allocated to the call by the central processor, one for each direction
25 of transmission. The intelligence bus is thus used only to convey intelligence, i.e. speech and/or data and tones.

The tones needed in the exchange are all produced from a centrally located electronic tone generator using digital techniques. This produces two base tones, one,
30 called the DR tone, consisting of two notes with frequencies of 350 Hz and 440 Hz mixed together, and the other, called the BN tone, consisting of a single note of 400 Hz. These tones are distributed via the PCM bus (intelligence bus) referred to above, the DR tone
35 occupying time slot 0 in the PCM frame and the BN tone occupying time slot 1.

At each of the ports or interfaces referred to

above, both the subscriber line ports and the trunk line ports, the digital to analogue circuitry extracts and decodes the DR and the BN tone. Hence at each of these interfaces the two tones are available in effect as continuous tones. The tones to be produced each consists of one or more of the DR and BN tones, either as continuous tones or as tones interrupted according to a defined cadence. The derivation of the tones as heard by the subscriber is done by the ports' processors, under control of instructions from the central processor. Thus when a given tone is needed for a line or trunk the appropriate port processor receives an instruction from the central processor over the signalling bus as a result of which it produces the required tone from the distributed DR and BN tones.

The tones provided in the present arrangement are as follows :

- (a) Dial Tone is the DR tone applied continuously
- (b) Busy Tone is the BN tone applied with a cadence of 375ms on, 375ms off
- (c) Ring Tone is the DR tone applied with a cadence of .75sec on and 2.25sec off
- (d) Number Unobtainable Tone is the BN tone applied continuously
- (e) Warning Tone which is applied when operator or executive intervention is in operation, is the BN tone applied with a cadence of 200ms on and 200ms off.

The generation of the BN and DR tone is effected in the manner shown in the accompanying drawing. Digital PCM representations of these two basic tones are stored in alternate locations of a bipolar PROM (Programmable Read Only Memory) 1. This PROM is controlled by a sequence counter 2 which counts through the range of addresses of the PROM 1 needed to generate one cycle of each of the tones. The parallel output from the PROM 1 is connected to a parallel-in-serial-out (PISO) shift

register 3, which provides parallel-to-serial conversion for application of the PCM to the intelligence bus 4. As already mentioned, this bus distributes the basic BN and DR tones to all of the interfaces at which they are needed.

5 The shift register 3 is clock pulse controlled by the PCM clock via a gate 5, this clock occurring at the PCM bit rate. The other clock input FRMSYNC defines the commencement of the PCM frame and sets a latch 6
10 which opens gate 5 for a period dependent on the time for which the latch is set. This time is two time slots long, i.e. 16 bit times, defined by a - 16 output from the fair bit counter 7.

 Thus the shift register 3 is controlled by a
15 clock circuit 5-6-7, which generates 16 pulses at the PCMCLK rate following every FRMSYNC pulse received. The pulses from the counter 7 are divided by 8 to drive the counter 2, which ensures that a byte of each tone sequence is latched into the shift register 3 after each
20 FRMSYNC pulse. Thus the time slots 0 and 1 will each contain 8 bits of PCM code for the two base tones.

 At a port the digital-to-analogue conversion circuitry decodes the two base tones, each at its own time slot so that these tones are each continuously
25 available at that port. When one of the tones listed above, which tones are known as supervisory tones, is needed in the course of call setting and control, the central processor sends an instruction over the
30 exchange's signalling bus to the interface for the line or trunk needing it. This instruction is received by the line's or trunk's processor, which therefore enables one of a set of tone control programmes. Each such program controls gates from the outputs of the digital-to-analogue converter in a manner appropriate to the tone
35 wanted.

 Thus, for instance, for the dial tone, a gate between the converter output for the DR tone is opened

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continuously until a cut-off instruction is received. In the case of dial tone, this occurs in response to the caller commencing to dial or key in the wanted number, or if he hangs up without "dialling".

5 To quote another example, for the ring tone, the BN output from the converter is enabled for 375ms on and disabled for 375ms off for as long as needed.

Each such controlling sequence uses a relatively simple program in the port's processor.

10 If it was inconvenient for any reason to centrally generate a mixed tone such as the DR tone, the frequencies which make up that tone could be separately generated at the centralised generation point. In such case these tones would be sent out separately, i.e. in
15 the arrangement described on separate time slots of the TDM cycle. Mixing then occurs at the interfaces, at the digital-to-analogue converter outputs.

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CLAIMS:-

1. An automatic telecommunication exchange, in which speech and tones are conveyed in TDM manner using PCM via a common intelligence bus which
5 interconnects a central unit and a number of terminal interfaces each of which serves one or a small number of subscriber's lines, in which the central unit and the terminal interfaces are also interconnected by a common signalling bus used to convey control
10 information, in which said central unit includes common processing means and a tone generation means, in which said tone generation means produces a plurality of different tones with each said tone conveyed in PCM form on the intelligence bus in a time
15 slot reserved therefor, in which when a tone is needed for any one of the lines served by the two busses, the common processing means sends control signals appropriate to the wanted tone via the common signalling bus to the terminal interface for that one
20 of said lines, in which each said terminal interface includes processing means, digital-to-analogue conversion means for said tones and gating means for said tones, in which the reception of said control signals at a said terminal interface causes the gating
25 means appropriate to the required tone or tones to be enabled so that that tone is transmitted to the appropriate one of the subscriber's lines, and in which, dependent on the control signals thus transmitted, one or more of said tones can be sent to
30 the subscriber's line, either continuously or cadenced as appropriate to the information to be notified to that subscriber's line.
2. An exchange as claimed in claim 1, and in which said tone generation means is a digital system
35 which includes stored PCM code bytes for the respective tones, which bytes are read out successively from the memory in which they are stored to produce PCM codes for the wanted tones.

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3. An exchange as claimed in claim 2, in which the tones are two in number with the PCM code bytes stored in alternate rows of said memory.

4. An automatic telecommunication exchange substantially as described with reference to the accompanying drawing.

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