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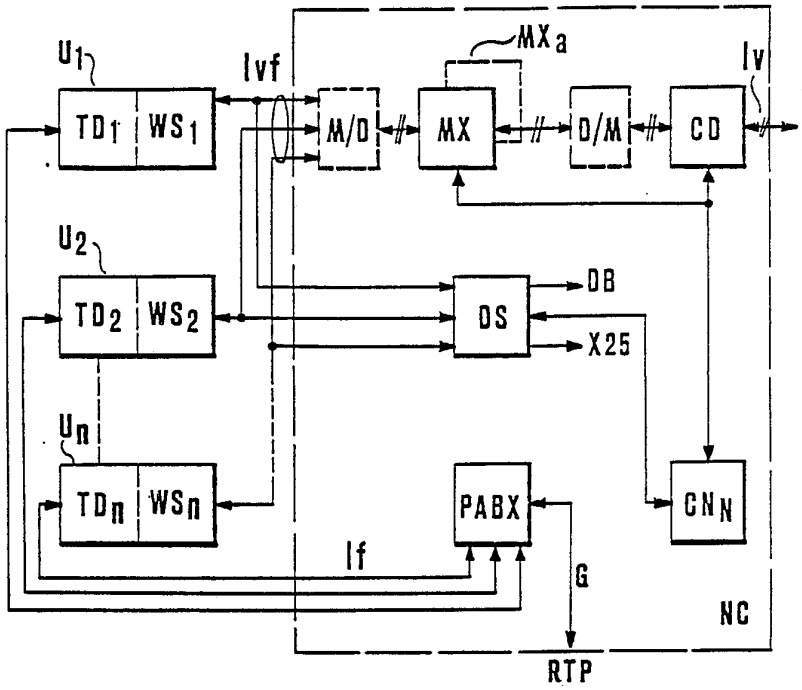
(54) Title: WIDE BAND COMMUNICATION SYSTEM



(57) Abstract

A wide band communication system allows the exchange of audio signals, video signals and data among a plurality of users (U_1, U_2,..., U_i), either connected to the same switching node (NC) or to different switching nodes. Simple and economic realization is given of the signalling control means relevant to the video link (lv), via the data facilities (MD) of the user terminal (WS, TD) and the exchange means (PABX, RTP) for audio connections.

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WIDE BAND COMMUNICATION SYSTEM

DESCRIPTION

This invention refers to a wide band communication system, and in particular to a system suitable to switch audio signals, video signals and data.

In the field of added value telephone services, it is recorded the increasing demand of exchange - besides audio signals - of video signals and data. In particular it is recorded the need to exchange the above mentioned signals both in local environments (e.g. users of a same company) and remote environment (e.g. users of two different companies placed in distant geographical areas even hundreds of kilometers apart).

In order to meet the above mentioned requirements, users must be supplied with a working station including equipment such as:

- one telephone set;
- one terminal equipped with display;
- one telecamera.

These work stations are connected to a switching node which must also be connected to one or more remote switching nodes by means of transmission lines suitable to enable the transmission of video signal, possibly in a compressed form. Of course the connection between two users abutted to two different switching nodes involves the presence, in each node, of means suitable to detect signalling criteria and also to send them towards the remote switching node.

Solutions are known, where the unit preposed to the control of the switching node is configured in such a way to detect signalling criteria relating to the video link and send them, through a signalling channel abutted to it, to the control unit of the remote switching node. This solution allows the connection between two geographically distant users, but it results being expensive since the control unit of each switching node is of such a complexity which can be compared to that of control units of a digit switwing exchange.

Always in the field of wide band communication system there is the problem to realize diffusion services, that is the problem to sent on whichever matrix output a predetermined number of channels which can in this way be distributed to users requiring the same. Audio, visual and data sources can be abutted to diffusion channels which can be distributed to whichever user connected to the switching matrix, interested in receiving signals emitted by such sources. This is the case for instance of a lesson recorded on videocassette and transmitted on a determined diffusion channel to be received - through the switching matrix - by all concerned users.

Solutions are known foreseeing the use of a "monostage" matrix, that is a matrix having a number of crossing points equal to the number of inputs for the number of outputs.

These solutions allow the immediate realization of diffusion services but determine cost problems, especially when the number of inputs/outputs is high (e.g. 200 inputs and 200 outputs).

It has infact to be considered that the cost of a crossing point of the subject type is presently of approximately 40 dollars and therefore the cost of the mentioned matrix totals to 1.6 million dollars.

Solutions are also known that, in order to reduce the number of crossing points, foresee the realization of multistage matrixes obtaining a blocking probability which is the higher, the higher is reduction of crossing points compared to the above mentioned number.

Solutions are also known allowing a reduction in the number of crossing points without increasing the matrix blocking probability (they are known in the specific technique under the term "closs"), but they do not allow the realization of diffusion services.

A generic working station, as specified above, can be connected to a working station abutted to a remote switching node by means of coding equipment suitable to compress the band of the video signal.

Coding equipment are configured in such a way to emit at the output bit strings obtained by processing the video signal received at the input. Considering that processing operations require a determined time - sometimes of variable magnitude - it results that the remote user receives the audio signal and, with a variable delay, the video signal.

The deriving effect is disturbing for instance when the face

of the remote user is framed, since tne voice is received in advance versus the image reproducing movements of the mouth. To obviate this, solutions have been identified foreseeing the insertion of delay circuits on audio lines in such a way to introduce a delay equal to the one introduced by coding equipment on video signals.

Considering that coding equipment introduce a variable delay related to the speed of change of images shot by the telecamera, the delay circuits of the audio signal result being expensive an complicated to realize.

The aim of this invention is to identify circuit solutions suitable to enable a particularly simple and cheap realization of the means controlling the signalling relevant to the video link. Another aim is to identify solutions suitable to enable a particularly simple and cheap realization of a switching matrix suitable to enable the distribution - in a non blocking manner - of diffusion channels.

A further aim is to identify solutions suitable to align the audio signal to the video one, when a videolink between two users abutted to two different switching nodes is established.

The subject of this invention is therefore a wide band communication system including at least a switching node to which it is abutted at least one user equipped with working

station suitable to receive/emit audio signals, video signals and data.

Each switching node is configured in such a way to include:

- coupling means to which it results being connected at least one line suitable to transmit/receive video signals towards the remaining switching nodes, as well as one working station at least through a video-phonic connection line;
- control means suitable to receive signalling messages generated in the work station(s), to generate signalling messages rlevant to the state of said video line(s), and to drive said coupling means;
- means for the switching of phonic signals to which the telephone sets of each working station are connected through phonic lines;
- means for data transmission/reception, associated to each working station, suitable to send, or receive, to or from, the working station of the calling user - through said means for phonic signal switching - signalling messages received from, or to send to, the control means of the relevant switching node.

Always according to the invention, in the cases where a plurality of users enables to make videocommunications and to receive diffusion channels are abutted, the above mentioned coupling means consist of a multistage matrix whose last stage includes a given number of crossing points

necessary to establish the connections foreseen in the field of videocummunications and p = n . m crossing points for the distribution, in a non blocking manner, to m users of n diffusion channels.

The invention foresees also the presence of switching means positioned in each working station, suitable to disconnect the telephone set from the relevant phonic line and to connect it to the relevant video-phonic line replying to a videocommunication request generated by the user. In this way, also the phonic signal arrives at the input of coding means and consequently it has the same delay of video signals.

Using the circuit solutions forming the subject of the invention, it is possible to realize said video links without employing a switching node control unit of difficult realization. It is also possible to implement the above mentioned diffusion services keeping unchanged the blocking probability of the matrix and employing a number of crossing points a little bit higher than the one necessary when these services are absent. It is also possible to align the audio signal to the video one.

Further characteristics of the invention are detailed in the following description, relevant to a non-limitative example of realization and supplied with the following figures where:

- figure 1 shows the block diagram of the communication system carried out according to the invention;
- figure 2 shows the block diagram of a generic switching node NC of figure 1;
- figure 3 shows in detail data transmission means TD of figure 2 realized according to the invention;
- figure 4 shows the connection of diffusion channels to the elementary matrix MX of figure 2;
- figure 5 shows the block diagram of matrix MX of figure 4, realized according to the invention;
- figure 6 shows a generic switching plan of the third stage of matrix MX of figure 5.

Figure 1 shows the block diagram of a wide band communication system which is configured in such a way to include:

- a plurality of switching nodes NC_1, NC_2, NC_3,... each one of them connected to a predetermined number of users U_1, U_2, U_i,... equipped with a working station suitable to transmit/receive audio signals, video signals and data through video-phonic communication lines lvf;
- the public telephone network RTP, to which the switching nodes NC are connected through telephone lines lf (or trunks);

- one or more data base DB to which users can connect themselves for consulting reasons (the figure shows the data base DB associated only to node NC_3);
- one or more interface units X25 towards package switching networks (the figure shows the interface X25 associated only to node NC_1).

Considering that each user U can establisg an audio and/or video link with whichever user U abutted to the same node NC or to other switching nodes NC, these ones must be equipped with means suitable to control the signalling messages required for the construction and control of the video link. The invention foresees to employ circuit solutions allowing to considerably simplify the control means of each switching node compared with the above mentioned solution of already known type. The invention foresees infact the presence of circuit solutions suitable to allow the exchange of signalling messages (relevant to the video link between the calling user and the called one) through telephone lines lf and the public telephone network RTP, thus avoiding the use of "dedicated" signalling channels.

The RTP network, besides realizing the telephone link between the users, allows also the exchange of signalling messages concerning a video link, which is destined to be realized through the video lines lv.

Figure 2 shows in detail a generic switching node NC which is configured in such a way to include:

- a space matrix MX to which said users U and video lines lv, are abutted through coding parts CD suitable to reduce the band of the video signal;
- one switch of PABX audio signals to which the telephone sets equipping each working station of users U as well as a plurality of trunk lines G to the public telephone network RTP are connected;
- one data switch DS to which said data terminals of the working station of users U and the control unit CN_N of the switching node are connected. Said data base DB and said interface unit X25 towards package switching networks are connected to said data switch DS.

In the cases where one interface unit X25 towards package switching networks is not connected to the node NC and/or data switching is not foreseen, unit DS can consist of a signalling concentrator/expander, that is of one unit suitable to concentrate signalling coming from users U towards the control unit CN_N and suitable also to expand signalling outgoing from unit CN_N towards users U.

It must also be kept in mind that unit DS is unnecessary when a PABX unit is employed suitable to switch both phonic signals and data. The PABX unit is of course unnecessary when phonic lines lf are directly connected to the public network RTP.

In some cases only one user U is connected to the switching node NC: this is the case, for instance, of a company

supplied with an autoswitch of PABX phonic signals to which are connected a plurality of users enabled to make only phonic links and only one user enabled to make both phonic and video links.

In this case, matrix MX consists of a simple coupling circuit and unit DS is unnecessary.

In order to considerably simplify the realization of the control unit of the switching node CN_N, the invention foresees that signalling relevant to the video connection is sent to the remote switching node through the phonic link established between the calling user and the called one.

In this way it is possible to avoid to supply the unit CN_N with a signalling channel connected to unit CN_N of the remaining switching nodes NC, drastically reducing the costs of said unit.

However, it must be considered that the sending of data (messages containing the signalling) on the above mentioned phonic link involves the overcoming of technical problems tied to the need of not disturbing the phonic conversation.

To this purpose figure 3 shows the solution realized according to the invention and in particular it shows only the pieces of the working station necessary to the comprehension of solutions adopted.

Figure 3 shows in fact a telephone line lf' abutted to an autoswitch of PABX' phonic signals connected through trunk lines G (and possibly through the public telephone network)

to a similar autoswitch PABX" to which a telephone line lf" is abutted. To the telephone line lf' abutted to the PABX' unit, or to the telephone line lf" abutted to the PABX" unit, a telephone set TL' is connected through a switching device SW'_1, or a telephone set TL" through a switching device $SW"_1$. The switching device SW'_1, or $SW"_1$, is operated by control devices CN_S', or $CN"_S$, of the working station. To the telephone line lf', or lf", it is also connected a modem MD', or MD", which always according to the invention is connected in parallel to the telephone set TL, in order not to disturb phonic calls.

In this figure it is assumed therefore that the user equipped with the telephone set TL' has requested the construction of a phonic link with the user equipped with telephone set TL".

This link has been carried out according to traditional methods through PABX' units, PABX" unit and possibly the public telephone network RTP.

When one of the two users declares his intention to activate a videocommunication, pressing for example a key T' associated to the relevant CN_S', this event is detected by the unit CN_S' which starts a number of procedures such as:

- it requires to the control unit of the relevant switching node CN_N one video free line lv among those connecting the same to the node NC to which the called user is connected. This request reaches the unit CN_N

through the data switch DS and, always through this unit, the unit CN_N sends a message containing all information (e.g. number of free line lv, etc.) necessary to establish a link through video lines lv to unit CN_S;

- it controls the sending by the modem MD' of a first frequency f_1 which through PABX', RTP and PABX" units reaches modem MD".

This last unit communicates the reception of frequency f_1 to the relevant control unit CN_S" which controls the switching of the relevant switch $SW"_1$ as well as the sending by the modem MD" of a frequency f_2.

Through units PABX", RTP and PABX', frequency f_2 reaches the modem MD' which communicates this event to unit CN_S' which determines the switching of unit SW'_1 and sends on line lf the signalling message(s) received from the control unit of the relevant switching node CN_N'.

Considering that frequencies f_1 and f_2 form two carriers which can be modulated by units MD' and MD", the control units of working stations CN_S' and CN_S" can carry out an exchange of signalling messages in the full-duplex form, thus allowing the construction of a video link even if units CN_N' and CN_N" do not have a signalling channel.

In order to obviate the above mentioned problems in reference with the delay introduced by the coding means CD of the video signal, the invention foresees the possibility

to transmit phonic signals both via the phonic lines lf and video lines lv.

According to a preferential form of realization, phonic signals are sent through the phonic lines lf until the two users intend exchange only phonic signals. When one of the two users declares his intention to make also a video link (operating for instance said key T of figure 3), the telephone set TL is connected to video-phonic lines lvf instead of phonic lines lf by means of a switch SW_2. In this way the phonic signal follows the same path of the video signal and has the same delays overcoming the above mentioned problem.

The invention foresees two possible solutions to send the audio signal to coding means CD.

A first solution foresees the modulation of the audio signal on a frequency band higher than those occupied by the video signal using a modulating/demodulating circuit M/D (see figure 2). The signal so obtained is sent to the input of the wide band matrix MX at whose output a demodulating/ modulating circuit D/M is connected. In this way the video signal and the audio signal are sent to the input of the coding circuits CD - on two separate inputs - and are processed by unit CD which emits the same at the output on video lines lv aligned among them.

A second solution foresees the presence of an audio matrix MX_a, to which input audio signals are sent, while video

signals are sent to the input of the above mentione matrix MX. The presence of M/D and D/M circuits results being unnecessary in this case.

Figure 4 shows the switching matrix MX to which users U_1, ...,U_n are connected.

For example sake, user U_1 consists of a videoconference room, user U_2 of an user equipped with videoterminal and telecamera while user U_N consists of a user equipped with telecamera, videoterminal and data terminal.

Each user U_i can establish a link with whichever n - 1 users by means of the switching matrix MX which is driven by unit CN_N.

A number of diffusion channels $D_{1,....,Dn}$ are connected to matrix MX, and figure 4 shows the connection to channel D_1, always for example sake, of a videorecording equipment suitable to send to the matrix input audio and video signals concerning for instance a language lesson.

Figure 5 shows the block diagram of matrix MX which, according to a preferential form of realization, is of the threestage type and is suitable to switch 200 inputs on 200 outputs (n = 200). In particular this matrix foresees the use of elementary switching matrixes ME suitable to switch 10 inputs on 10 outputs and is configured in such a way to include 10 switching levels P.

The first stage IS foresees the use of switching levels P_1',

P_2',....., P_{10}'each one including two elementary matrixes ME connected in such a way to perform a concentration function by switching 20 inputs on 10 outputs.

The second stage IIS foresees the presence of a single elementary matrix ME in each switching level P_1'', P_2'',...., P_{10}'', in such a way to switch 10 inputs on 10 outputs, where each unit ME receives at the input the i-th output of the first stage IS.

The third stage IIS includes 10 switching levels P_1''', P_2''',...., P_{10}''' and each level consists of:

- a first pair of elementary matrixes ME connected in such a way to perform an expansion function, switching 10 inputs on 20 outputs;
- a second pair of elementary matrixes ME, connected in such a way to perform an expansion function switching 10 diffusion channels on said 20 outputs.

Making a dimensioning of matrix MX as said above, it shows a predetermined blocking probability as far as videocommunications are concerned while it is of the non blocking type as for the distribution of diffusion channels.

On the basis of the above mentioned example of realization of matrix MX, this matrix is configured to include 5 thousands crossing points (2 thousands in the first stage, 1000 in the second stage, 2 thousands in the third stage) to switch 200 inputs on 200 outputs, and further 2 thousands

crossing points to diffuse 10 diffusion channels D_1,...., D_{10} to the 200 users connecter to the switching matrix.

Making reference to the application example considered above, the space matrix for diffusion services realized according to the invention employs therefore 7 thousands crossing points to switch 200 inputs on 200 outputs and diffuse 10 diffusion channels.

In the mentioned solutions of the known type foreseeing the employ of monostage matrixes having the same capacity (200 inputs on 200 outputs) the number of crossing points totals to 40 thousands, which gives proof of cost reduction which can be obtained using the solutions according to the invention.

Of course depending on the change in the number of inputs/outputs, on the blocking probability of videocummunications and on the number of diffusion channels, the number of crossing points deviates from the one mentioned above being always considerably lower than the one obtained in presence of monostage matrixes.

The calculation of the number of the crossing points necessary for the distribution of said diffusion services in a non blocking manner, can be made using the relation:

$$p = n \cdot m,$$

where p is the number of necessary crossing points, n is the number of diffusion channels and m is the number of users abutted to the matrix.

Figure 6 shows in detail the connections among elementary matrixes ME of a generic switching plan of the third stage IIS.

In particular matrixes ME_1 and ME_2 have the function to distribute without blocking, the diffusion channels $D_1,....,D_{10}$ to the 20 users abutted at the output of the subject switching plan.

Matrixes ME_3 and ME_4 receive at the input the 10 outputs of the second switching stage IIS and make an expansion function distributing these 10 outputs to the above mentioned 20 users.

Of course if on a generic moment a diffusion channel D reaches one of said 20 outputs, no videocommunication can be sent to that output.

In the light of the above it is clear that the communication system realized according to the invention fully meets the requirements described in the object, since it allows a particularly simple and cheap realization of the control unit CN_N of the switching node, of the switching matrix MX and of the means for the alignment of audio and video signals.

CLAIMS

1) Wide band communication system including at least one switching node to which one user at least, equipped with working station suitable to receive/emit audio signals, video signals and data, characterized by the fact that each switching node (NC) is configured in such a way to include:

- coupling means (MX) to which it results being connected at least one line (lv) suitable to transmit/receive video signals towards the remaining switching nodes (NC), as well as one working station (WS) at least through a video-phonic connection line (lvf);
- control means (CN_N) suitable to receive signalling messages generated in the work station(s), to generate signalling messages relevant to the state of said video line(s), and to drive said coupling means (MX);
- means for the switching of phonic signals (PABX and/or RTP) to which telephone sets (TL) of each working station (WS) are connected through phonic lines (lf);
- means for data transmission/reception (TR), associated to each working station (WS), suitable to send, or receive, to or from, the working station of the calling user - through said means for phonic signals (PABX and/or RTP) switching - signalling messages received from, or to send to, the control means (CN_N) of the relevant switching node (NC).

2) System as per claim 1, characterized by the fact that said data transmission/reception means (TR) include:

- first switching means (SW_1) positioned in each working station (WS) suitable to select the telephone line (lf) further to the reception of a control coming from the control unit (CN_S) of the working station (WS);
- one modem (MD), connected in parallel to the telephone line upstream said switch (WS), suitable to signal to the control unit (CN_S) of the working station the reception of a first frequency (f_1) and suitable also to emit a second frequency (f_2) further to the reception of a control by the control unit (CN_S) of the working station, to modulate, or demodulate, signalling messages received, or to be sent, from, or to, the control unit (CN_S) of the working station.

3) System as per claim 1 where to each switching node a plurality of users (U) are abutted, characterized by the fact that among said users (U) and said control unit of the switching node (CN_N) a concentrator/expander of signalling (DS) is connected.

4) System as per claim 1 where to at least one switching node (NC) an interface unit (X25) towards data transmission networks is connected, characterized by the fact that said switching node includes a data switching unit (DS).

5) System as per claim 1 characterized by the fact that it includes:

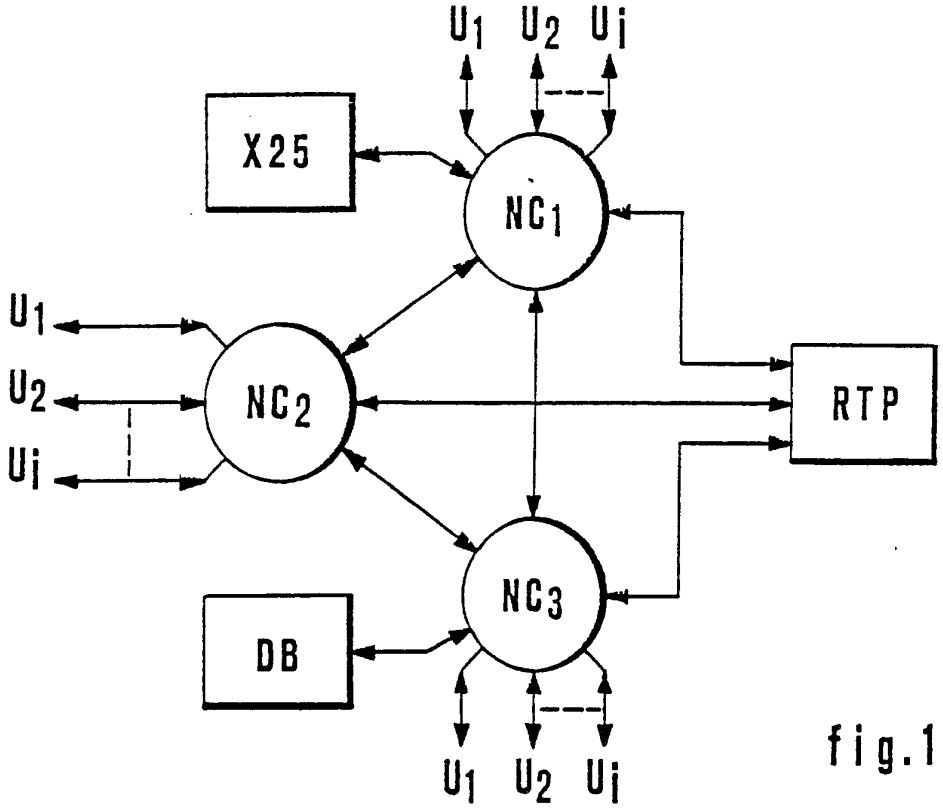
- second switching means (SW_2) positioned in each working station (WS) suitable to disconnect the telephone set (TL) from the relevant phonic line (lf) and to connect it to the relevant videophonic line (lvf) further to a request of videocommunication generated by the user;
- modulation - demodulation means (M/D - D/M), connected at the input - output of coupling means (MX), suitable to allocate the phonic signals, or video ones, in a frequency band different from the one occupied by video signals, or phonic ones.

6) System as per claim 1 characterized by the fact that it includes:

- second switching means (SW_2) positioned in each working station (WS) suitable to disconnect the telephone set (TL) from the relevant phonic line (lf) and to connect it to the relevant viedophonic line (lvf) further to a request of videocommunication generated by the user;
- coupling means (MX_a) of audio lines, positioned in parallel to the above mentioned coupling means (MX) at the inputs -outputs of which audio wires of said video-phonic lines (lvf) are connected.

7) System as per claim 1 where to each switching node (NC) are abutted m users enables both to make videocommunications and to receive diffusion channels, characterized by the fact that said coupling means are made of a multistage matrix whose last stage includes a predetermined number of crossing

points necessary to establish the links foreseen in the field of videocommunications, and p = n . m crossing points for the distribution, in a non blocking manner, to m users of n diffusion channels.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U2
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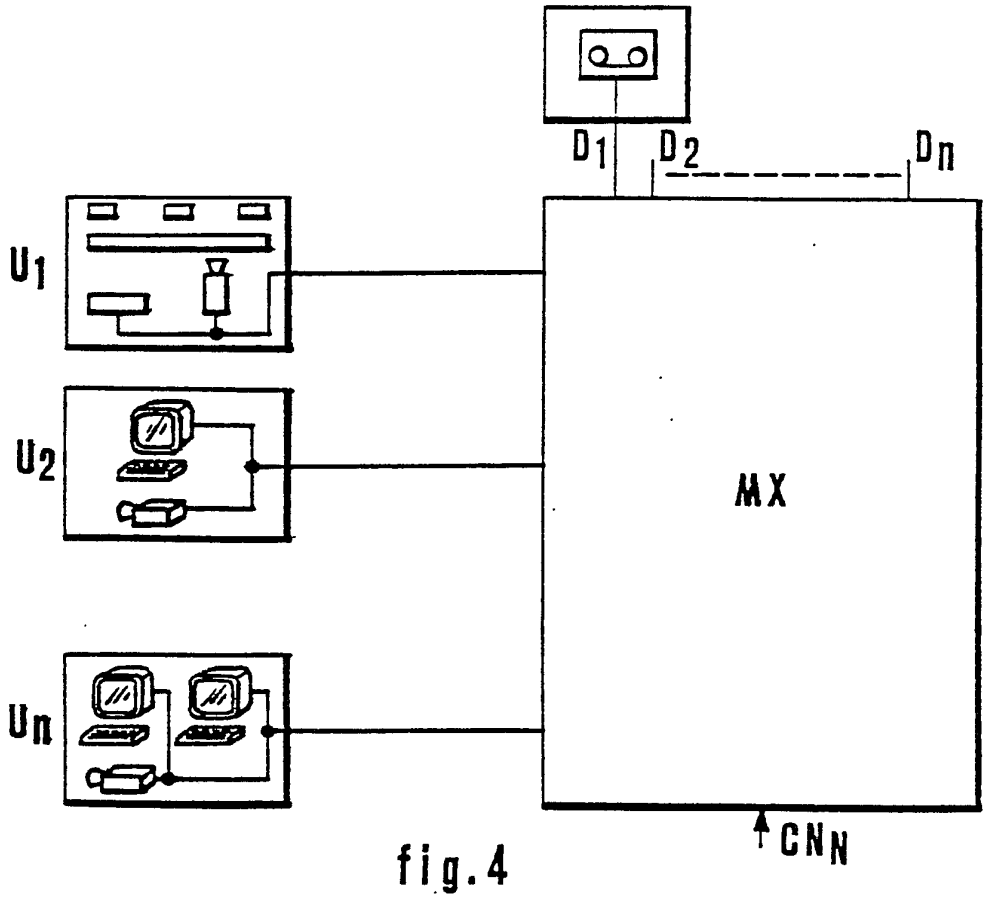
RTP
NC3
DB
U1 U2 Ui

fig.1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MX
CNN

fig.4

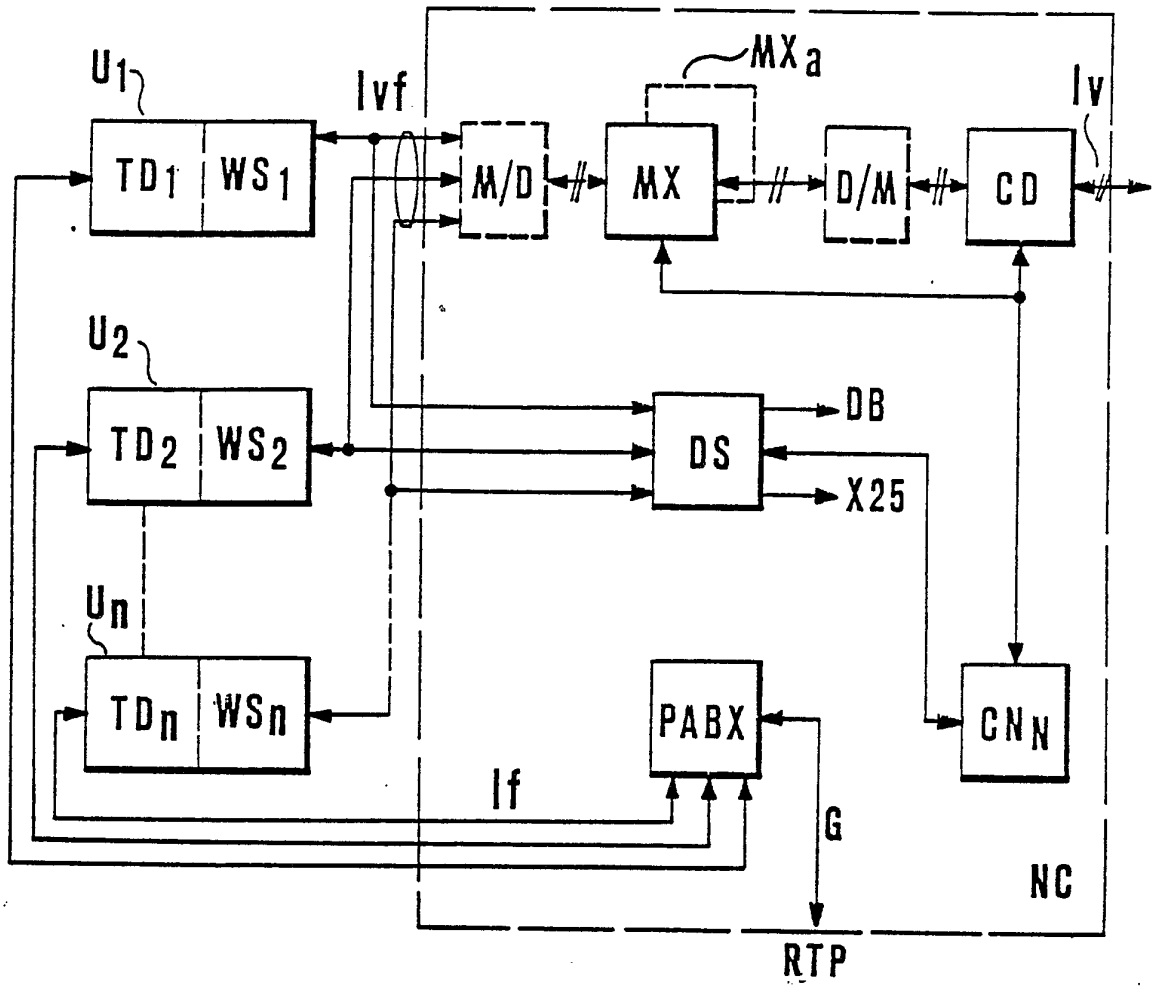
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fig.2

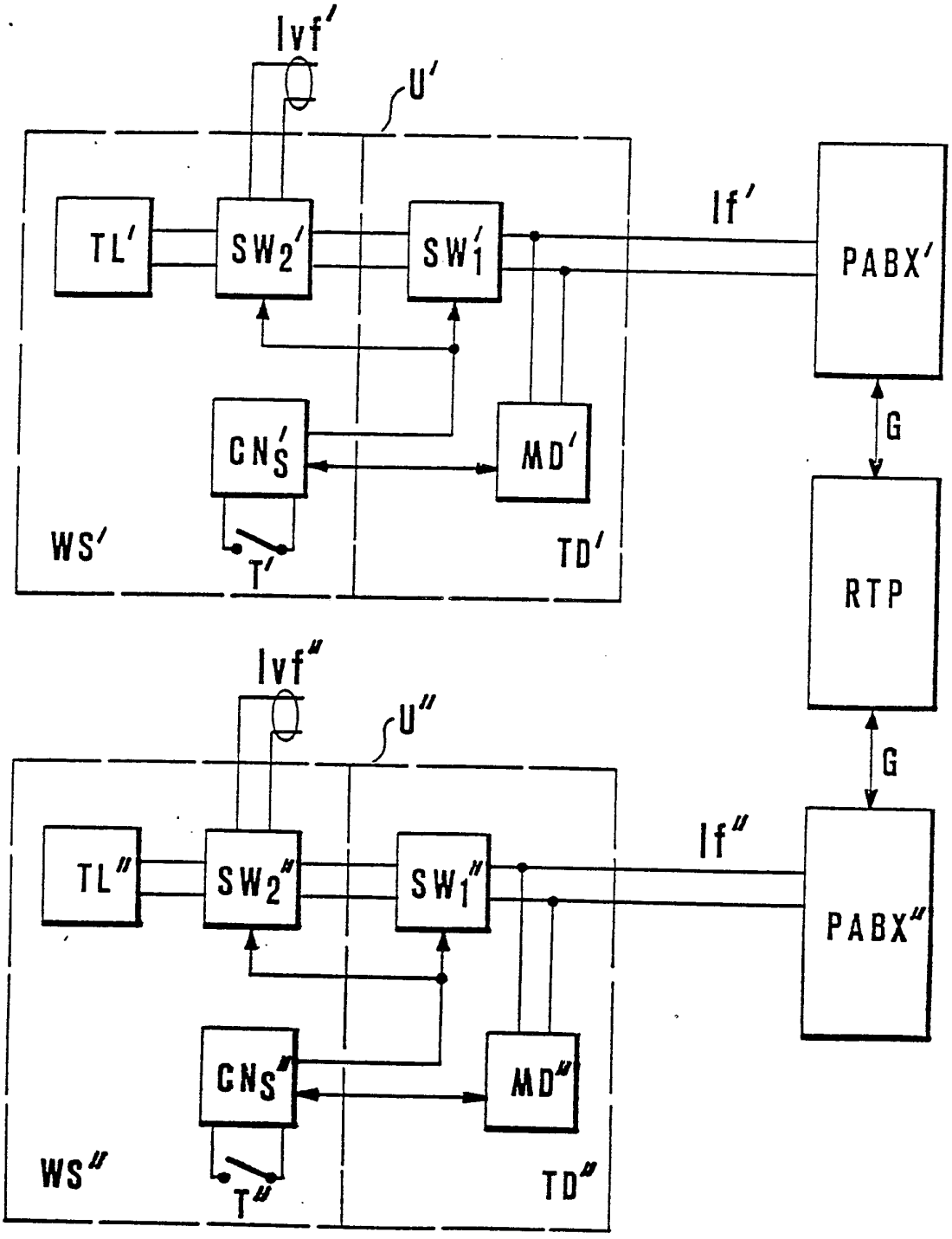
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fig.3

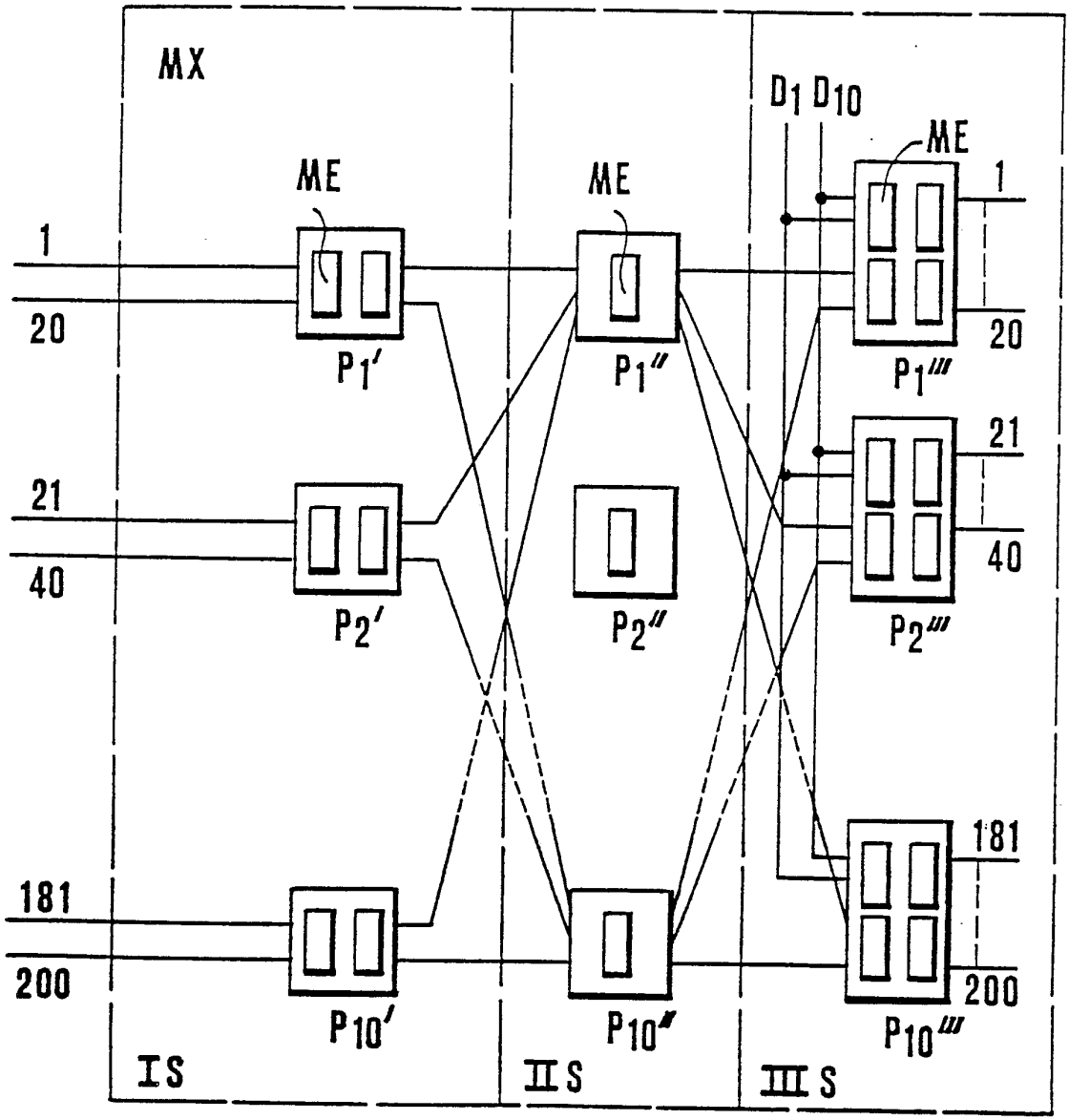
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fig.5

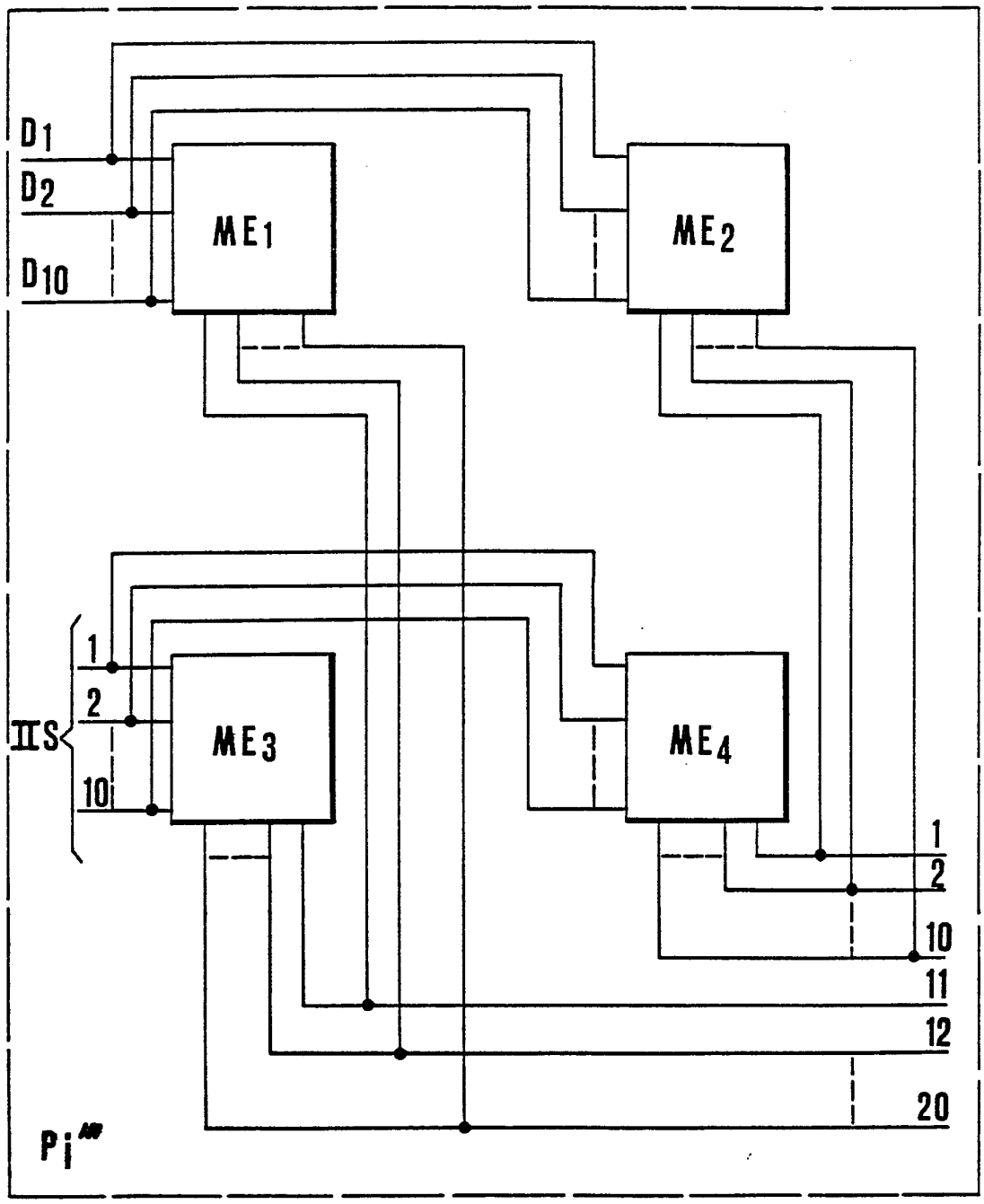

fig.6

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 89/00569

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: H 04 Q 3/62

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	H 04 Q

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	Proceedings of the National Communications Forum, volume 39, 1985, (Oak Brook, Illinois, US), J.S. Mayo: "Universal information services", pages 540-549 see page 542, right-hand column, line 59 - page 543, left-hand column; figures 7,8	1-6
Y	--	7
Y	IEEE Global Telecommunications Conference, GLOBECOM'86, 1-4 December 1986, Houston, Texas, volume 2 of 3, session 26, IEEE, (US), K.J. Allen et al.: "Customer-controlled video switching for teleconferencing", session 26, paper 4, pages 1-8 see page 2, left-hand column, line 25 - right-hand column, line 40; figure 1; page 3, right-hand column, lines 6-40; page 4, figure 2 --	1-3,5,6

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16th August 1989	04 SEP. 1989
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	US, A, 3997736 (GORMAN) 14 December 1976 see figure 1; column 2, line 52 - column 3, line 52 --	1-3,5,6
Y	EP, A, 0196527 (INTERNATIONAL STANDARD ELECTRIC) 8 October 1986 see column 2, line 4 - column 3, line 33; figure 1 --	7
A	EP, A, 0208991 (HITACHI) 21 January 1987 see page 4, line 3 - page 6, line 7; figure 2	5

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 8900569 SA 29003

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 30/08/89
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3997736	14-12-76	None	
EP-A- 0196527	08-10-86	DE-A- 3510567	25-09-86
		AU-A- 5463086	25-09-86
		BE-A- 904462	24-09-86
EP-A- 0208991	21-01-87	JP-A- 62012250	21-01-87