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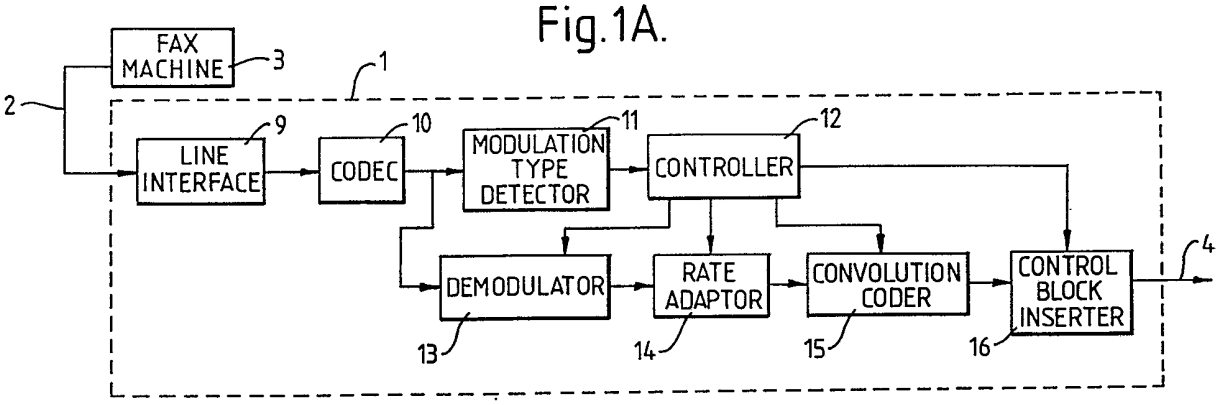
(54) Facsimile transcoder

(57) A facsimile transcoder for enabling communications between Group 3 fax machines within a radiotelephone communications network. The transcoder enables conversion of the analogue fax signal into a digital bit stream suitable for transmission over a digital RF communications channel. A protocol between transmitting and receiving fax machines is established by inserting signalling blocks into the digital bit stream. The transcoder also provides means for overcoming any incompatibility of data rates between Group 3 fax operation and radiotelephone network operation.

Fig.1A.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1A.

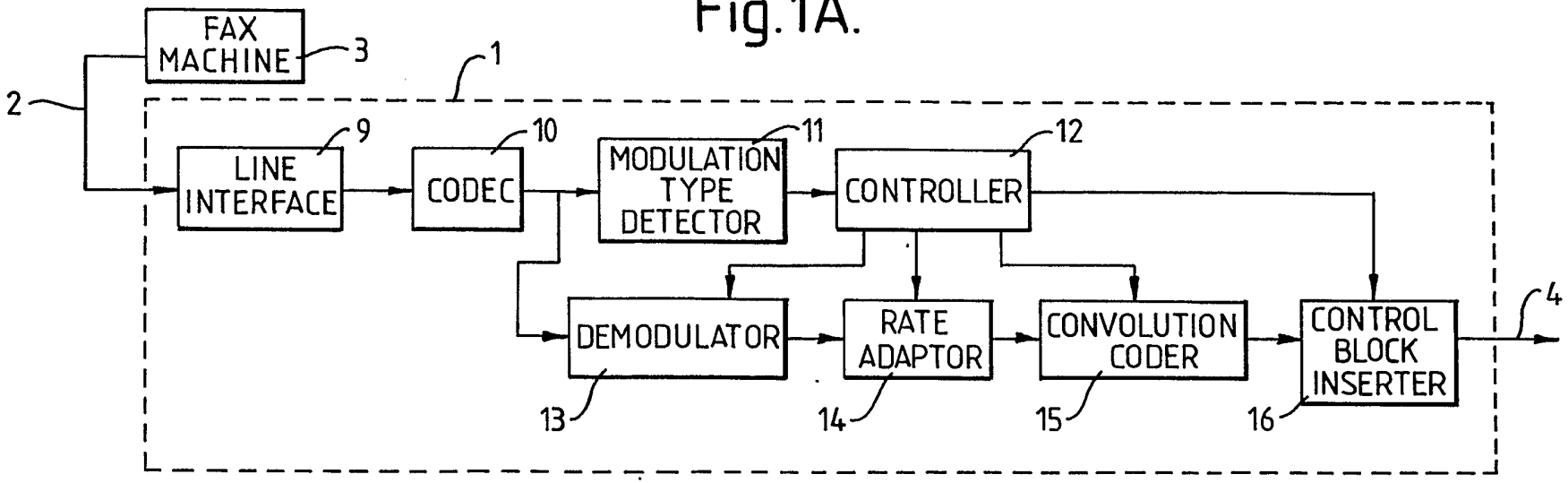
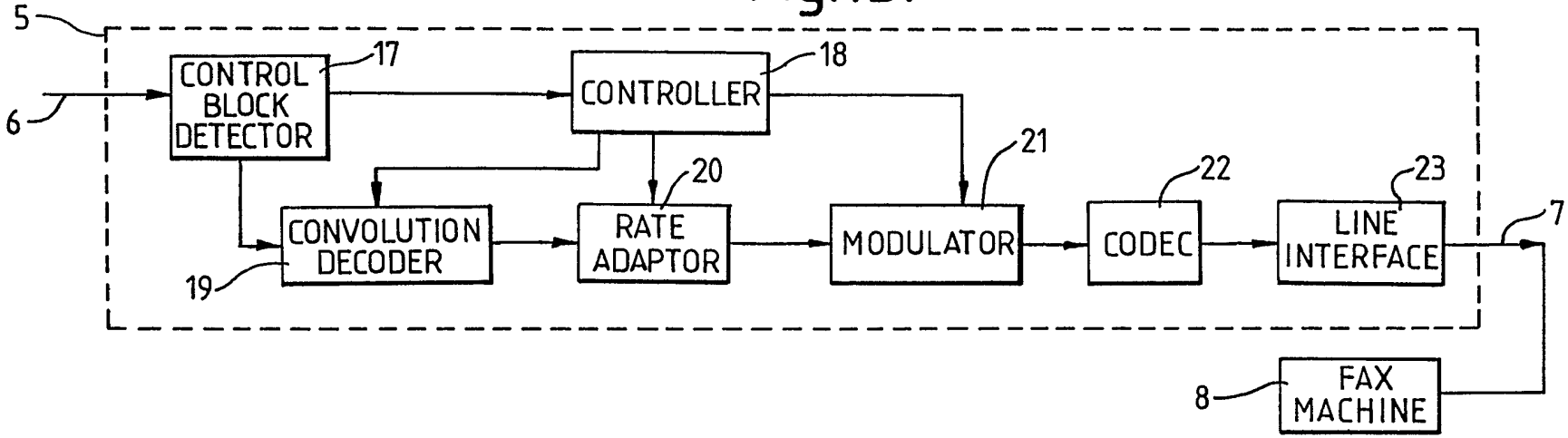


Fig.1B.



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FACSIMILE TRANSCODER

This invention relates to communication systems and in particular to facsimile (or "FAX") machines normally used for the transmission of documents over telephone lines.

An object of this invention is to provide means for permitting facsimile-generated information to be modulated (and demodulated) into a form for transmission (and reception) via an RF carrier over an air interface.

In particular, it is an object to achieve Group 3 fax operation within a radiotelephone communication systems network.

Unfortunately, speech channels cannot be used because the voice coding scheme used in some known radio telephone communications systems is not compatible with the V.27 or V.29 modem signalling used by conventional fax machines.

In one known type of radiotelephone communication system, a plurality of radio frequencies is employed to provide appropriate allocation of speech communication channels. Each frequency is time divided into time frames which are further subdivided into time slots (or bursts). Speech communications are enabled by converting the analogue signal from a handset into a digital bit stream. Typically, some form of pulse code modulation (PCM) is employed and the resulting bit stream is modulated onto an RF carrier for transmission over the air interface.

A conventional fax machine has an output in analogue form, a form which cannot be transmitted over certain radiotelephone communications network without modification.

A further problem arises owing to incompatibility of data rates. Group 3 fax machines are capable of operating at variable data rates; eg. 300bps, 2400bps, 4800bps, 7200bps or 9600bps. In contrast, current radiotelephone communication systems cannot support all of these different data rates.

For further details of Group 3 fax operation, the reader is referred to CCITT (Consultative Committee for Telephones and Telegraphy) Recommendations: T4 and T30.

The present invention overcomes the above problems and provides a fax transmitter interface circuit and a fax receiver interface circuit for enabling communications between fax machines over an air interface.

A fax transmitter interface circuit in accordance with the invention thus comprises:

an input for receiving from a fax machine a modulated analogue signal;

means for determining the type of modulation present on said analogue signal;

means for converting the analogue signal into a digital bit stream having a predetermined data rate;

means for inserting information relating to said type of modulation into said digital bit stream to produce a composite signal for onward transmission via an air interface.

A fax receiver interface circuit in accordance with the invention comprises:

an input for receiving from a radio receiver a digital bit stream which comprises data generated by a remote fax machine and data relating to a type of modulation employed by said remote fax machine;

means for determining said type of modulation;

means for adjusting the data rate of the digital bit stream to a rate appropriate to said type of modulation;

and means for converting the rate-adjusted digital bit stream into an analogue signal for transmission to a receiver fax machine.

Hence, in order to transmit a fax message, the invention enables recovery of the digital information describing the fax message from the V series analogue modulation and uses an RF data channel to transmit the message over an air interface. On reception, the analogue modulation (or a conventional PCM representation of it) can then be reconstituted prior to further transmission of the signal on wired connections.

The invention will accept and regenerate all of the V series modulations used by Group 3 fax machines, together with the CED and CNG tones used for initial link establishment.

The transmitter and receiver interface circuits located at opposite ends of the RF link are synchronised so that their respective operations are complementary at all times. A preferred communications protocol between the two transmitting

and receiving ends is transmitted in-band in the traffic (data) channel and is unacknowledged.

Further, the invention will automatically recognise any of the valid V series modulations and adapt their operation to suit, synchronising the receiving end accordingly (fortunately the fax protocols are strictly half duplex). In our preferred implementation, all modes of fax operation employing the normal V series modulations are carried transparently, with the sole exclusion of operator intervention.

The means for inserting information relating to the type of modulation into the bit stream may comprise a block inserter. The information is then in the form of signalling blocks which are decoded by a block detector at the receiving end. This measure establishes a protocol between transmitting and receiving interface circuitry.

Data rates of the digital bit streams may be adjusted by using rate adaptors and convolutional coders/decoders.

In a preferred embodiment, the predetermined data rate is always 9600 baud. If the fax machine is transmitting at a lower rate, the transmitter interface circuitry takes advantages of the spare bandwidth for error correction. Thus a fax machine fall-back to lower data rates eg. 4800bps or even 2400bps will reduce the delivered bit error rate, as does a wired connection across a public switched telephone network.

An embodiment of the invention will now be described, by way of example only, with reference to the drawing which is a

block diagram of fax transmitter and fax receiver circuitry in accordance with the invention.

In Fig 1A a fax transmitter interface circuit designated 1 is shown having an input on line 2 for connection to a transmitting fax machine 3 and an output on line 4 for connection to a radio transmitter (not shown). Signals appearing on line 4 are channel coded and modulated onto an RF carrier by the radio transmitter for onward transmission over an air interface.

In Fig 1B, a fax receiver interface circuit 4 has an input 6 for connection to a radio receiver and channel decoder (not shown) and an output 7 for connection to a receiving fax machine 8. Modulated signals transmitted over the air interface by the radio transmitter are detected and demodulated into a digital bit stream by the radio receiver for subsequent decoding by the fax receiver interface circuit 5.

Operation of the fax transmitter interface will now be described with reference to Fig. 1A.

The transmitting fax machine 3 output (line 2) is connected to a Line Interface 9 which provides the normal telephony functions of ringing, dial tone generation, off hook detection, etc., and thence to a codec 10 (PCM coder) which digitises the analogue signal on line 2 to 64kbits/sec PCM.

The first requirement is to detect which type of modulation is in use, viz CNG or CED tones, V21, V27, or V29. This is determined by a modulation type detector 11 which signals this information to a controller 12. The controller 12 sends the appropriate signal to a demodulator 13 which is also connected to

receive the PCM data from the codec 10. In most cases the modulation type is determined during a preamble to the main data so the demodulator 13 is configured to suite the modulation type before data is sent to it. (NB in the case of CNG and CED the demodulator 13 is not used since these are only status tones).

The demodulator 13 outputs a bit stream at a rate appropriate to the modulation type (300, 2400, 4800, 7200 or 9600 baud). This is then passed to a rate adaptor 14 and subsequently a convolution coder 15 which increases the data rate up to 9600 by the addition of a combination of padding and error detection and correction bits. In a particular example, padding is used to bring 300 up to 2400 baud by eight-fold repetition of the data in suitable blocks 2400, 4800 and 7200 baud are converted to 9600 baud using rate compatible punctured convolution codes. 9600 baud signals are passed unchanged.

To maintain transparency of the system it is also necessary to inform the fax receiver interface circuit 1B of the type of modulation being used by the transmitting fax 3. The controller 12 can therefore command the insertion of signalling blocks into the data stream using a control block inserter 16. (NB insert, not overlay). These blocks are structured in a way that allows them to be recognised easily at the receiving end with a sufficiently low probability of them being emulated by real fax data.

Operation of the fax receiver interface will now be described with reference to Fig 1B.

The received 9600 baud digital bit stream appearing on line 6 is passed to a control block detector 17 which decodes the signalling blocks, passes them a a controller 18 and passes the remaining data to a convolutional decoder 19 and rate adapter 20 which then recreates the original data stream at the correct baud rate. This data stream is then modulated in accordance with the appropriate standard (V21, V27, V29) in the modulator 21 and passed to a codec 22 (PCM decoder) and line interface 23 and thence in analogue form to the receiving fax machine 8. CNG and CED tones are generated in the modulator 21 under direct control of the controller 18.

It is necessary that the signalling blocks be passed in-band and unacknowledged in order to avoid signalling path delays causing either fax machine (usually the transmitting one) to "time out". For the same reason, the signalling blocks are unacknowledged and are themselves error protected using a block code. The balance between error protection capability in the block code and population of the code data space is chosen so as to minimise the aggregate probability of emulation of a valid command by fax data following false trigger on an emulated block marker, while providing a good probability that a genuine command will be correctly recognised and interpreted.

Obviously in a practical implementation an equivalent reverse path is available although the Group 3 fax protocol is half duplex.

Optionally, echo suppression circuitry can be employed if required. Such circuitry could operate by blocking the

transmission path at the receiving end during transmission and for a period equal to the round-trip time.

CLAIMS

1. A fax transmitter interface circuit comprising:

an input for receiving from a fax machine a modulated analogue signal;

means for determining the type of modulation present on said analogue signal;

means for converting the analogue signal into a digital bit stream having a predetermined data rate;

means for inserting information relating to said type of modulation into said digital bit stream to produce a composite signal for onward transmission via an air interface.

2. A fax receiver interface circuit comprising:

an input for receiving from a radio receiver a digital bit stream which comprises data generated by a remote fax machine and data relating to a type of modulation employed by said remote fax machine;

means for determining said type of modulation;

means for adjusting the data rate of the digital bit stream to a rate appropriate to said type of modulation;

and means for converting the rate-adjusted digital bit stream into an analogue signal for transmission to a receiving fax machine.

3. A fax transmitter interface circuit according to claim 1 in which the means for inserting information relating to said type of modulation comprises a block inserter.

4. A fax transmitter interface circuit according to claim 1 or claim 3 in which the means for converting the analogue signal into a digital bit stream of predetermined data rate comprises a pulse code modulation (PCM) coder, rate adaptor and convolutional coder.

5. A fax receiver interface circuit according to claim 2 in which the means for adjusting the data rate of the digital bit stream comprises a convolution decoder and rate adaptor.

6. A fax receiver interface circuit according to claim 5 in which the means for determining said type of modulation is a block detector.

7. A fax receiver interface circuit according to claim 5 or claim 6 in which the means for converting the rate-adjusted digital bit stream into an analogue signal comprises a PCM decoder.

8. A fax transmitter interface circuit substantially as hereinbefore described with reference to the drawing.

9. A fax receiver interface circuit substantially as hereinbefore described with reference to the drawing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition K) H4K (K0D2, D0D6)

(ii) Int Cl (Edition 5) H04N

Search Examiner

MR S J L REES

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

23 MARCH 1992

Documents considered relevant following a search in respect of claims

ALL CLAIMS

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4771335 (TOSHIBA) whole document especially column 1 lines 54-66 and column 4 lines 57 - column 5 line 23	

tp - c:\wp51\doc99\fil000372

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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