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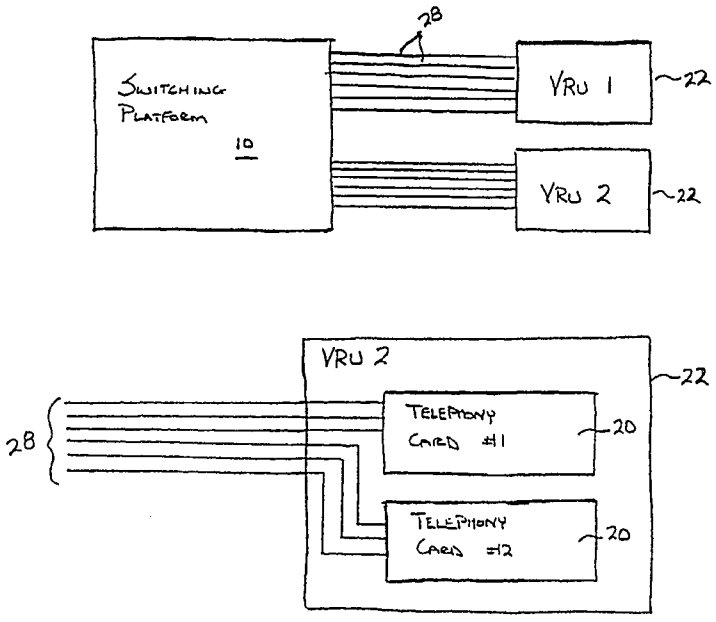

(57) Abstract

A method and system for balancing the load on a plurality of voice response units (22) in a prepaid telephone system in which call processing request made to a prepaid telephone system are assigned to a bank of voice response units in a predetermined sequence without regard to the number of requests being handled by any one voice response unit to reduce wear on the units, to reduce response time, and to eliminate the need for the prepaid telephone system to query the status of the units in making the selection of unit to query.

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VRU LOAD BALANCING

BACKGROUND OF THE INVENTION

Voice response units ("VRUs") are well known. They allow a caller to enter and retrieve information by using the telephone keypad to respond to a voice menu. They can provide, for example, the playback of prerecorded, or voice synthesization of, successive digits in a telephone number in response to a request for directory assistance. In other instances, they may provide voice confirmation of a number entered into a remote unit by depression of the dual tone multiple frequency dialing push buttons of a telephone.

In prepaid telephone systems VRUs are used to inform the subscriber of the time available to talk, the availability of voice mail, etc. The management of a prepaid system is generally under the control of a call processing application resident within the VRU. The call processing application, in association with peripheral equipment, determines the action to be taken (e.g., determining the correctness of a PIN entry, the prompting of users for destination numbers or desired services, outdialing to a requested telephone number, etc.) during the processing of a call request.

Because of the volume of such requests in a system of any practical size, a bank of VRUs are normally maintained to handle the workload as shown in the prior art system of Figure 1. Since the amount of time required for a VRU to respond to a request varies, and since the busy period of a VRU in response to any request begins only when the request is received, the status of the various VRUs in the bank

fluctuates significantly. In order to determine which of the available VRUs a specific request should be directed, many prior art systems implement call distribution using a VRU workload management algorithm/unit to track the status and load of the various VRUs. While these systems efficiently utilize the VRUs, the "net gain" of such systems is minimal due to the extensive time and resources spent in determining the call distribution.

In an alternative prior art system shown in Figure 2, all call requests are processed by the first VRU if it is available. If the first VRU is busy, the request is directed to the second VRU, and so on down the bank until an available VRU is reached. This scheme results in the handling of the majority of the requests by the first VRU, with almost all requests handled by the first few of the VRUs in the bank. This uneven loading of the VRUs creates significant maintenance and repair problems.

Accordingly, it is an object of the present invention to provide a novel method and system for obviating the problems associated with the uneven loading of the VRUs in a bank.

It is another object of the present invention to provide a novel system and method of balancing the usage of plural VRUs in a bank.

It is yet another object of the present invention to provide a novel system and method for distributing telephone calls among a bank of VRUs.

It is still another object of the present invention to provide a novel system and method of reducing the expense of maintaining a bank of VRUs.

It is a further object of the present invention to provide a novel system and method to reduce the possibility of single point failure within an enhanced services environment.

It is a still further object of the present invention to provide a novel system and method for reducing the response time associated with each call request.

These and many other objects and advantages of the present invention will be readily apparent to one skilled in the art to which the invention pertains from a perusal of the claims, the appended drawings, and the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a functional block diagram illustrating a prior art call distribution scheme based on VRU workload.

Figure 2 is a functional block diagram illustrating a prior art call distribution scheme based on the allocation of VRU resources as needed.

Figure 3 is a functional block diagram of one embodiment of the system of the present invention.

Figure 4 is a functional block diagram of an embodiment of the present invention showing the VRU embedded within the switching platform.

Figure 5 is a flow chart of the call distribution scheme for one embodiment of the present invention.

Figure 6 is a functional block diagram of one embodiment of the present invention illustrating load balancing among telephony cards contained within a VRU.

Figure 7 is a functional block diagram illustrating the load balancing of the VRUs for a trunk circuit in a prior art system.

Figure 8 is a functional block diagram illustrating the application of the load balancing scheme of the present invention to a trunk circuit.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 3, illustrating an enhanced services platform in the embodiment of a prepaid telephone system, shows a suitable conventional telephone switch 10 such as the Harris Corporation 20/20 switch in a conventional public switched telephone network (PSTN) connected to large numbers of subscriber telephones such as the caller telephones 24 and the called party telephones 26. Also connected to the switch 10 may be a bank of voice response units (VRUs) 22 on which the prepaid call processing application resides.

Alternatively as shown in Figure 4, the VRUs may be embedded within the architecture of an integrated network server (IN Server) 14 which is physically mounted on the back plane of the telephone switch 10. The embedding of the VRU in the switch platform effects seamless transfer of information

and may be accomplished by means of an adaptor card with the elimination of the T1 and E1 circuits.

As illustrated in Figure 5, the call distribution scheme of the present invention assigns the incoming calls to the VRUs using a modulo (C,N) scheme where C is the number of calls received and N is the number of servicing VRUs.

For example, with reference again to Figure 3, CALL 1 and CALL N+1 are automatically assigned to VRU 1 for call processing. This scheme eliminates the time and resources allocated to the work load algorithms of the prior art systems shown in Figure 1, while increasing the lifetime of the system hardware over the prior art systems of Figure 2 due to equal distribution of wear on the VRUs.

As shown in Figure 6, a VRU 22 consists of a number of telephony cards 20 such as the DIALOGIC #### which perform the call processing. Each of the telephone lines 28 existing between the switch 10 and the VRU 22 is connected to an I/O port of a telephony card 20. The modulo (C,N) scheme used in assigning calls to the various VRUs for processing may also be applied within the VRU such that the calls are distributed among the telephony cards 20.

Figure 7 shows the call distribution for a trunk circuit of a prior art system in which each trunk is permanently assigned to a specific VRU 12 for call processing. In such systems, the response time for processing the call requests is inhibited due to the servicing of a trunk by a single VRU. Further, as the load on a particular trunk is not considered in distributing the call requests, an uneven distribution of

wear on the VRUs may occur resulting in the decreased lifetime of the equipment.

Figure 8 illustrates one embodiment of the present invention in its application to a trunk circuit. Each trunk 40 connected to the switch 10 is divided into a number of subtrunks 42 with each subtrunk 42 serviced by a separate VRU 22. The calls associated with the trunk 40 may then be assigned in accordance with the present invention using the modulo (C,M) scheme where C is the call number and M is the number of subtrunks 42 per trunk 40. In the embodiment of Figure 7, for example, M=6 subtrunks per trunk, each consisting of 5 lines such that the VRU1/Subtrunk 1,1 will be assigned both the first and the seventh call (i.e., call 1 and call 7) occurring on Trunk 1.

While the call distribution scheme of the present invention eliminates the time and resources expended in a workload determination algorithm, there exists a diminishing returns issue in its application to a trunk circuit as disclosed due to the amount of time and resources spent on trunk division. For example, while a larger number of subtrunks/VRUs will increase the response time for processing the call request, the equipment needed, and therefore the associated cost of the system, also increases.

While preferred embodiments of the present invention have been described, it is to be understood that the embodiments described are illustrative only and the scope of the invention is to be defined solely by the appended claims when accorded a full range of equivalence, many variations and modifications

naturally occurring to those of skill in the art from a perusal hereof.

WHAT IS CLAIMED IS:

1. In a telephone prepaid system having a server for determining the need for a voice prompt and a plurality of VRUs each capable of providing the requested voice prompt and of maintaining a queue of such requests for sequential response in the order in which requested, the method of balancing the load between the plurality of VRUs in the bank comprising the steps of:

(a) determining by the server in the telephone system that a specific voice prompt is desired in a specific language; and

(b) applying a request for the desired voice prompt to each of the plurality of VRUs in a predetermined sequence without regard to the busy status of the VRU or to the number of requests in the queue for that VRU.

2. In a prepaid telephone system having a server which controls the operation of a telephone switching network and which determines the need for supplying various voice prompts to a prepaid subscriber and a bank of VRUs for supplying the requested prompt upon the request of the server, the improvement comprising means associated with said server for applying a request for a desired voice prompt to each of the plurality of VRUs in said bank in a predetermined sequence without determining the status of any of the VRUs in said bank or to the number of requests in the queue for any of the VRUs in said bank.

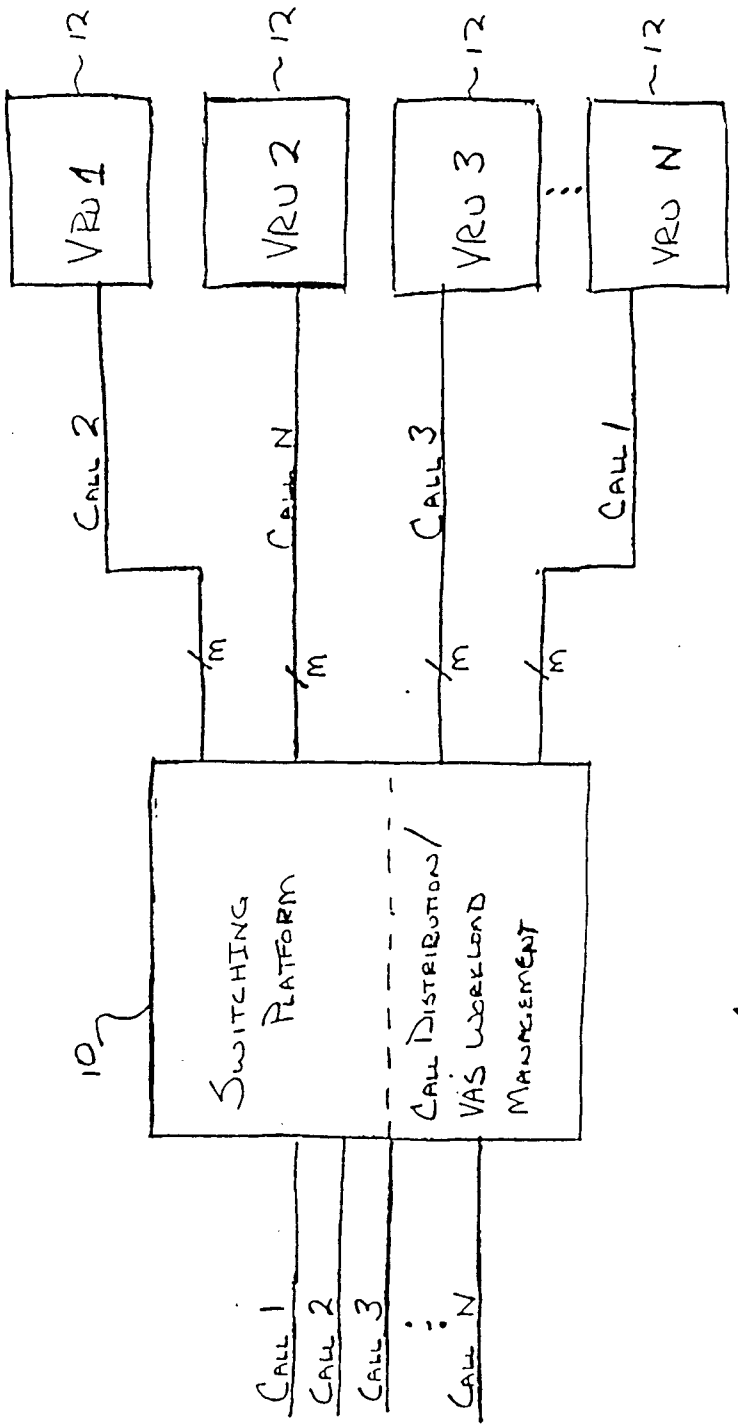

FIG. 1
(PRIOR ART)

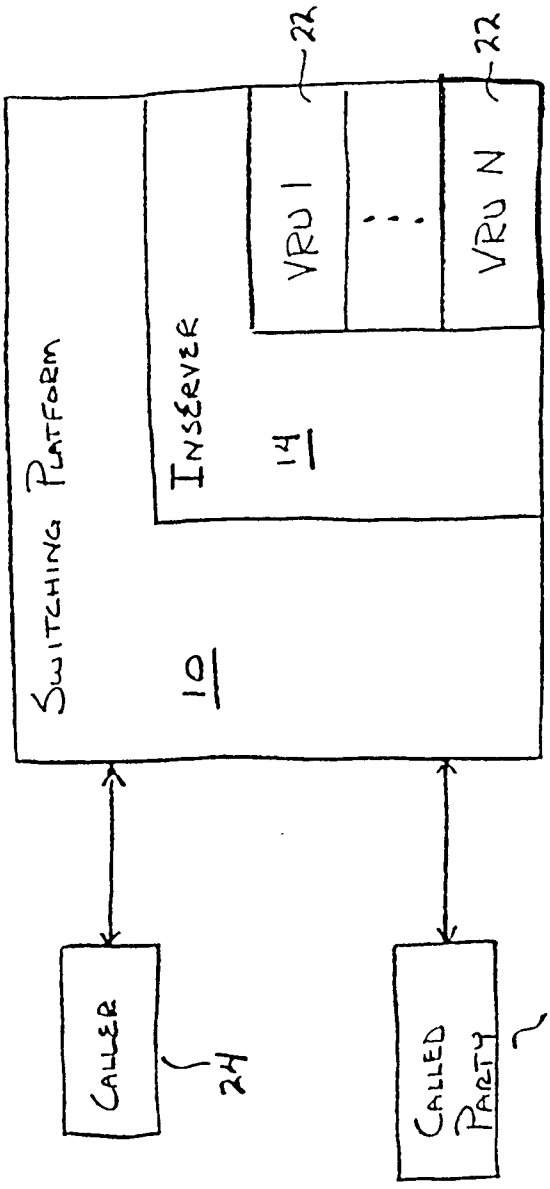
SWITCHING PLATFORM
10
INSERVER
14
VRU 1
VRU N
22
22
CALLER
24
CALLED PARTY
26

FIG. 4

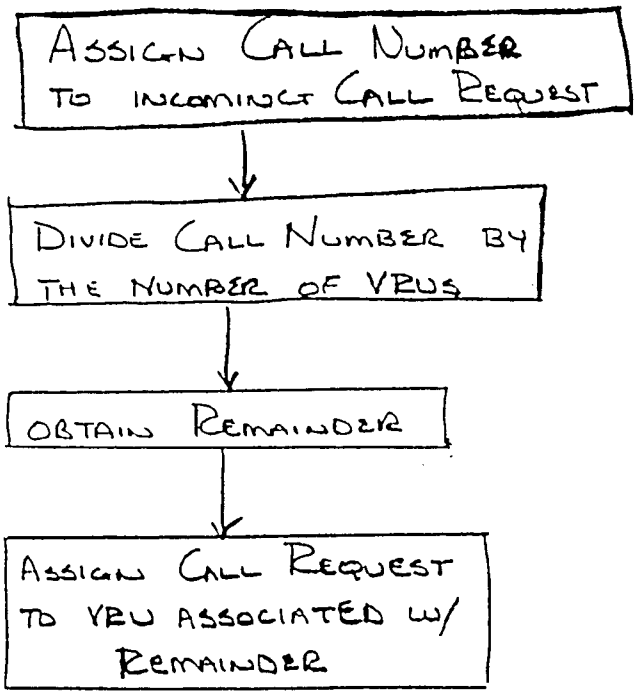

FIG. 5A

DISTRIBUTION OF CALL TO VRU = MOD (C, N)

WHERE C = CALL NUMBER ASSIGNED
N = NUMBER OF VRUS

FIG. 5B

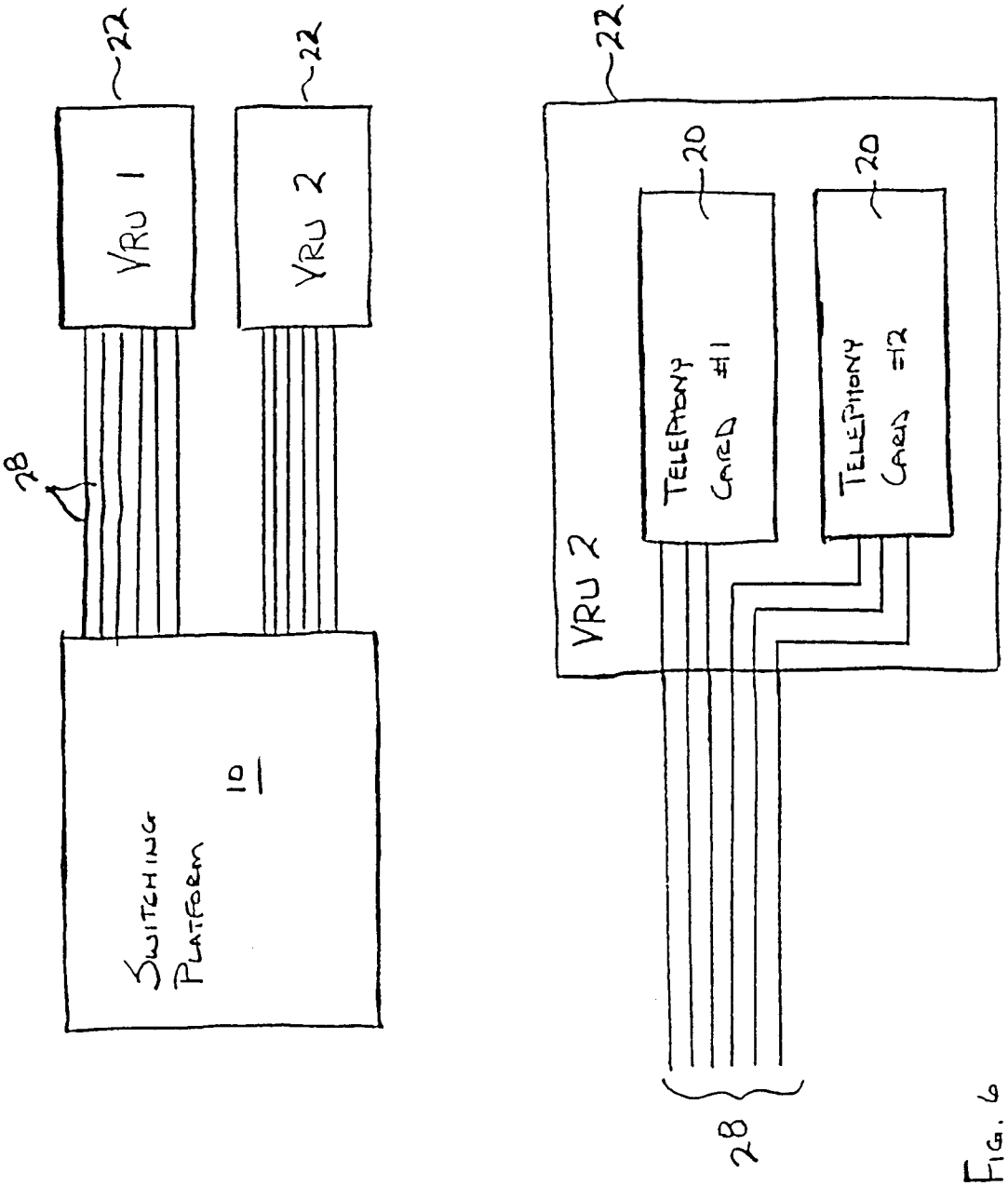
22
22
VRU 1
VRU 2
28
SWITCHING PLATFORM
10
22
20
20
TELEPHONY CARD #1
TELEPHONY CARD #2
VRU 2
28

Fig. 6

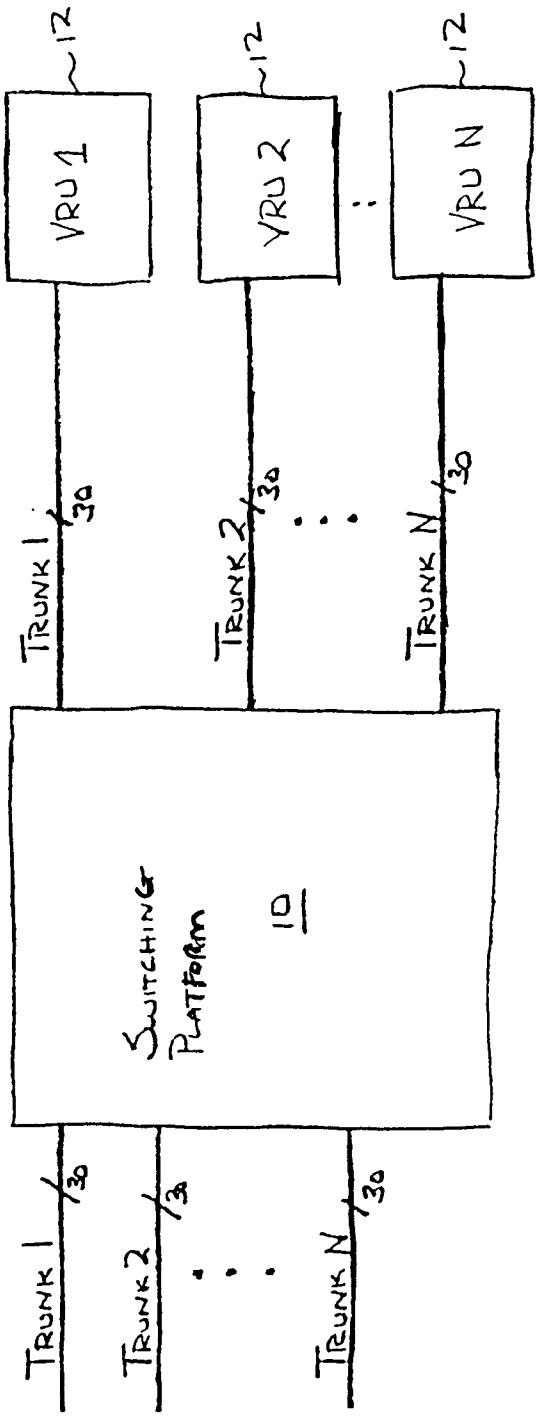

FIG. 7
(PRIOR ART)

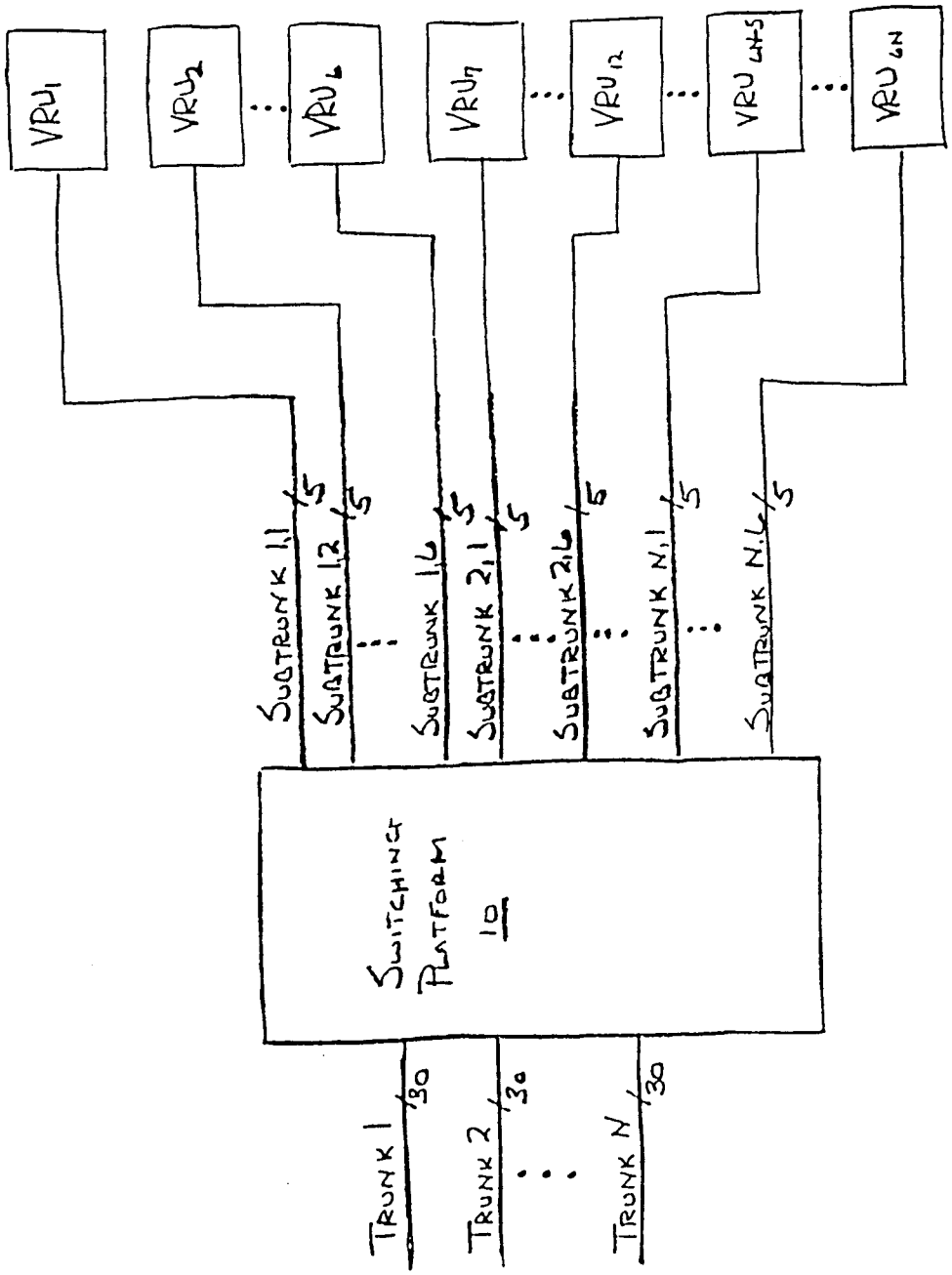
VRU1
VRU2
VRU6
VRU7
VRU12
VRU 4N-5
VRU 4N
SUBTRUNK 1,1
SUBTRUNK 1,2
SUBTRUNK 1,6
SUBTRUNK 2,1
SUBTRUNK 2,6
SUBTRUNK N,1
SUBTRUNK N,6
SWITCHING PLATFORM 10
TRUNK 1
TRUNK 2
TRUNK N
30
30
30

FIG. 8

Figs. 2 and 3

NOT TO BE CONSIDERED FOR PCT PROCEDURE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/17431

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04M 3/50 3/00

US CL :379/71, 88.05, 88.06, 88.16

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. : 379/71, 88.05, 88.06, 88.16, 72, 67.1, 88.25

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,439,635 A (THEIS et al.) 27 March 1984 (27.03.84).	1-2
A	US 4,706,270 A (ASTEGIANO et al.) 10 November 1987 (10.11.87).	1, 2
A	US 5,388,146 A (MORDUCH et al.) 07 February 1995 (07.02.95).	1, 2

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

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