United States Patent [19]

Fabris et al.

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[45] **Date of Patent: May 7, 1985**

[54] **TELECONFERENCING METHOD AND SYSTEM**

[75] Inventors: **Alfonso V. Fabris**, Oakton; **Robert M. Strickland, Jr.**; **John T. Toth**, both of McLean, all of Va.

[73] Assignee: **Satellite Business Systems**, McLean, Va.

[21] Appl. No.: **358,548**

[22] Filed: **Mar. 15, 1982**

[51] **Int. Cl.**[3] **H04N 7/14**

[52] **U.S. Cl.** ..... **358/85**; 358/210; 340/709; 340/712; 179/2 TV; 179/18 BC

[58] **Field of Search** ..... 358/85, 86, 210; 340/709, 712; 179/2 TV, 2 TS, 18 BC

[56] **References Cited**

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3,668,312	6/1972	Yamamoto et al.	358/85
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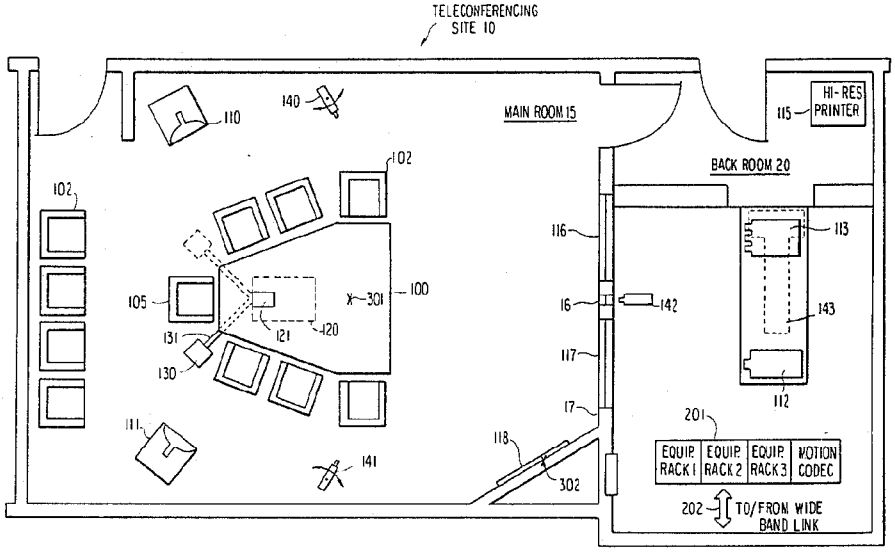
Primary Examiner—John C. Martin
Assistant Examiner—Edward L. Coles
Attorney, Agent, or Firm—Pollock, Vande Sande & Priddy

[57] **ABSTRACT**

Control of teleconference is facilitated so as to allow relatively unskilled operators to implement such control. The invention includes at least a pair of teleconferencing sites, each of which includes at least a pair of controllable video sources for deriving video signals from controllable regions of the associated site, an audio source for deriving an audio signal from the associated site, at least a pair of video displays for controllably displaying either locally or remotely generated images, an audio transducer responsive to a remotely generated audio signal for generating perceptible sound, an interface for coupling digital representations of locally generated audio and video signals to a communication link linking the sites and for coupling digital representations of remotely generated audio and video signals, a control device including a digital microprocessor and controlling, among other things, a video matrix switch, the video matrix switch having plural video inputs and outputs for controllably coupling at least a locally generated video signal to the interface and for controllably coupling locally and/or remotely generated video to said displays. The control device also includes a control video display with a touch sensitive screen for controlling the video sources and video matrix switch in response to touches on the touch sensitive screen by an operator and further including, in the form of a program in said microprocessor, apparatus to interpret commands initiated by operator touches of the touch sensitive screen and for thereafter implementing the commands if elements of the command are consistent with each other and with available resources as well as message formatting which are responsive to the logic for formatting digital messages destined for the video sources and the video matrix switch.

14 Claims, 22 Drawing Figures



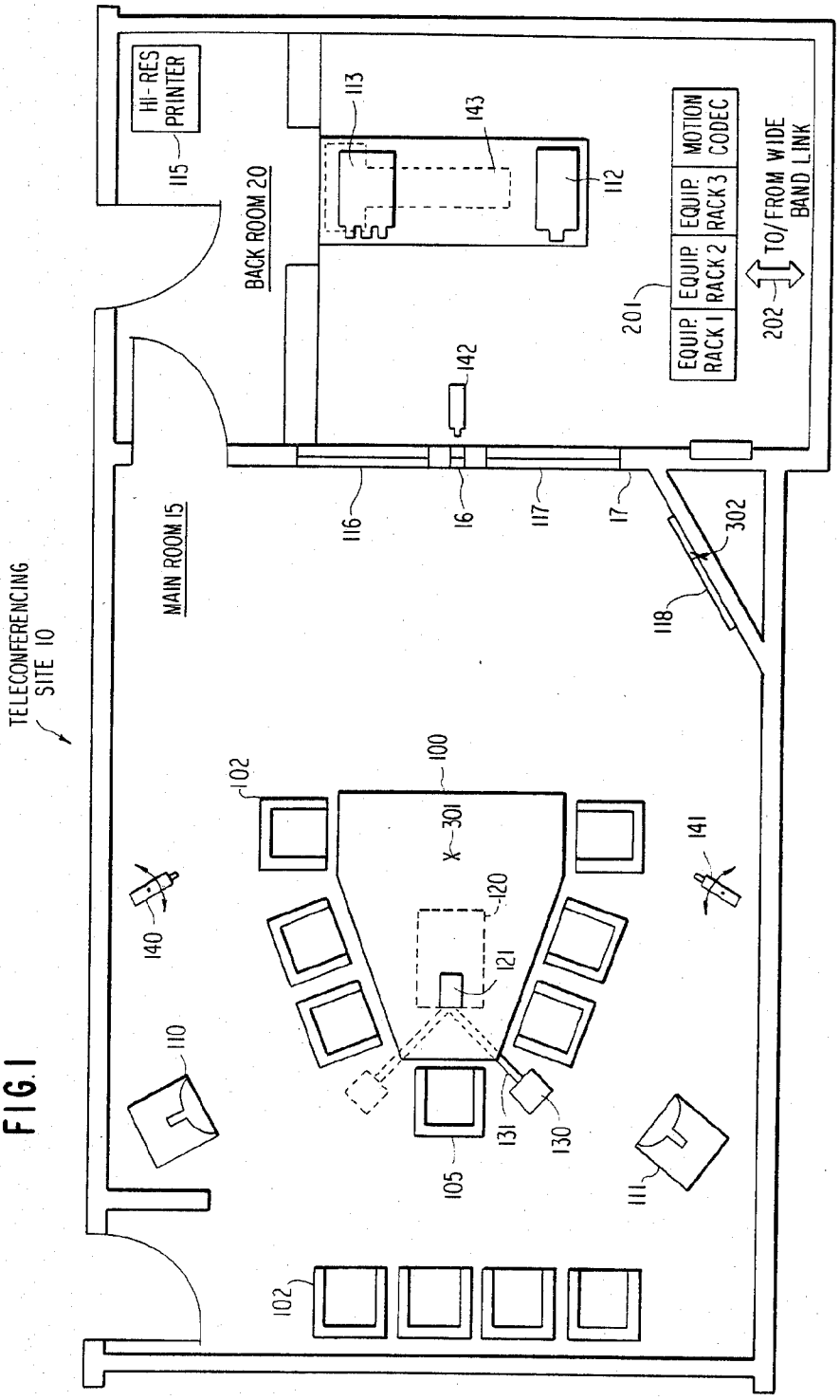

HI-RES PRINTER
115
113
143
112
BACK ROOM 20
MOTION CODEC
EQUIP. RACK 3
EQUIP. RACK 2
EQUIP. RACK 1
201
202
TO/FROM WIDE BAND LINK
142
116
16
117
17
302
118
MAIN ROOM 15
TELECONFERENCING SITE 10
100
102
301
120
121
140
141
110
131
130
105
111
102

FIG. 1

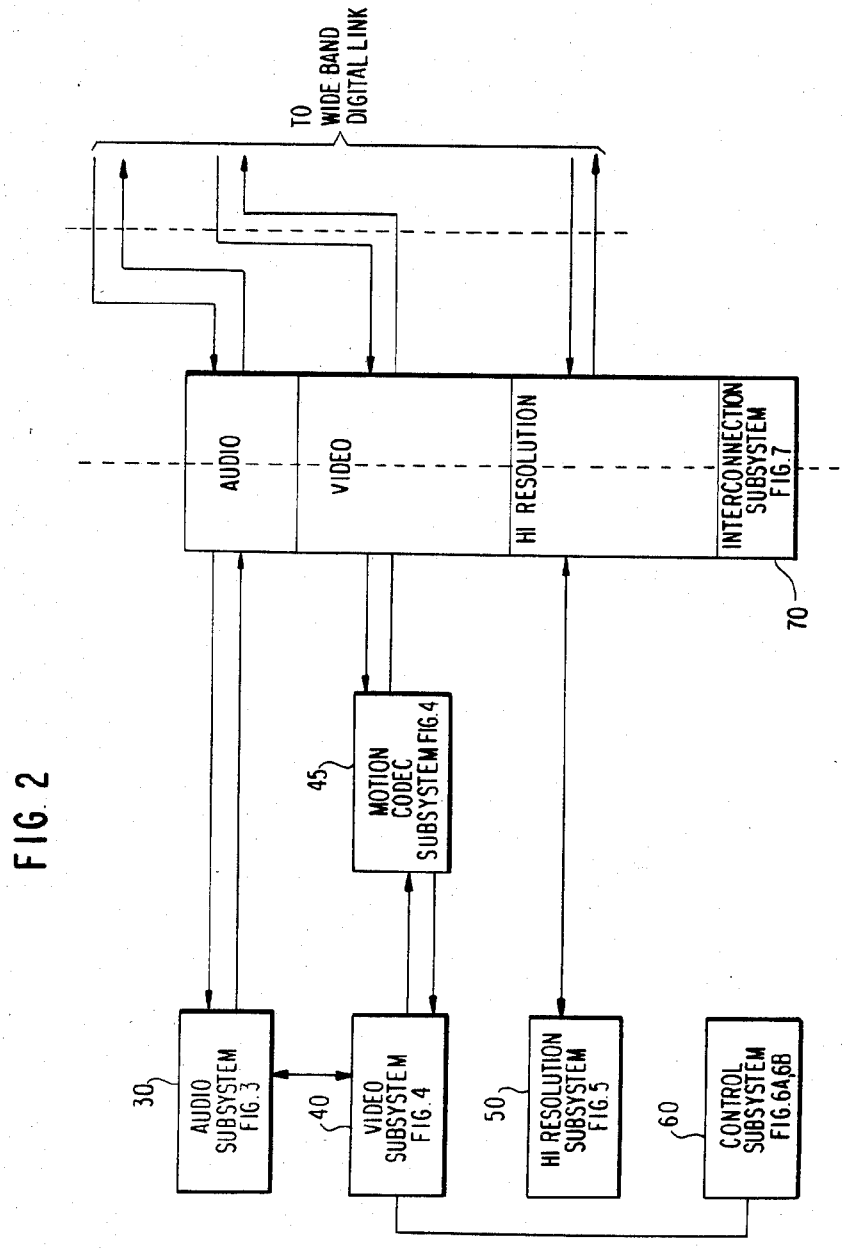

TO WIDE BAND DIGITAL LINK
AUDIO
VIDEO
HI RESOLUTION
INTERCONNECTION SUBSYSTEM FIG.7
70
45
MOTION CODEC SUBSYSTEM FIG.4
30
AUDIO SUBSYSTEM FIG.3
40
VIDEO SUBSYSTEM FIG.4
50
HI RESOLUTION SUBSYSTEM FIG.5
60
CONTROL SUBSYSTEM FIG.6A,6B

FIG. 2

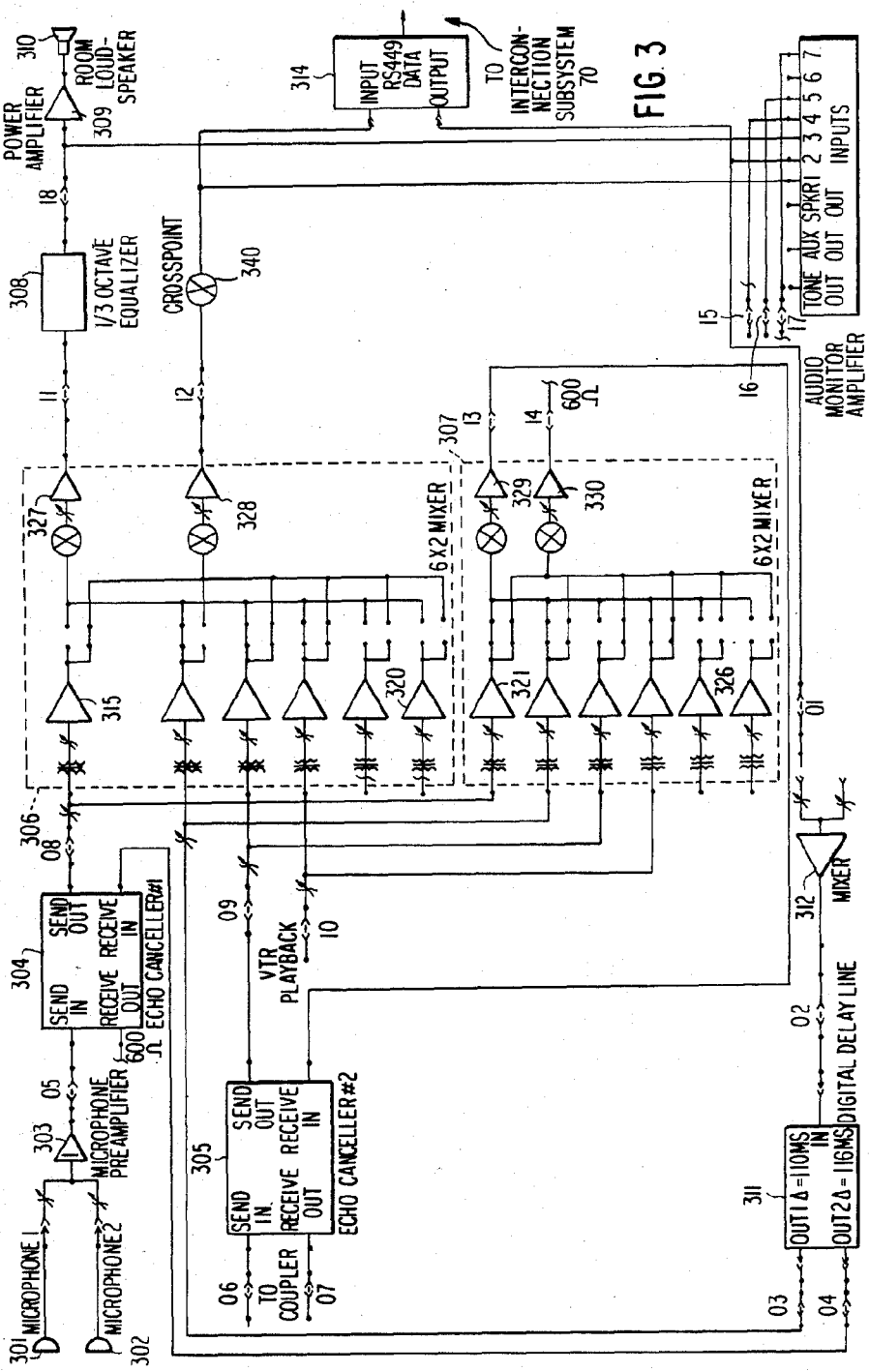

POWER AMPLIFIER
ROOM LOUD-SPEAKER
INPUT RS449 DATA OUTPUT
TO INTERCON-NECTION SUBSYSTEM 70
I/3 OCTAVE EQUALIZER
CROSSPOINT
TONE AUX SPKRT OUT OUT OUT
INPUTS
AUDIO MONITOR AMPLIFIER
6X2 MIXER
6X2 MIXER
SEND OUT
SEND IN
RECEIVE IN
RECEIVE OUT
ECHO CANCELLER#1
VTR PLAYBACK
MICROPHONE PREAMPLIFIER
SEND OUT
SEND IN
RECEIVE IN
RECEIVE OUT
ECHO CANCELLER#2
TO COUPLER
MICROPHONE 1
MICROPHONE 2
OUT1 Δ=110MS
OUT2 Δ=116MS
DIGITAL DELAY LINE
MIXER

FIG. 3

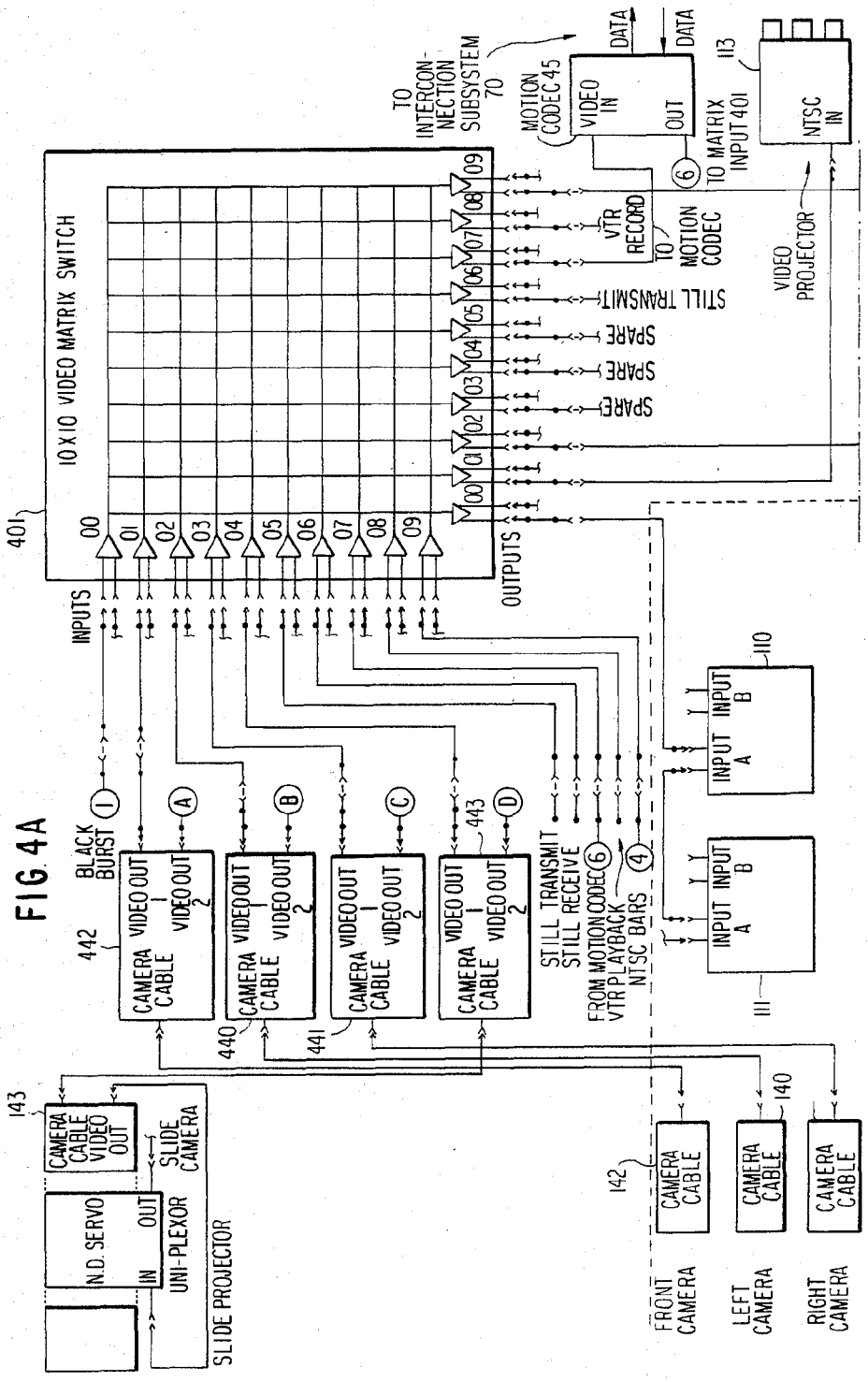

10 X 10 VIDEO MATRIX SWITCH
401
INPUTS
OUTPUTS
00
01
02
03
04
05
06
07
08
09
TO INTERCONNECTION SUBSYSTEM 70
MOTION CODEC 45
VIDEO IN
OUT
DATA
DATA
113
NTSC IN
TO MATRIX INPUT 401
VIDEO PROJECTOR
VTR RECORD
TO MOTION CODEC
STILL TRANSMIT
SPARE
SPARE
SPARE
BLACK BURST
CAMERA CABLE
VIDEO OUT 1
VIDEO OUT 2
442
440
441
443
STILL TRANSMIT
STILL RECEIVE
FROM MOTION CODEC
VTR PLAYBACK
NTSC BARS
INPUT A
INPUT B
110
111
143
CAMERA CABLE VIDEO OUT
SLIDE CAMERA
N.D. SERVO
IN
OUT
UNI-PLEXOR
SLIDE PROJECTOR
142
140
FRONT CAMERA
LEFT CAMERA
RIGHT CAMERA

FIG 4A

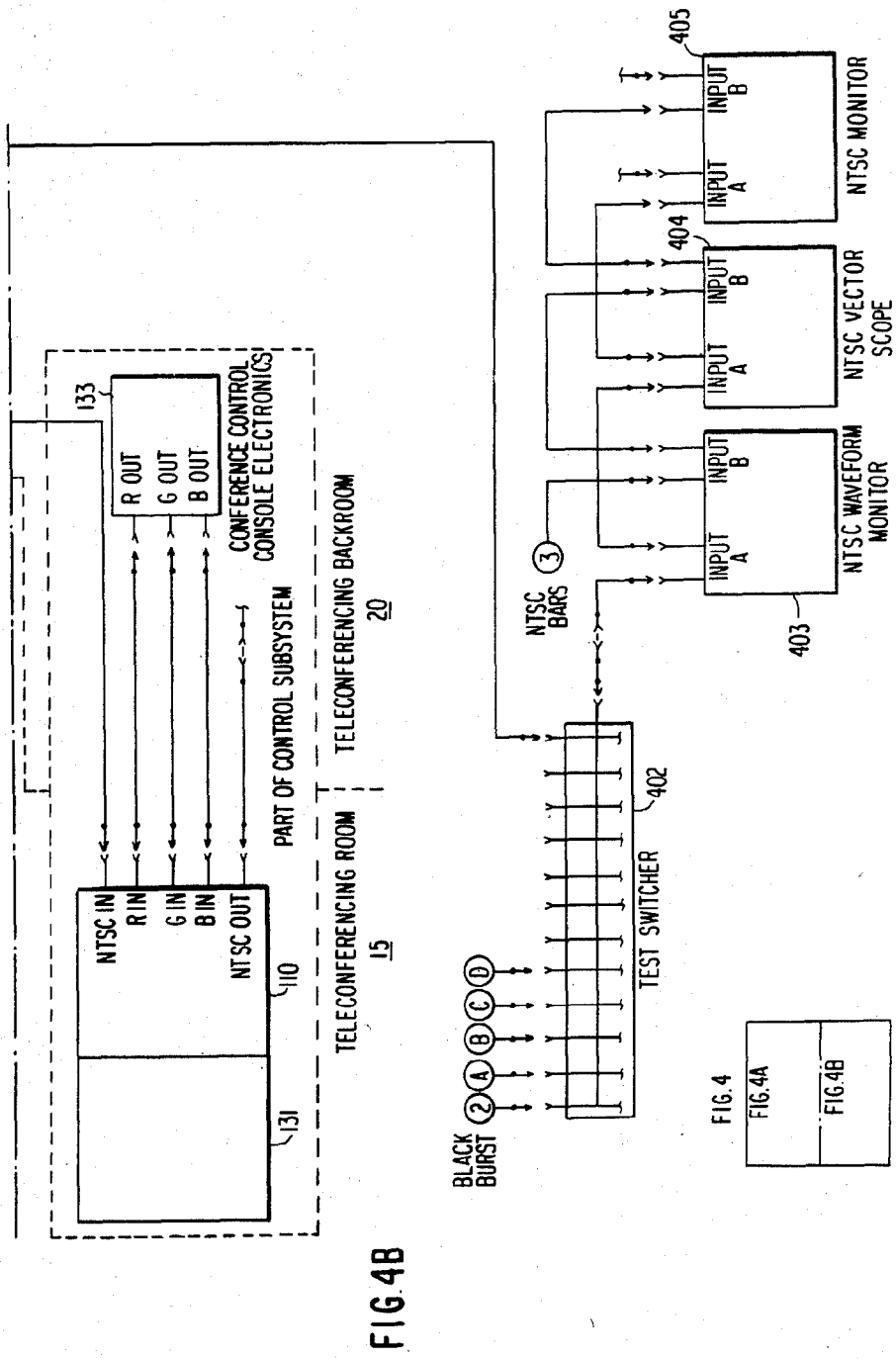


FIG. 4B

FIG. 4

FIG. 4A | FIG. 4B

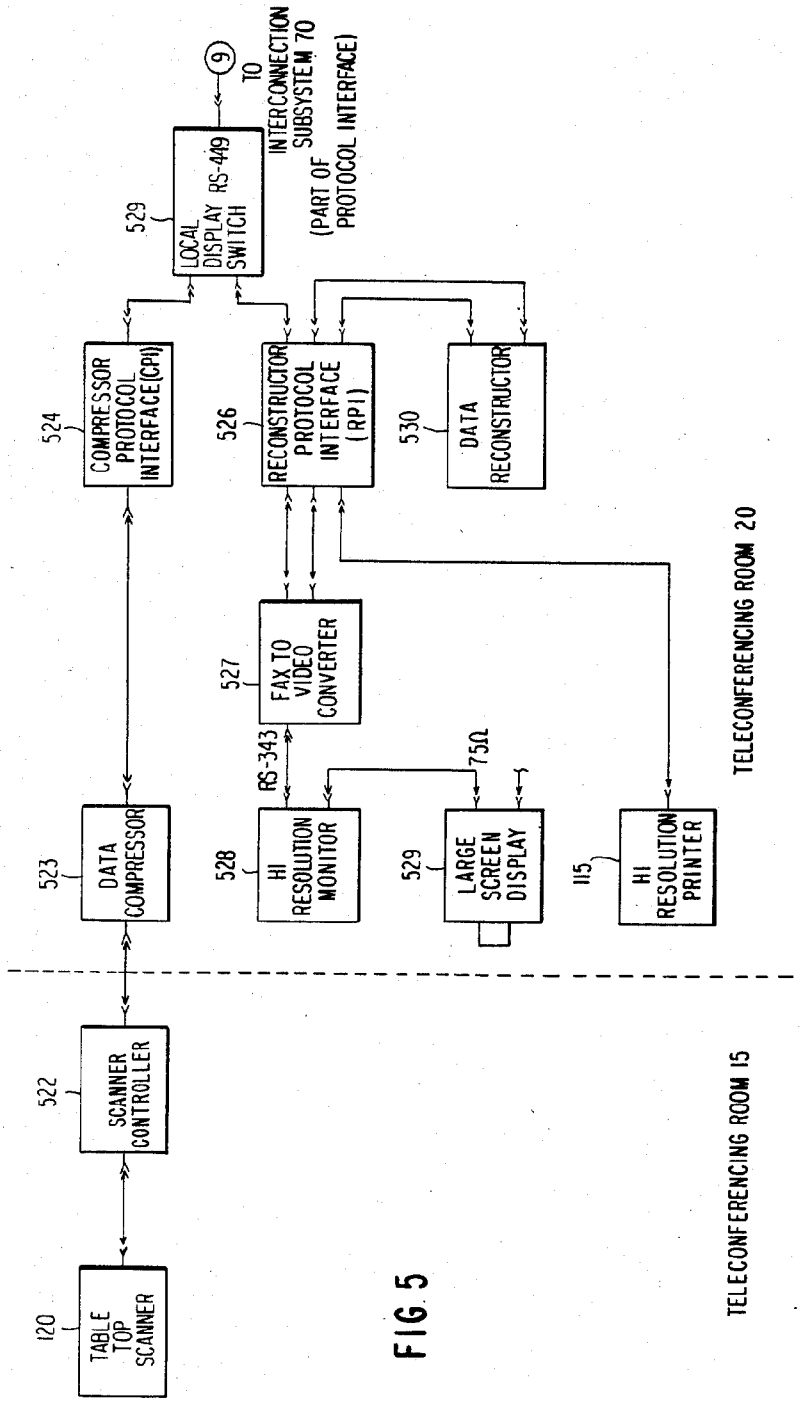
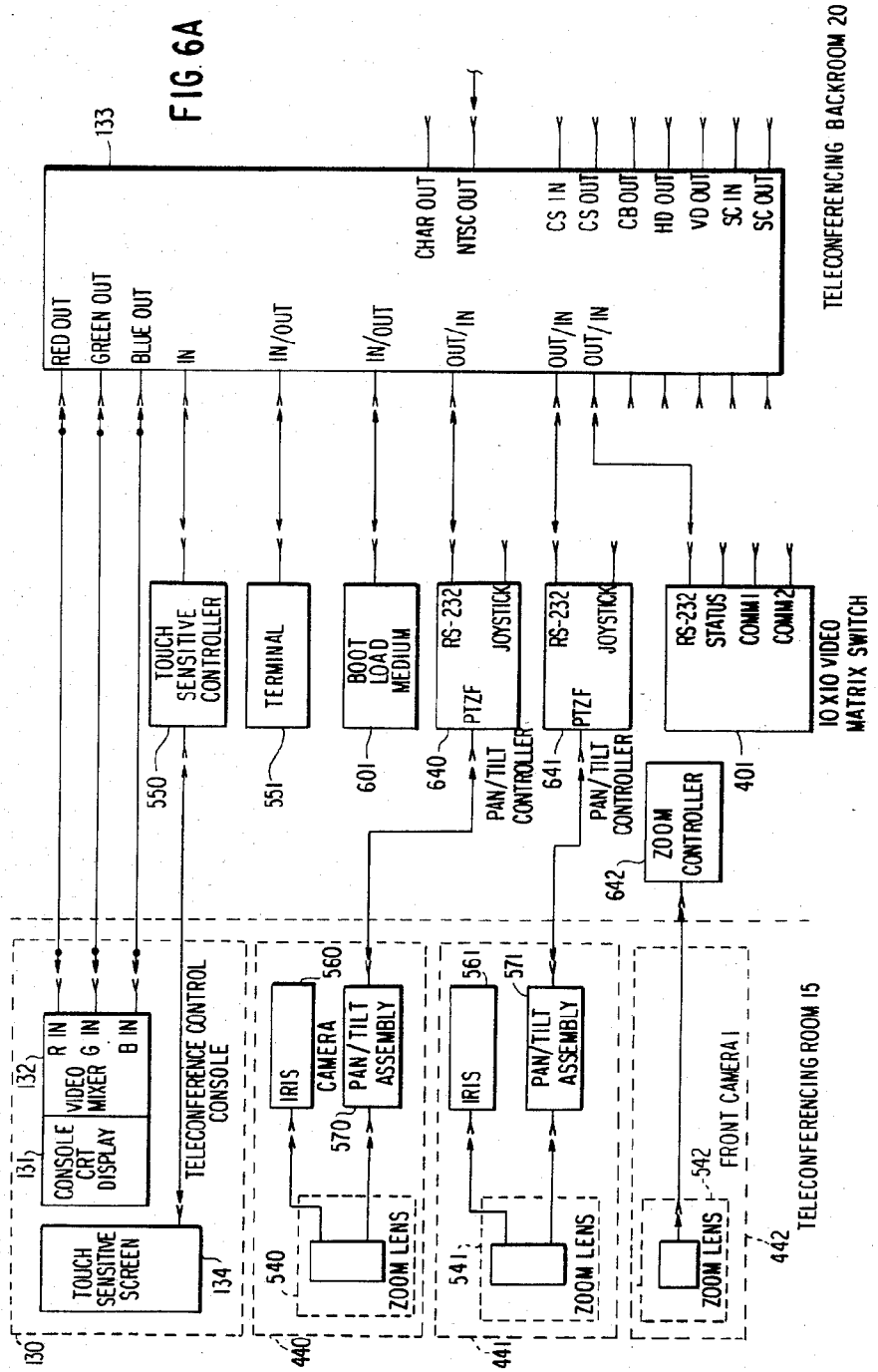

9
TO INTERCONNECTION SUBSYSTEM 70
(PART OF PROTOCOL INTERFACE)
529
LOCAL DISPLAY SWITCH RS-449
524
COMPRESSOR PROTOCOL INTERFACE(CPI)
526
RECONSTRUCTOR PROTOCOL INTERFACE (RPI)
530
DATA RECONSTRUCTOR
527
FAX TO VIDEO CONVERTER
RS-343
75Ω
523
DATA COMPRESSOR
528
HI RESOLUTION MONITOR
529
LARGE SCREEN DISPLAY
115
HI RESOLUTION PRINTER
TELECONFERENCING ROOM 20
522
SCANNER CONTROLLER
120
TABLE TOP SCANNER
TELECONFERENCING ROOM 15

FIG. 5

FIG. 6A


TELECONFERENCING BACKROOM 20
133
RED OUT
GREEN OUT
BLUE OUT
IN
IN/OUT
IN/OUT
OUT/IN
OUT/IN
OUT/IN
CHAR OUT
NTSC OUT
CS IN
CS OUT
CB OUT
HD OUT
VD OUT
SC IN
SC OUT
TOUCH SENSITIVE CONTROLLER
550
TERMINAL
551
BOOT LOAD MEDIUM
601
RS-232
PTZF
JOYSTICK
640
PAN/TILT CONTROLLER
RS-232
PTZF
JOYSTICK
641
PAN/TILT CONTROLLER
ZOOM CONTROLLER
642
RS-232
STATUS
COMM1
COMM2
401
10 X10 VIDEO MATRIX SWITCH
TELECONFERENCE CONTROL CONSOLE
R IN
G IN
B IN
VIDEO MIXER
132
CONSOLE CRT DISPLAY
131
TOUCH SENSITIVE SCREEN
134
130
IRIS
CAMERA
560
PAN/TILT ASSEMBLY
570
ZOOM LENS
540
440
IRIS
561
PAN/TILT ASSEMBLY
571
ZOOM LENS
541
441
542
FRONT CAMERA I
ZOOM LENS
442
TELECONFERENCING ROOM 15

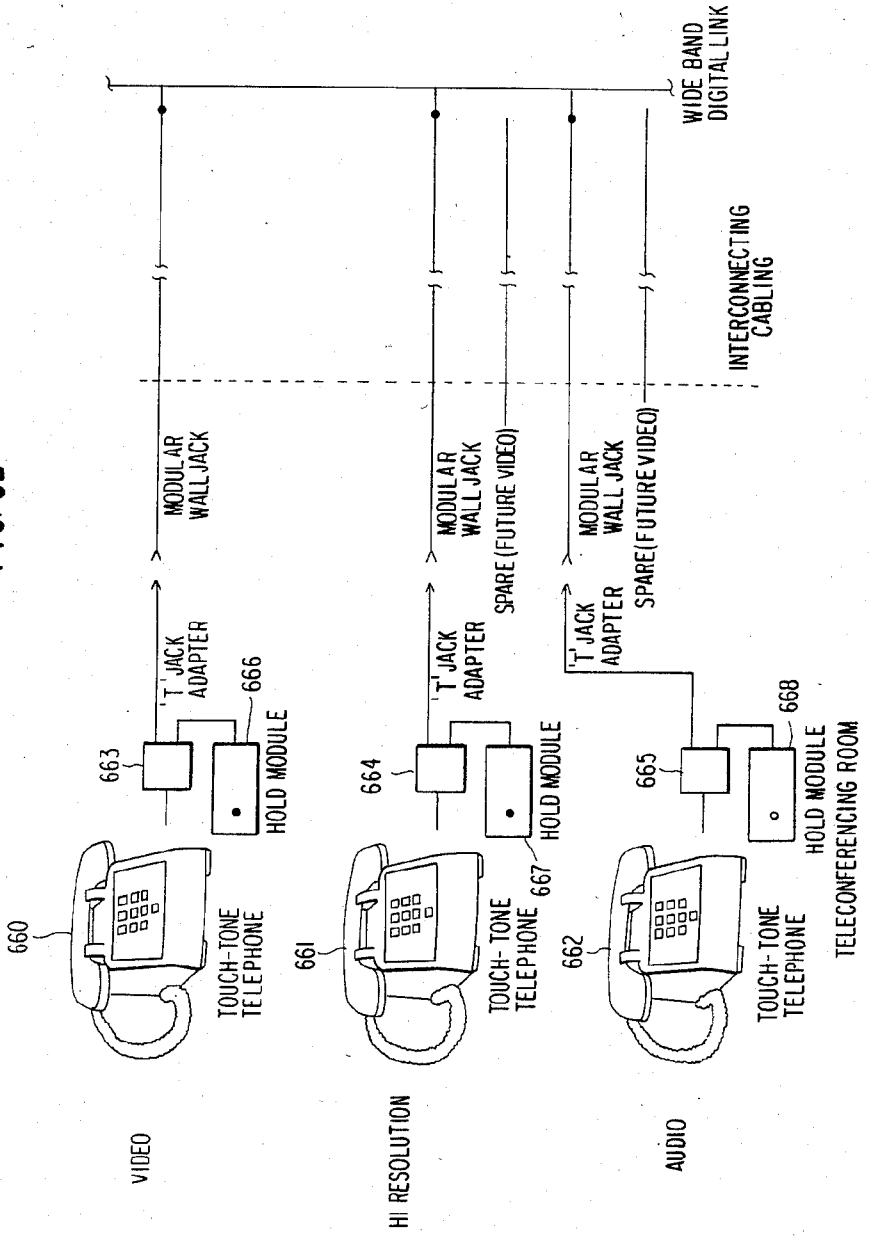
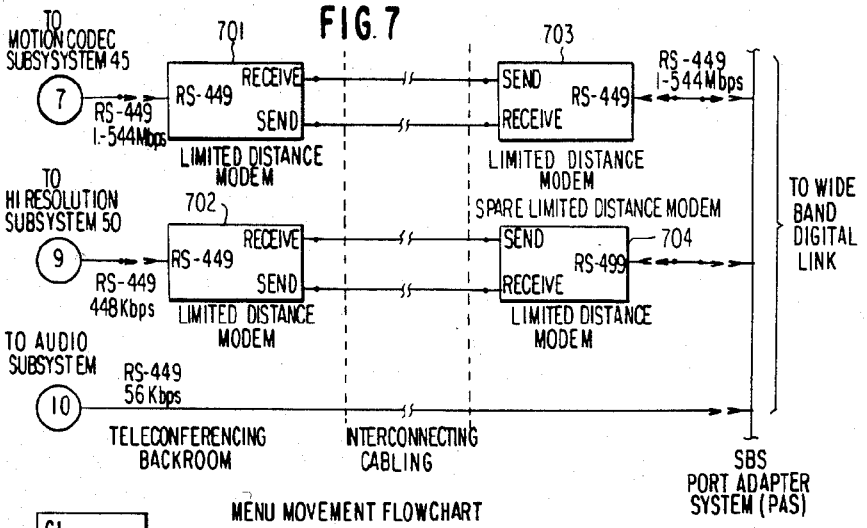

WIDE BAND DIGITAL LINK
INTERCONNECTING CABLING
MODULAR WALL JACK
'T' JACK ADAPTER
SPARE (FUTURE VIDEO)
SPARE (FUTURE VIDEO)
663
664
665
666
667
668
HOLD MODULE
660
661
662
TOUCH-TONE TELEPHONE
VIDEO
HI RESOLUTION
AUDIO
TELECONFERENCING ROOM

FIG. 6B

FIG. 7


TO MOTION CODEC SUBSYSYSTEM 45
7
RS-449 1-544Mbps
701
RS-449
RECEIVE
SEND
LIMITED DISTANCE MODEM
703
SEND
RECEIVE
RS-449
RS-449 1-544Mbps
LIMITED DISTANCE MODEM
TO HI RESOLUTION SUBSYSTEM 50
9
RS-449 448Kbps
702
RS-449
RECEIVE
SEND
LIMITED DISTANCE MODEM
SPARE LIMITED DISTANCE MODEM
SEND
RECEIVE
RS-499
704
LIMITED DISTANCE MODEM
TO WIDE BAND DIGITAL LINK
TO AUDIO SUBSYSTEM
10
RS-449 56 Kbps
TELECONFERENCING BACKROOM
INTERCONNECTING CABLING
SBS PORT ADAPTER SYSTEM (PAS)

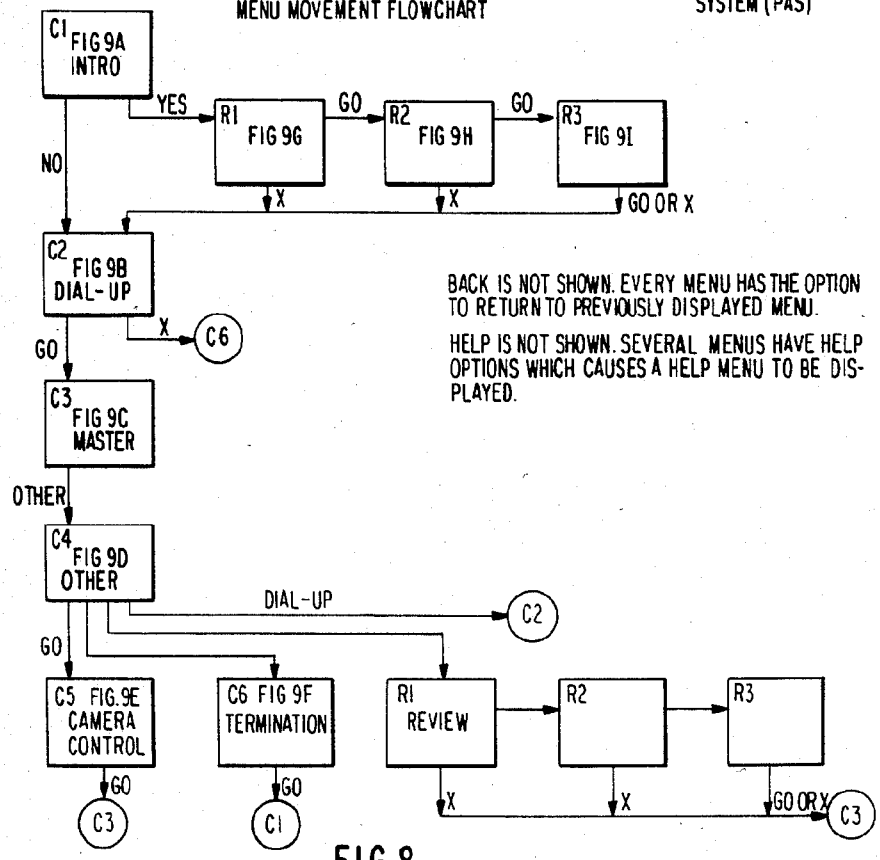

MENU MOVEMENT FLOWCHART
C1 FIG 9A INTRO
YES
R1 FIG 9G
GO
R2 FIG 9H
GO
R3 FIG 9I
NO
X
X
GO OR X
C2 FIG 9B DIAL-UP
X
C6
GO
C3 FIG 9C MASTER
OTHER
C4 FIG 9D OTHER
DIAL-UP
C2
GO
C5 FIG. 9E CAMERA CONTROL
C6 FIG 9F TERMINATION
R1 REVIEW
R2
R3
GO
C3
GO
C1
X
X
GO OR X
C3
BACK IS NOT SHOWN. EVERY MENU HAS THE OPTION TO RETURN TO PREVIOUSLY DISPLAYED MENU.
HELP IS NOT SHOWN. SEVERAL MENUS HAVE HELP OPTIONS WHICH CAUSES A HELP MENU TO BE DISPLAYED.

FIG. 8

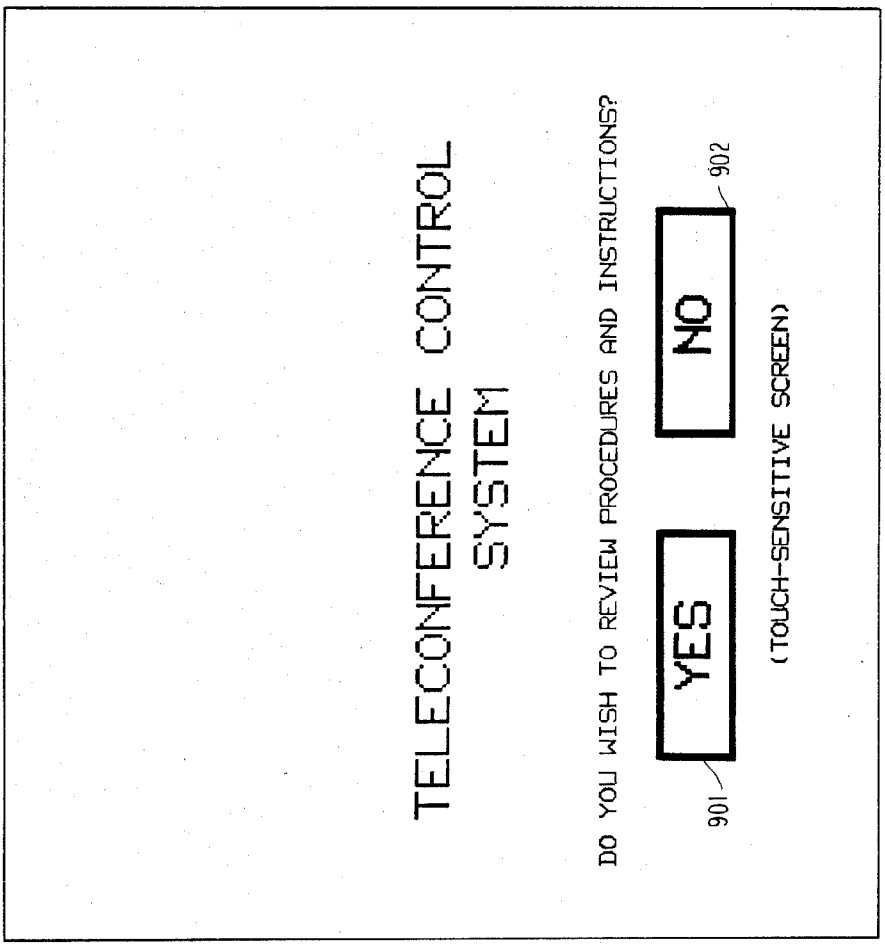

TELECONFERENCE CONTROL SYSTEM
DO YOU WISH TO REVIEW PROCEDURES AND INSTRUCTIONS?
YES
NO
901
902
(TOUCH-SENSITIVE SCREEN)

FIG. 9A

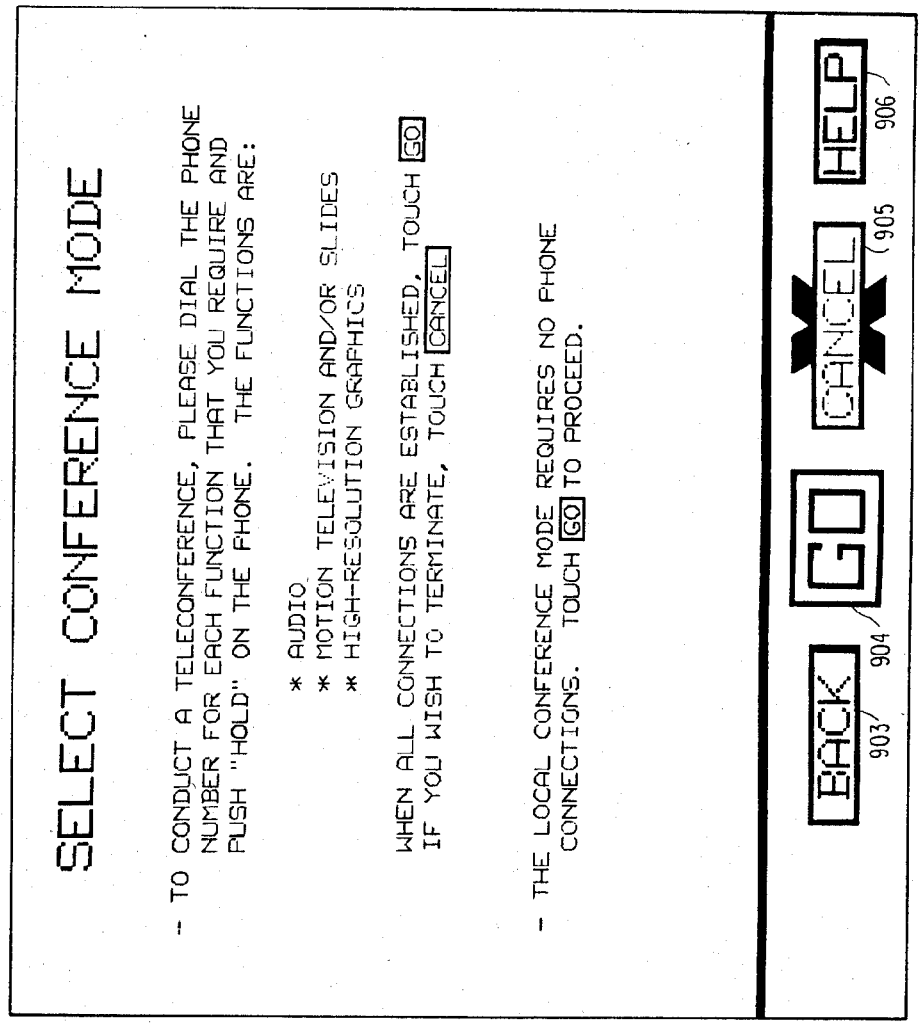

SELECT CONFERENCE MODE
- TO CONDUCT A TELECONFERENCE, PLEASE DIAL THE PHONE NUMBER FOR EACH FUNCTION THAT YOU REQUIRE AND PUSH "HOLD" ON THE PHONE. THE FUNCTIONS ARE:
* AUDIO
* MOTION TELEVISION AND/OR SLIDES
* HIGH-RESOLUTION GRAPHICS
WHEN ALL CONNECTIONS ARE ESTABLISHED, TOUCH GO
IF YOU WISH TO TERMINATE, TOUCH CANCEL
- THE LOCAL CONFERENCE MODE REQUIRES NO PHONE CONNECTIONS. TOUCH GO TO PROCEED.
BACK
GO
CANCEL
HELP
903
904
905
906

FIG. 9B

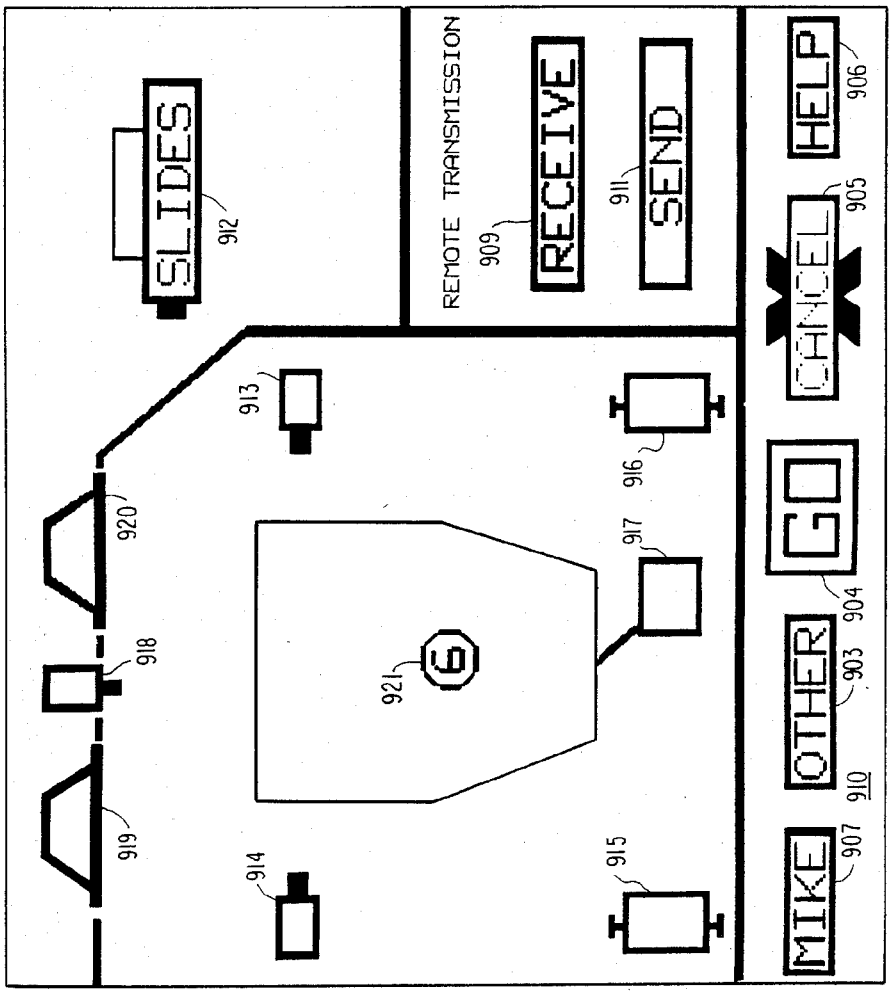

SLIDES
912
REMOTE TRANSMISSION
909
RECEIVE
911
SEND
HELP
906
CANCEL
905
GO
904
OTHER
903
910
MIKE
907
913
914
915
916
917
918
919
920
921
6

FIG 9C

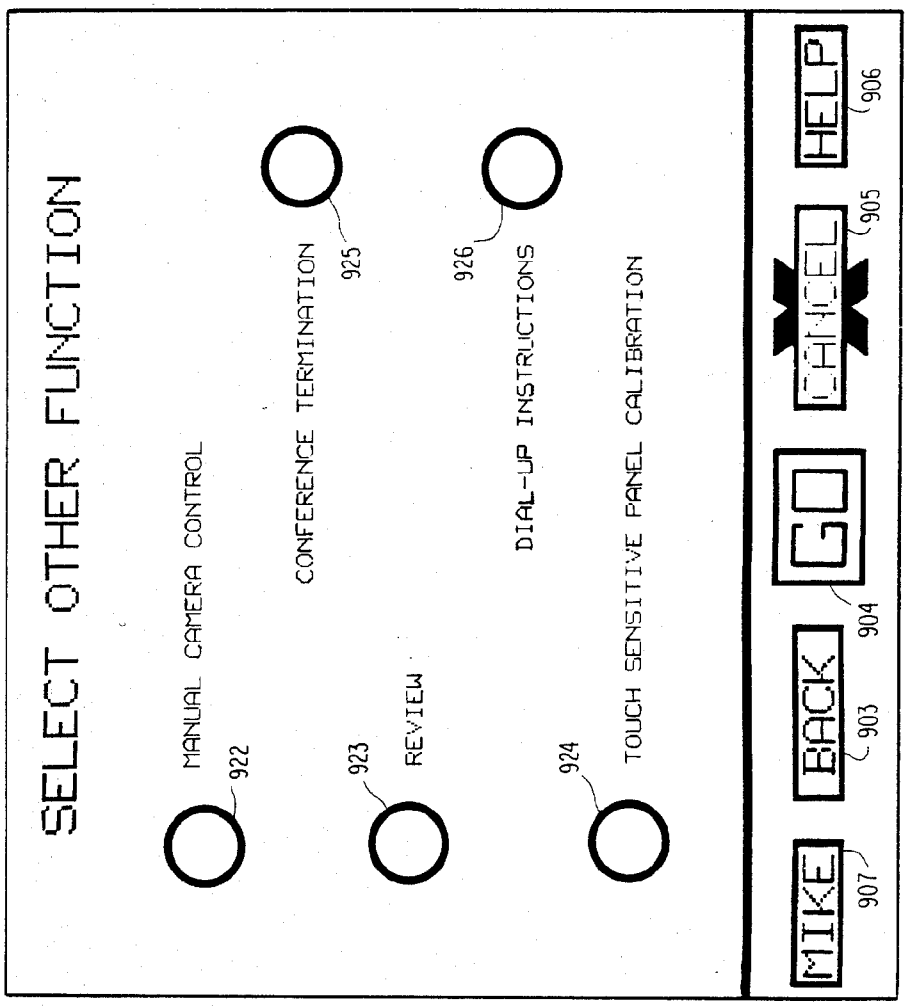

SELECT OTHER FUNCTION
MANUAL CAMERA CONTROL
922
CONFERENCE TERMINATION
925
926
DIAL-UP INSTRUCTIONS
923
REVIEW
924
TOUCH SENSITIVE PANEL CALIBRATION
MIKE
907
BACK
903
GO
904
CANCEL
905
HELP
906

FIG. 9D

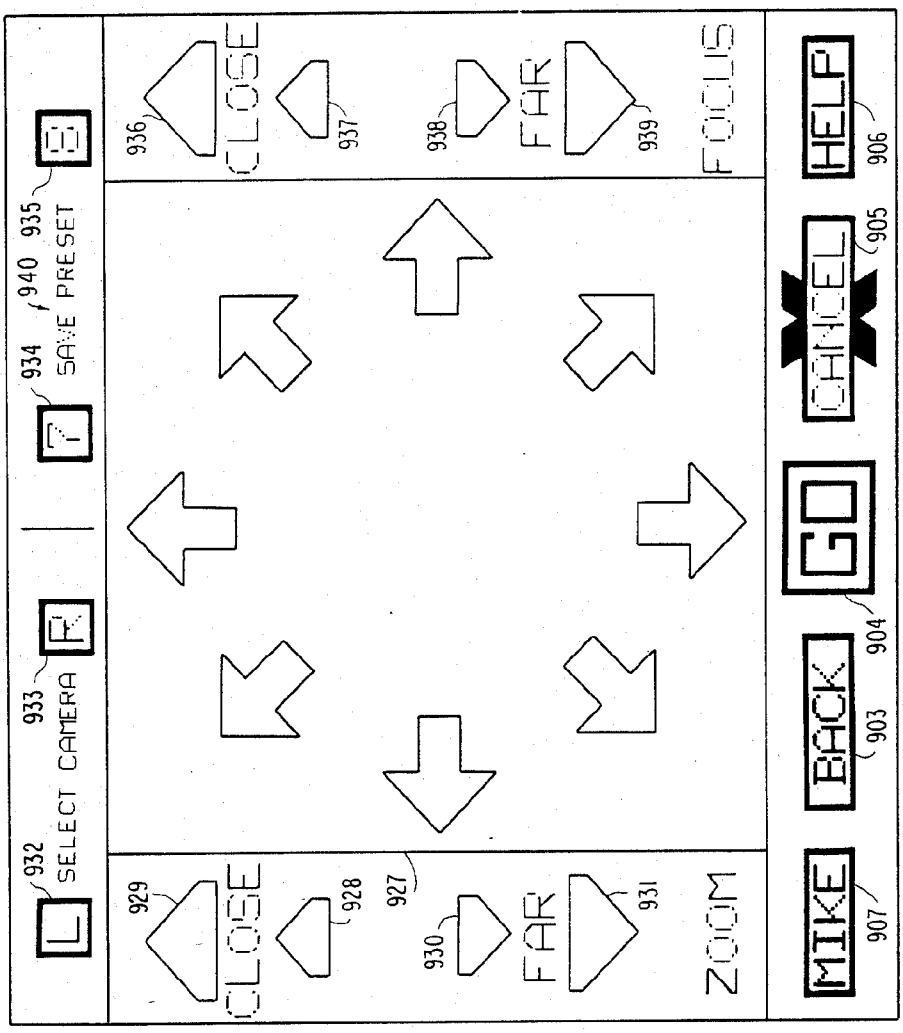

932
SELECT CAMERA
933
934
SAVE PRESET
940
935
936
CLOSE
937
938
FAR
939
FOCUS
929
CLOSE
928
927
930
FAR
931
ZOOM
HELP
906
CANCEL
905
GO
904
BACK
903
MIKE
907

FIG. 9E

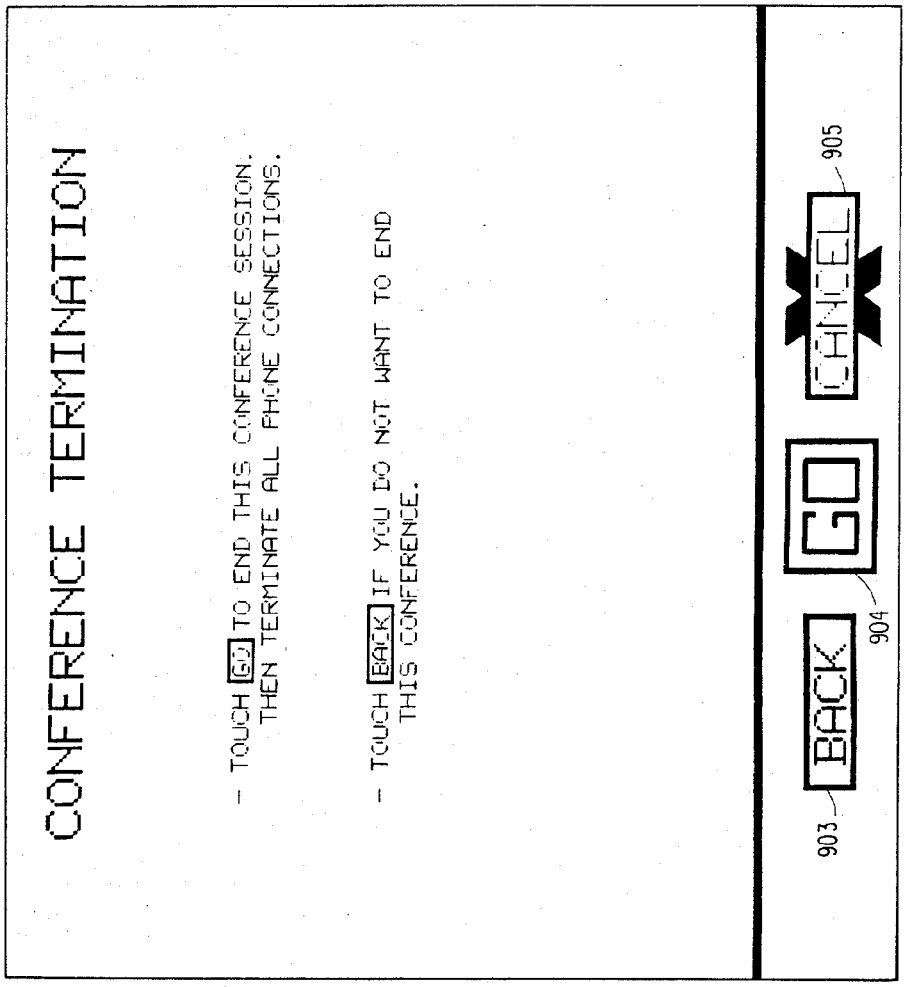

CONFERENCE TERMINATION
- TOUCH GO TO END THIS CONFERENCE SESSION. THEN TERMINATE ALL PHONE CONNECTIONS.
- TOUCH BACK IF YOU DO NOT WANT TO END THIS CONFERENCE.
BACK
GO
CANCEL
903
904
905

FIG. 9F

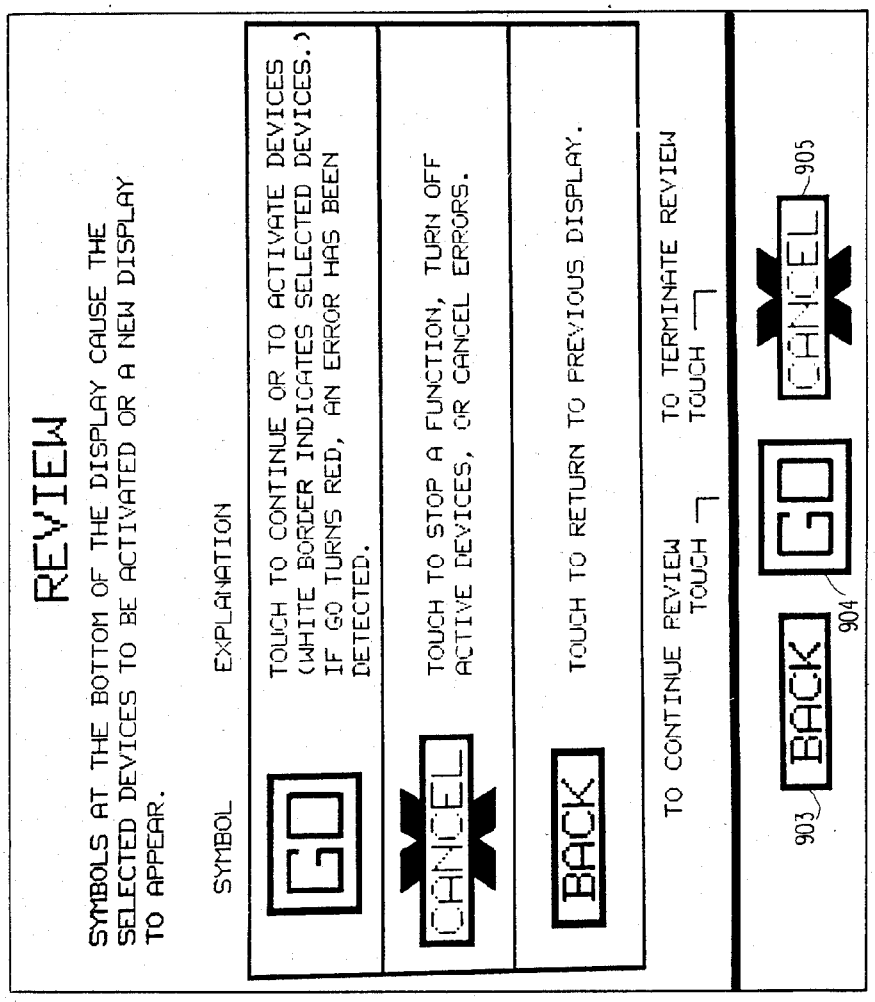

REVIEW
SYMBOLS AT THE BOTTOM OF THE DISPLAY CAUSE THE SELECTED DEVICES TO BE ACTIVATED OR A NEW DISPLAY TO APPEAR.
SYMBOL
EXPLANATION
GO
TOUCH TO CONTINUE OR TO ACTIVATE DEVICES (WHITE BORDER INDICATES SELECTED DEVICES.) IF GO TURNS RED, AN ERROR HAS BEEN DETECTED.
CANCEL
TOUCH TO STOP A FUNCTION, TURN OFF ACTIVE DEVICES, OR CANCEL ERRORS.
BACK
TOUCH TO RETURN TO PREVIOUS DISPLAY.
TO CONTINUE REVIEW TOUCH
TO TERMINATE REVIEW TOUCH
BACK
GO
CANCEL
903
904
905

FIG.9G

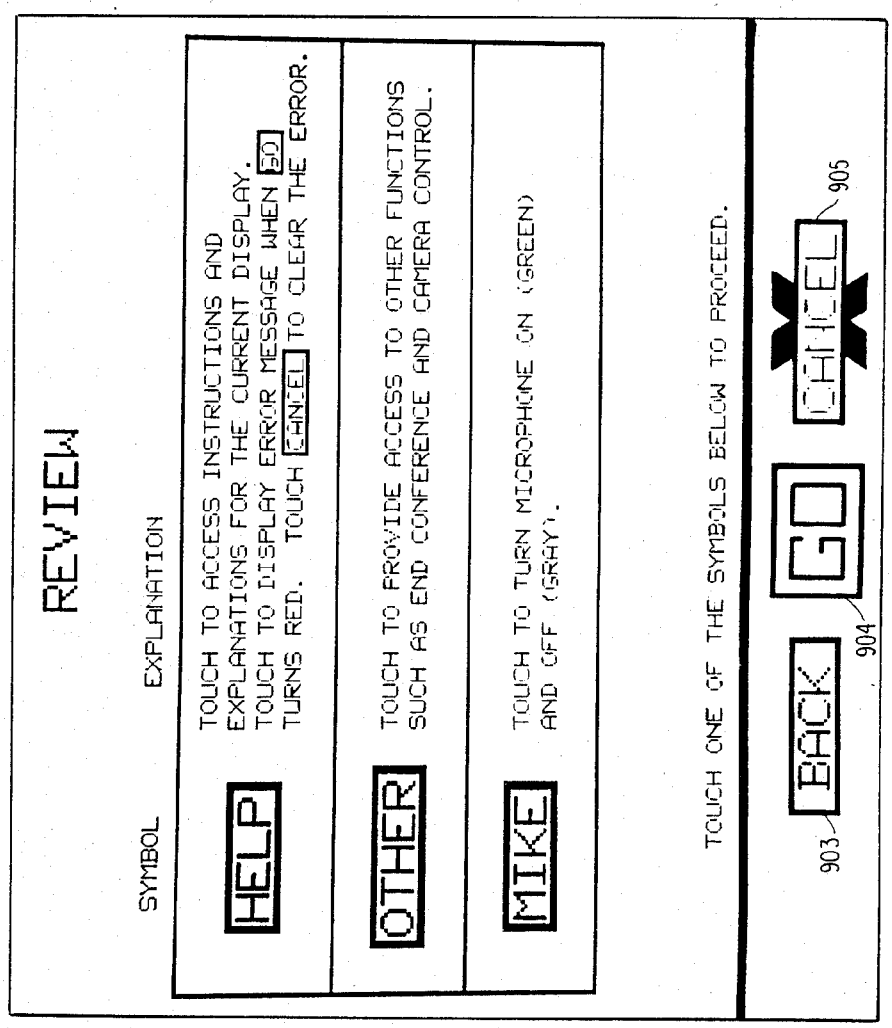

REVIEW
SYMBOL
EXPLANATION
HELP
TOUCH TO ACCESS INSTRUCTIONS AND EXPLANATIONS FOR THE CURRENT DISPLAY. TOUCH TO DISPLAY ERROR MESSAGE WHEN GO TURNS RED. TOUCH CANCEL TO CLEAR THE ERROR.
OTHER
TOUCH TO PROVIDE ACCESS TO OTHER FUNCTIONS SUCH AS END CONFERENCE AND CAMERA CONTROL.
MIKE
TOUCH TO TURN MICROPHONE ON (GREEN) AND OFF (GRAY).
TOUCH ONE OF THE SYMBOLS BELOW TO PROCEED.
BACK
GO
CANCEL
903
904
905

FIG 9H

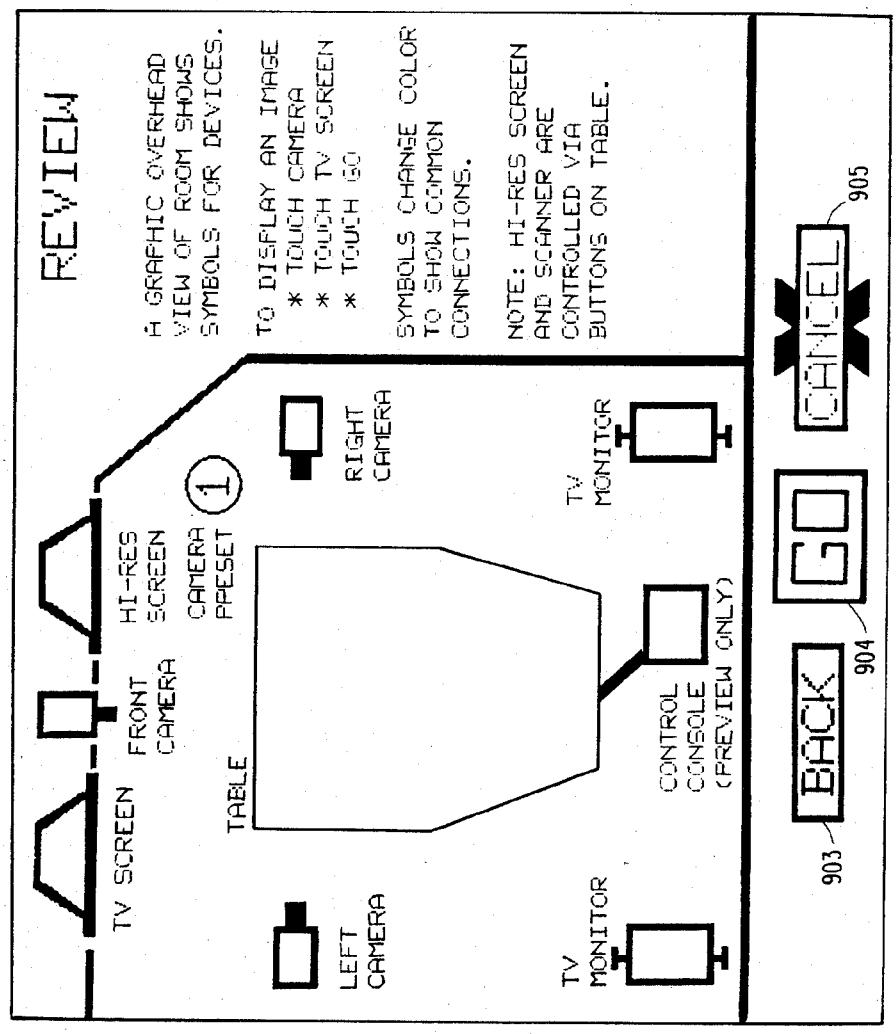

PREVIEW
A GRAPHIC OVERHEAD VIEW OF ROOM SHOWS SYMBOLS FOR DEVICES.
TO DISPLAY AN IMAGE
* TOUCH CAMERA
* TOUCH TV SCREEN
* TOUCH GO
SYMBOLS CHANGE COLOR TO SHOW COMMON CONNECTIONS.
NOTE: HI-RES SCREEN AND SCANNER ARE CONTROLLED VIA BUTTONS ON TABLE.
TV SCREEN
FRONT CAMERA
HI-RES SCREEN
CAMERA PRESET
1
RIGHT CAMERA
TV MONITOR
TABLE
CONTROL CONSOLE (PREVIEW ONLY)
LEFT CAMERA
TV MONITOR
CANCEL
905
GO
904
BACK
903

FIG. 9I

FIG. 10

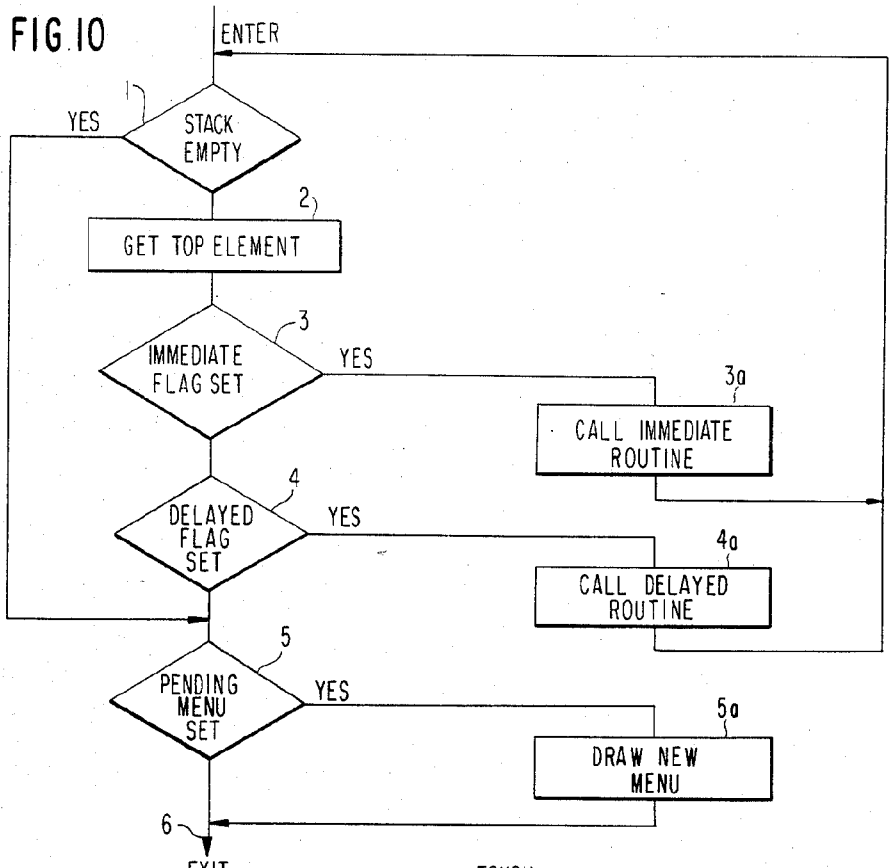
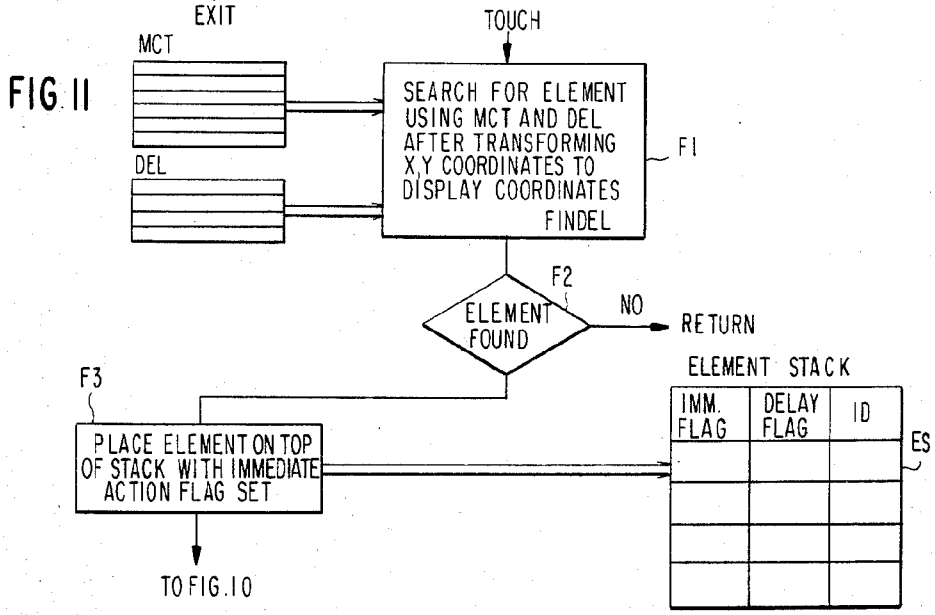

ENTER
1
STACK EMPTY
YES
2
GET TOP ELEMENT
3
IMMEDIATE FLAG SET
YES
3a
CALL IMMEDIATE ROUTINE
4
DELAYED FLAG SET
YES
4a
CALL DELAYED ROUTINE
5
PENDING MENU SET
YES
5a
DRAW NEW MENU
6
EXIT

FIG. 11


MCT
DEL
TOUCH
SEARCH FOR ELEMENT USING MCT AND DEL AFTER TRANSFORMING X,Y COORDINATES TO DISPLAY COORDINATES
FINDEL
F1
F2
ELEMENT FOUND
NO
RETURN
F3
PLACE ELEMENT ON TOP OF STACK WITH IMMEDIATE ACTION FLAG SET
TO FIG. 10
ELEMENT STACK
IMM. FLAG
DELAY FLAG
ID
ES

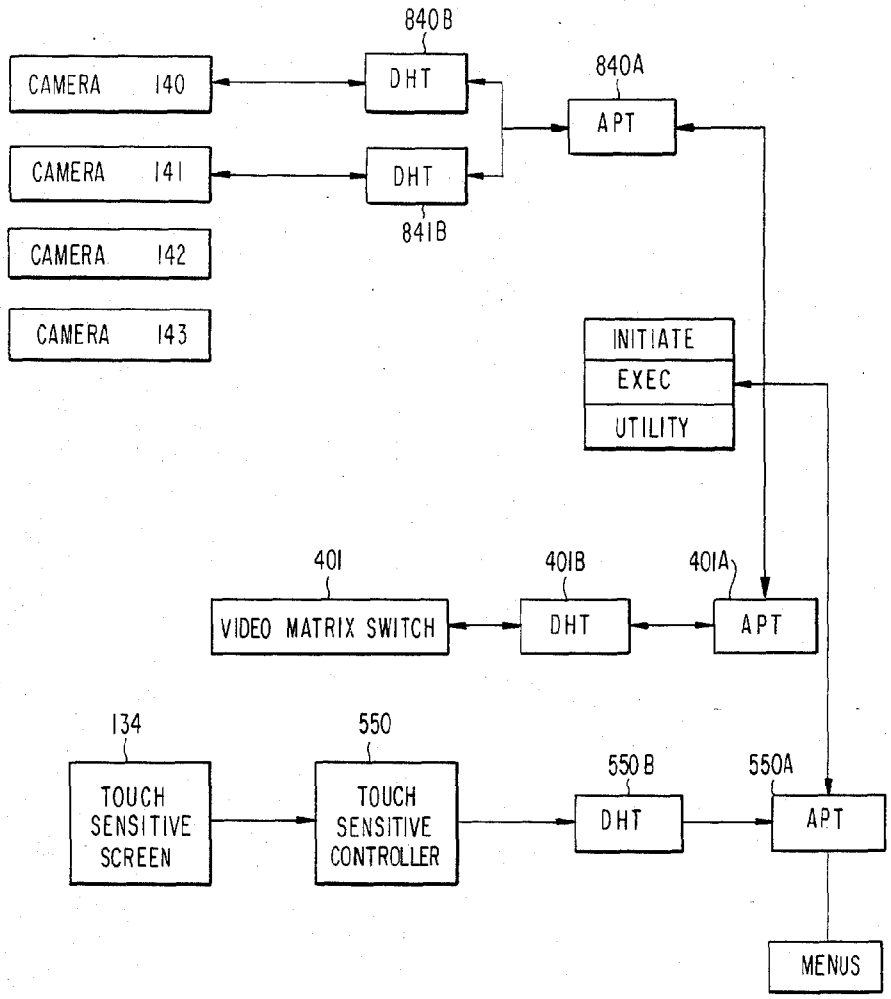

840B
CAMERA 140
DHT
840A
APT
CAMERA 141
DHT
841B
CAMERA 142
CAMERA 143
INITIATE
EXEC
UTILITY
401
401B
401A
VIDEO MATRIX SWITCH
DHT
APT
134
550
550B
550A
TOUCH SENSITIVE SCREEN
TOUCH SENSITIVE CONTROLLER
DHT
APT
MENUS

FIG. 12

TELECONFERENCING METHOD AND SYSTEM

FIELD OF THE INVENTION

The invention relates to communication systems, and more particularly to communication systems for effecting teleconferencing functions including selective transmission and reception of audio and video information.

BACKGROUND ART

The advent of commercially available wide band digital communication links carries with it the ability to add new dimensions to the functions effected by a communication system. One aspect of these new dimensions is a teleconferencing function. In teleconferencing, conference participants are brought together via a communication link for the purpose of information interchange. The "tele" prefix to the word telecommunications implies that one or more of the participants is remotely located from other of the participants in the conference. Teleconferencing is a function which has been performed using prior art techniques and apparatus. Teleconferencing is achieved so as to give the perception that there is no distance barrier between participants who may actually be widely separated. This goal has not been achieved until the advent of this invention.

The prior art in teleconferencing can be broken down into two readily segregatible classes, those in which only audio information is interchanged, and those in which video information is interchanged as well. The first class of prior art techniques (audio information interchange only) has not been accepted as a viable alternative to bringing all the conference participants to a common site. In other words, while audio teleconferencing is a function which is carried out today, there are many instances in which it is not perceived to be an acceptable substitute to travel.

Other prior art methods and apparatus have added a video dimension to the teleconferencing function. These prior art approaches, too, have not been perceived as acceptable substitutes to actually bringing all participants to a common location. See "The Global Video Conference" by Mokhoff appearing in *IEEE Spectrum,* September 1980, pp 44–47. There appears to be two reasons for this perception. The first reason is that there has not been available to the prior art, the wide band communication facility which appears to be required for effective telecommunications. This problem appears to have been solved through the use of wide band communication links provided by domestic communication satellites and/or direct or line-of-sight microwave communication facilities. The other problem, however, still remains and it is the problem of equipment complexity. Effective telecommunication requires giving each participant the perception that there is no distance barrier between himself and each other conference participant. While this appearance was technically achievable using prior art methods and apparatus, it necessarily required plural TV cameras, each of which is capable of altering the image generated by varying parameters such as pan, tilt, zoom and focus. While the prior art could supply such equipment, that equipment necessarily required the presence of one or more equipment operators, who were technically trained to achieve the desired results. The cost associated with providing the operator(s) prohibited the widespread use of teleconferencing.

The prior art made several attempts to avoid this requirement for equipment operator(s). One attempt was by American Telephone and Telegraph Company. Their service used a combined television camera/video display unit. A user positioned himself in front of the equipment with two results. By reason of his position, the television camera generated a video image of the user which could be transmitted to other users. At the same time, the participant's presence in front of the equipment enabled him to view the video display which could produce an image of a distant user. In this regard see "Experiments with Picturephone Service" by A. D. Hall in the *Bell Laboratories Record,* April 1964, pp. 114 et seq; "New Picturephone Set 'Zooms' and Shows Graphics" in *Bell Laboratories Record,* December 1967, pp. 374 et seq. This simple level of service was inadequate where a conference included more than two users; while equipment could be provided to select the video signal to be transmitted from one user's camera to the other displays, that equipment necessarily required an operator. Other prior art, as exemplified in U.S. Pat. Nos. 3,419,674; 3,723,653; 3,601,530; 3,725,587; 3,944,736 and 4,054,908, used plural TV cameras, each associated with a different field of view, and audio-driven majority voting logic to select from the set of TV cameras, the camera associated with a region including the highest audio source level. This approach too proved ineffective for a number of reasons; in the absence of an audio signal source, the system defaulted to a single camera which might or might not be trained on the image most desired by the participants. Secondly, unintentioned sounds (such as a cough or sneeze, etc.) could well cause a change in the video image being transmitted which was undesirable. Furthermore, no simple provision was made for changing a TV camera's field of view, i.e. pan, tilt, zoom and focus were not available. Some other approaches are referred to in "Teleconferencing Communications Activities" by Noll in *Communications* (September 1976), pp. 8 et seq.

Accordingly, it is an object of the present invention to provide a teleconferencing system enabling video teleconferencing which does not require the presence of skilled equipment operators, but which nevertheless has the capability of imparting to participants in a teleconferencing situation the perception of a lack of a distance barrier between participants who may actually be separated by great distances. It is another object of the present invention to provide such a system in which a conference leader, unskilled in the operation of the associated equipment, can nevertheless readily control the various components so as to generate this perception. It is still another object of the present invention to provide such a teleconferencing system in which an unskilled conference leader can control plural TV cameras so that a video image from a selected camera will be transmitted to a remote site, and who can also control the same camera in terms of pan, tilt, zoom and focus. It is another object of the present invention to allow an unskilled operator to effect the functions necessary to carry on a teleconferencing scenario and to select locally-generated images for transmission to a remote site so as to give the remote participants the perception of no distance barrier between themselves and other remotely located site(s).

SUMMARY OF THE INVENTION

To achieve the foregoing, and other objects, the invention provides a teleconferencing system which is adapted to be connected by a wide band digital communication link, such as a domestic satellite communication system or a microwave communication system which teleconferencing system includes at least a pair of teleconferencing sites, remotely located from each other. Each of the teleconferencing sites includes resources including at least a pair of controllable TV cameras, readily controllable in terms of pan, tilt, zoom and focus, so that a video image can be transmitted from one site to another via a selected one of the cameras. The ability to select an image from among more than one camera coupled with the ability to control each camera in terms of pan, tilt, zoom and focus allows the image being transmitted to be selected as the image originating from a controllable region in the teleconferencing site . Each teleconferencing site also includes further resources such as an audio signal source, and the inventive apparatus allows a conference leader to selectively enable or disable transmission of audio from the site at which he is located to the remote site. Further resources include at least a pair of video displays under the control of the conference leader, allowing the conference leader to select the image that will be portrayed on each display from at least among a remotely-generated video image and a locally-generated video image. In accordance with this level of control, the conference leader can locate the remotely generated video signal on either display, and the locally generated video signal on the other display. Each conference site also includes audio transducers (e.g. speakers) so as to reproduce remotely generated audio signals. Each teleconferencing site also includes an interface for coupling locally generated audio and video signals to the communication link and for coupling remotely generated audio and video signals from the communication link. Inasmuch as there are plural video sources and sinks at each teleconferencing site, the interface includes a video matrix switch which is also under control of the conference leader at each site. By controlling the video matrix switch, the conference leader can selectively couple a particular video source (any of the locally generated video sources or a remotely generated video signal) to any of the local video displays. In order to enable effective control over this equipment by an unskilled operator, each teleconferencing site further includes a control means to assist the operator in achieving the desired control. The control means includes a digital processor, video display and associated touch-sensitive screen. Through this control system, the operator can manifest a command by touching the screen once or several times at different locations. The control means includes logic means for interpreting the commands and for thereafter implementing each such command if elements of said command are consistent with each other and with available resources.

Once the command has been checked for consistency (both among the various command components and with the available resources) it is implemented by the logic means passing to message formatting means information necessary to control the necessary devices in a fashion so as to implement the command.

Accordingly, in accordance with one aspect, the invention provides:

a teleconferencing system adapted to be connected by a wide band digital communication link comprising at least a pair of teleconferencing site means for communicating audio and video signals therebetween, each said site means comprising:

at least a pair of controllable video source means for deriving a video signal from controllable regions of the associated site,

audio signal source means for deriving an audio signal from the associated site,

at least a pair of video displays for controllably displaying either locally or remotely generated video signals,

audio transducer means responsive to a remotely generated audio signal for generating perceptible sound,

interface means for coupling digital representations of locally generated audio and video signals to said communication link and for coupling digital representations of remotely generated audio and video signals from said communication link,

said interface means including video matrix switch means with plural video inputs and outputs for controllably coupling at least a locally generated video signal to said communication link and for controllably coupling locally and remotely generated video signals to said video displays, and

control means, including a digital microprocessor, control video display and touch sensitive screen, for controlling said video source means and video matrix switch means in response to sequential touches on said touch sensitive screen by an operator, said control means including:

logic means for interpreting commands initiated by operator touches of said touch sensitive screen for thereafter implementing said commands if elements of said commands are consistent with each other and with available resources and message formatting means responsive to said logic means for formatting digital messages destined for said video source means and said video matrix switch,

whereby unskilled operators can control said teleconferencing site means.

The control means, i.e. digital microprocessor, video display and touch sensitive screen provide for the display of at least one and preferably several different menus. A menu may represent some or all of the site's resources (i.e. cameras, send and receive functions, displays, etc.) along with one or more command execution elements (i.e. go, cancel, etc.). One of the main functions required of the operator is to bridge (connect) sources and sinks. A source is a camera or a receive function in that it represents a video image source. A sink is a display or a send function in that it represents a video image receptor. One type of command is to bridge a selected source with one or more sinks. This is effected on the menu by touching the selected source and sinks (in any order) and then touching the GO command element. Since such a bridge with more than one source or no source may be inconsistent with what can be implemented, the logic is arranged to check the command for this consistency prior to execution. Since bridges may be added to, however, not only is it necessary to check for internal command consistency but it is also necessary to check for consistency with the condition of the site's other resources.

In addition, another type of command is effected to selectively position a camera. In a preferred embodiment, this is effected via a different menu which allows

for commands representing camera control functions such as a change in zoom, focus, pan or tilt status. This menu provides for a first set of two selected touch areas to select a particular camera (of course more than two movable cameras could be handled by increasing the number of touch areas in the first set), a second set of touch areas to provide for a change in a zoom parameter, a third set of touch areas to provide for a change in a focus parameter and a fourth set of touch areas to provide for a change in a pan/tilt parameter.

To provide the operator with feedback indicating that the commands are appropriately recognized, the various elements of the menus are displayed in selectable colors and, depending on the status of commands associated with an element, its border may be displayed as the color of the element or as a white border. Thus, as commands are entered the border and/or body color of various elements may change. For example, each source has a distinctive color, and any representation of that source in a menu takes on that color only when the source is on or operating. When a source and sink are bridged, the sink(s) takes on the color of the source.

Some commands require plural touches and a touched element included in a plural touch command is said to be pending before the command is executed. Elements associated with pending touches have their borders on (displayed as white). Once this convention is learned the operator can verify that touches are responded to, which commands have been implemented and the current status of all site resources.

Thus, the combination of simple command logic plus the added intelligence embodied in software allows the control of complex functions. The logic then:

1. Displays and maintains the various menus.
2. Interprets the coordinates of a touched location in the context of the menu presently being displayed.
3. Acknowledges operator touches.
4. Translates the operator touches into a logic sequence of functional and control operations and implements control operations.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be further described so as to enable those skilled in the art to make and use the same, in the following portions of this specification when taken in conjunction with the attached drawings in which like reference characters identify identical apparatus and in which;

FIG. **1** is part plan part schematic illustration of a typical teleconferencing site;

FIG. **2** is a block diagram of subsystem interconnection at the typical site;

FIG. **3** is a detailed block diagram of the audio subsystem;

FIGS. 4A and 4B, when assembled as shown in FIG. **4** is a detailed block diagram of the video subsystem;

FIG. **5** is a detailed block diagram of the high resolution facsimile subsystem.

FIGS. 6A and 6B are detailed block diagrams of the control subsystem;

FIG. 7 is a detailed block diagram of an interconnection subsystem;

FIG. **8** is a flow chart showing control menu movement;

FIGS. 9A–9I illustrate different control menus.

FIGS. **10** and **11** are flow diagrams of commonly used procedures.

FIG. **12** shows the intialization module, an executive module and the interface between the hardware component.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

FIG. **1** is a part plan part schematic illustration of a typical teleconferencing site **10**. As shown in FIG. **1**, the typical teleconferencing site **10** includes two separate areas, a main room **15** and a back room **20**.

The main room **15** includes a conference table **100**, of suitable shape for reasons which will become clear hereinafter. Conveniently located about the conference table and elsewhere in the room are chairs **102** for the use of conference participants. The conference leader is located at chair **105** where the controls for operating the teleconferencing site **10** are conveniently available. Inset into the conference table **100** is the platen **120** of a high resolution graphics scanner; associated therewith is a control panel **121** within easy reach of the conference leader at chair **105**. A control console **130** is shown as supported on a pivotable boom **131***a*. By positioning the boom **131***a*, the conference leader **105** can position the control console **130** either on his right of left hand side as desired. The control elements to be operated by the conference leader at the chair **105** are located in the main on the control console **130**, with the high resolution control panel **121** as a adjunct.

For generating a video image for transmission to a remote teleconferencing site, the teleconferencing site **10** includes four TV cameras. A first TV camera **142** is located in the back room **20** and views the main room **15** via a hole **16** in a front wall **17** of the main room **15**. The camera **142** is located so that the image generated can encompass conference table **100** as well as each of the participants seated in the chairs **102** located about the conference table **100** as well as the conference leader at chair **105**. A pair of side cameras **140** and **141** are located within the main room **15**. Each of the side cameras are located on platforms (not illustrated) which enables the cameras' orientation with respect to the main room **15** to be changed in terms of pan and tilt. Furthermore, the cameras **140** and **141** have also associated with each, camera controllers which, in addition to controlling the pan and tilt of the platforms, can also control the zoom and focus of the camera lenses. Finally, a fourth camera **143** is located in the back room **20** and imaged on the screen of a slide projector and uniplexer. Through the use of the control system, the conference leader can, by manipulating the control console **130** select the image generated by any of the cameras **140–143**. Once selected, the image from a camera can be either locally displayed on any of a plurality of monitors which will be described below, and/or that image can be transmitted to a remote teleconferencing site(s). Furthermore, through the use of the same control console **130** the conference leader can selectively orient the cameras **140** and **141** in terms of pan and tilt as well as controlling the zoom and focus of the camera lenses. Accordingly, through the use of the control system, the conference leader can generate a video signal corresponding to that generated by any controllable region within the main room **15**. Display capability is implemented through ceiling mounted video monitors **110** and **111** as well as large screen projection video display **113** associated with screen **116** and a video display included in the control console **130**. Finally, graphics can

be displayed on the large screen projection video display **112** associated with screen **117**.

FIG. **2** is an overall block diagram of the electrical connection of the various components. As shown in FIG. **2**, the equipment can be broken down into six subsystems. Firstly an audio subsystem **30** is interconnected via an audio portion of the interconnection subsystem **70** and therethrough to a wide band digital link. Overall control of the audio subsystem is effected by the control subsystem as will be explained.

Like the audio subsystem **30**, the high resolution subsystem **50** is interconnected via the high resolution portion of the interconnection subsystem **70** to the same wide band digital communication link.

FIG. **2** also shows a video subsystem **40**. The video subsystem **40**, which is coupled through the motion codec **45** to the video portion of the interconnection subsystem **70**, and thence to the wide band digital communication link, is interconnected to the control subsystem **60**.

In an embodiment of the invention which has actually been constructed, the interconnection subsystem **70** connects, at its output to the port adapter system of the SBS communications network service. This service is obtained by the use of a satellite communications controller (hereinafter SCC) which is available from Satellite Business Systems of McLean, Va. However, it should be apparent to those skilled in the art that supporting the transmission of digital signals representing audio, video, and high resolution signals at the required band width capacity is a function which does not require a satellite link. Such capacity is available through conventional facilities such as, for example, point-to-point microwave communication links, fiber-optic communications channels, etc. Accordingly, the invention should not be considered to be restricted to the use of the SBS communication network service, or any particular domestic satellite communications system or service, but rather can utilize any wide band digital link of sufficient band width.

Reference is made to FIG. 3 to illustrate the audio subsystem in detail.

As shown in FIG. **3**, a pair of pressure zone microphones **301** and **302** are located in the teleconferencing main room **15**. These microphones are located as shown in FIG. **1**, one centrally located on the conference room table, the other near the chalkboard **118**. The microphones **301** and **302** take advantage of surface wave propagation of sound across the plane surface of the table or wall to provide a highly sensitive, nearly hemispherical pick-up pattern.

The output from the microphones is coupled to a preamplifier **303**, the output of which is coupled to the "send-in" terminal of echo canceller **304**. The "send-out" terminal of the echo canceller **304** is coupled to an audio mixing system **306**. The mixing system **306** includes a plurality of inputs and a pair of outputs, an output from amplifier **328** to the input terminal of an audio codec **314**, and output from amplifier **327** to equalizer **308**.

Mixer **306** includes six amplifiers **315–320**, jumpered so that amplifiers **315, 317, 318** provides inputs to amplifier **328**, and amplifiers **316, 317** and **318** provide inputs to amplifier **327**. One output of the codec **314** is RS-449 (audio representing) data which is coupled to the interconnection system (FIG. 7). On the other hand, the output of the equalizer **308** is coupled through power amplifier **309** to a room loudspeaker (or loudspeakers) **310**.

Another codec audio output is coupled to amplifier **312** and then through a digital delay line **311**. The digital delay line has two outputs (with slightly different delays), one of which is coupled to the receive in terminal of the canceller **304**, and the other of which provides the input to amplifier **316** in the mixer **306**.

The audio subsystem also includes a second echo canceller **305** which can be used with a telephone coupler, for connection to a remotely located telephone. The "send-out" terminal of canceller **305** is connected as an input to amplifier **317** and as an input to amplifier **323**. A second mixer **307** is provided which can be used for the remote audio participants (connected to the canceller **305**) and/or in connection with a (video recorder) VTR. More particularly, the audio mixer **307** includes six amplifiers **321–326** and a pair of output amplifiers **329** and **330**. Amplifiers **321–324** are connected to receive the same inputs as are amplifiers **315–318**. The jumper arrangement in mixer **307** is slightly different so that for example the output of amplifiers **321, 322** and **324** provide inputs to both output amplifiers **329** and **300**, whereas amplifier **323** provides an input to **330**. The output of amplifier **329** is coupled to the "receive-in" terminal of canceller **305**. The output of amplifier **330** can be used as the audio input to a VTR. If used, the audio output of the VTR is coupled as the input to amplifier **318** and **324**.

In addition to the foregoing, the audio subsystem includes monitoring and testing instrumentation sufficient to support routine maintenance and first echelon trouble shooting, i.e. the audio monitor amplifier **313** connected as illustrated. In addition, the jumpering arrangements in the mixers **306, 307** allows changes in the nominal arrangement of equipment.

In view of the foregoing, it should be apparent that the audio subsystem allows audio signals generated by the microphones **301, 302** to be processed (i.e. echo cancelled and converted to digital form), and coupled to the wide band communication link. In addition, audio signal representing data, received from the remote location is converted back to audio signal form by the codec **314**, amplified, provided to the echo canceller and used to drive the room loudspeaker **310**. Provision is made for coupling a remotely located "telephone only" participants to the echo canceller **305** and provision is also made for VTR play-back or record of audio signals.

As shown in FIG. **2**, the output from the audio subsystem **30** is to the interconnection subsystem **70**. The video subsystem **40** includes a matrix switch **401** controlled by the conference leader via the control subsystem **60**. The matrix switch **401** includes a first video matrix interconnecting various video inputs and outputs, and a second audio matrix interconnecting the audio output of mixer **306** and the interconnection subsystem **70**. The connection to the audio plane of the switch **401** is at terminal **12**. An audio crosspoint, **340**, effects the connecting and disconnecting of the audio signal. Thus, the conference leader can enable the microphones **301, 302**, the telephone, and the VTR playback by connecting the output to codec **314**. The conference leader may also disable the microphones **301, 302** the telephone, and the VTR playback by disconnecting the output from codec **314**.

The video subsystem (shown in FIGS. **4, 4A** and **4B**) provides three color television cameras to view confer-

ence participants and fourth camera for pick-up and display of 35 mm slides or the like.

A front camera **142** is located in the front wall **17** of the main room **15** and is provided, in an embodiment of the invention which has actually been constructed, with a (remote) manually controlled zoom lens. When "zoomed out" this camera provides an overall view of all seated conference participants. When "zoomed in", the camera provides a "close-up" view of the conference participant seated at the far end of the table, i.e. in chair **105**.

The side cameras **140** and **141** are equipped with pan/tilt platforms and zoom lenses which are controlled via the control subsystem. As will be described hereinafter, these cameras are capable of being automatically positioned to view a selected one of several preset "shots" of the conference room. Generally these cameras are used to complement the overview camera by providing, when necessary, close-ups of individual participants and objects.

The 35 mm slide camera **143** is associated with a uniplexer located in the back room **20**. The uniplexer is provided with a slide projector, which, in an embodiment of the invention actually constructed, is capable of storing up to 80 slides for presentation during the course of a teleconference. A hand-held wireless controller (conventional) permits the projector to be cycled "forward" or "reverse" from anywhere in the teleconferencing room.

Video images can be displayed on any of four devices in the main room **15**. These are:

A large screen display **116** (in an embodiment of the invention actually constructed, four feet in width),

two overhead monitors **110, 111** (in an embodiment of the invention actually constructed, each with 25-inch screens), and

a video display included in the control console **130**.

The selection of an image on a particular camera to be displayed on any one of the four selected devices, and the additional selection of a camera whose image is used for transmission to the remote teleconferencing site is made through the use of a video matrix switch controlled via the control console **130**.

As in the audio subsystem, the video signal selected for transmission by the video matrix switch is in analog form and is converted to digital form for transmission over the wide band communication link. This transformation is accomplished by the motion codec **45**.

Video signals from the remote teleconferencing site are decoded by the motion codec **45** and applied to the video matrix switch. This permits the distant room's video signal to be displayed on any of the video display devices in the main room **15**.

The video subsystem includes in addition, the necessary timing generators, test instrumentation and monitoring equipment required to support routine maintenance and first echelon trouble shooting. A patching and distribution facility is provided to permit changes to the nominal equipment configuration.

Referring in more detail to FIG. 4A, the front camera **142**, side cameras **140** and **141** are identified as being coupled to associated camera control units **442, 440** and **441**, respectively. In addition, the slide projector associated camera **143** is coupled to a fourth camera control unit **443**. Each of these camera control units provide, as an output, a video signal which is coupled to a different one of the inputs of a 10×10 video matrix switch **401**. Other inputs to the video matrix switch include a still transmit, still receive, a video output from the motion codec **45**, an output from the VTR playback and, for testing and maintenance purposes, a black burst signal and NTSC bars.

A first output of the video matrix switch **401** is coupled to the side monitors **110, 111**. A second output of the video matrix switch **401** is coupled to the NTSC "in" terminal of the video projector **113**.

A third output of the video matrix switch **401** is coupled to the NTSC "in" terminal of the video mixer **132** which is associated with the control console **130**. The fourth through sixth outputs of the video matrix switch **401** are available for other functions. The seventh output of the video matrix switch is available for still transmit. The eighth output of the video matrix switch **401** is coupled to "video in" terminal of motion codec **45**. The ninth output of the video matrix switch **401** is available as a video input for a VTR recorder. Finally, the tenth output of the video matrix switch **401** is coupled to a test switcher **402**. The test switcher **402** can be coupled to test and maintenance equipment including NTSC wave form monitor, NTSC vectorscope, and NTSC monitor **403–405**.

The motion codec **45**, in addition to encoding locally generated video signals to produce data output for connection to the wide band digital link, is also used to decode data representing remotely generated video signals, to produce a video output signal which is coupled as one of the inputs to the 10×10 video matrix switch **401**. Not shown in FIG. 4A (and shown in FIG. 6A) is the control element for video matrix switch **401** which enables selective interconnection to be made between any of the ten input terminals and any of the ten output terminals. In this fashion, video matrix switch **401** can selectively route any of its input signals to any of its output terminals. For example, in this fashion a signal from any of the four local TV cameras can be coupled to any of the four display devices, i.e. the video projector **113**, the side monitors **110, 111** or the control console video display **131**. In the alternative, a video signal remotely generated could be coupled to any or all of the local monitors. In addition, the locally generated video signal can be coupled to the motion codec for transmission to the remote site, and the particular video signal selected for transmission can be that generated by any of four local TV cameras.

FIG. **5** is a schematic representation of the high resolution subsystem. The high resolution subsystem can transmit images which are too detailed for transmission by the NTSC television standard. Included in this category for example are letters, contracts, flow diagrams, other drawings and similar materials encountered in daily business meetings.

The high resolution subsystem is composite of facsimile and high resolution television technology. Documents to be transmitted are placed on a scanner **120** (FIG. **1**) much like that of a conventional office copying machine. When a scan is initiated, by operating control **121** an $8\frac{1}{2}\times11''$ document is scanned in approximately five seconds with a resolution of 200 lines per inch in both directions. The electrical signals generated by the scanning operation are coupled to a data compressor employing a digital data compression technique that allows signals generated during the scanning operation to be transmitted or received in less than ten seconds. The digitally compressed document is stored and buffered in a compressor protocol interface from which it is

transmitted to the distance teleconference room through a 448 KBPS digital data port.

At the distant teleconferencing site the digitally compressed document is buffered in a reconstructor protocol interface and reconstructed to its original (or decompressed) form by a data reconstructor.

The document is then printed on a high speed facsimile printer located at the remote teleconferencing site and it also converted by a facsimile to video converter for projection by large screen television display. Although hard copies obtained from the printer retain the original 200-line-per-inch resolution, the projected image of the document is presented at a lesser resolution, approximately equivalent to 100 lines per inch. The television technique chosen for the large screen display is different from the American NTSC standard used for the generation and display of other video images. The images are displayed in black and white. To improve legibility the projected display may be reversed (in contrast) from the original and hard copy printout. In addition, the orientation of the displayed graphics can be electronically rotated through 90°, 180° or 270°. As shown in FIG. **5**, the tabletop scanner **120** is coupled to a scanner power supply **522**. This is in turn coupled to a data compressor **523** which couples through a compressor protocol interface **524** to a local display switch **525**. The local display switch **525** allows locally generated data representing graphic images to be coupled to the interconnection subsystem **70**. In addition, either the locally generated signals or remotely generated signals can be coupled to a reconstructor protocol interface **526** and associated data reconstructor **530**. Reconstructed data can be coupled directly from the reconstructor protocol interface **526** to a high resolution printer **115**. In the alternative, or in addition, locally or remotely generated data representing graphic images can be coupled to a fax-to-video converter **527**. The resulting video signal can be coupled to optional high resolution monitor **528** and to a projector **529** for display on the high resolution screen **117** (FIG. **1**). The fax-to-video converter **527** is the subject of Schaphorst copending application Ser. No. 252,104 filed Apr. 8, 1981 (incorporated herein by this reference) and assigned to the assignee of this application.

Accordingly, it should be apparent that the high resolution subsystem allows the transmission and/or reception of graphic images and the display of either locally generated graphic signals or remotely generated graphic signals. Although not specifically disclosed herein the high resolution subsystem could be controlled via the control subsystem **60** with suitable modifications.

The control subsystem **60** provides the interface between the conference participants and the other subsystems of the teleconferencing system. The control subsystem **60** is based on a software driven microcomputer. A user interfaces with the microcomputer through a color CRT display **131** mounted on the boom **131***a*. This display is equipped with a touch sensitive overlay which permits the control subsystem **60** to respond to user "touches" or commands. The microcomputer generates a series of color graphic "menus" which are displayed. These menus provide limited, logical, self-prompting choices to the user. The eliminates the need to provide for all necessary controls at one time as would otherwise be the case with a typical hardware control panel.

The user indicates his choices through a series of touches known as a control sentence. A complete control sentence generally consists of a source element (a camera, for example, although the receive function is also a source) and an action (pan, tilt, zoom, focus to a preset set of parameters) or display (selection of a particular display) element followed by a touch to the "go" or sentence end element. In the event the user constructs a sentence with inappropriate (or impossible) or incomplete grammar, an automatic error message appears on the color CRT to prompt the user.

The "master menu" has been designed to manage most of the teleconferencing functions required during a meeting. This menu provides control over camera pointing through the selection of previously preset pan, tilt, zoom and focus parameters. Six of these preset positions are defined at system installation for each of the sidewall cameras **140** and **141**. Two additional presets are available for each camera through an additional menu which permits continuously variable camera pointing, zoom and focus. A user is able to:

point the sidewall camera **140** and **141** to one of six preset positions defined at installation,

point a sidewall camera **140**, **141** to any position within the limits of the pan, tilt, zoom and focus mechanism; and define two additional preset positions for each sidewall camera **140** and **141** which are valid only for the duration of the conference during which those presets are defined.

The master menu also permits the user to select images for transmission to the remote site, display on any of the local displays for previewing on either of the two wall monitors **110**, **111** or the CRT display **131** associated with the console **130**.

Selection is also possible of the slide camera **143** which can be selected for transmission or display (or both). A hand-held wireless remote control (conventional) permits the slide projector to cycle slides "forward" or "reverse" from anywhere in the main room **15**.

To provide display of color menu graphics, the microcomputer controller interfaces with the conference control console CRT **131** through separate video cables. There is a composite NTSC video interface between the CRT **131** and the video matrix switch **401** to permit menu graphics to be overlaid on video generated by the teleconferencing room cameras. This is useful with a menu which overlays pan, tilt, zoom and focus touch elements over the image of the camera being controlled to permit the user to view camera pointing while it occurs.

All other interfaces between the microcomputer and control devices are made through RS-232C serial data ports. These include:

the touch sensitive screen controller **550**,

the pan, tilt, zoom and focus controller for side cameras **140**, **141**, and

the video matrix switch **401**.

The microcomputer also includes additional RS-232C serial data ports to interface with:

the boot loading mechanism **601** which provides the IPL when power is applied, and

maintenance terminal **551** with keyboard and alpha numeric CRT.

The control subsystem is shown in detail in FIGS. **6A–6C**.

Referring first to FIG. **6A**, the teleconference control console **130** includes a touch sensitive screen **134**, con-

sole CRT display **131** and video mixer **132**. Each of the side camera controllers **440** and **441** includes a zoom lens controller, iris control, and pan/tilt assembly. Associated with each camera controller is a pan/tilt/zoom/-focus controller which in turn is driven via an RS-232 data link by the microcomputer **133**. In this fashion, data signals representing desired pan/tilt, zoom and focus settings can be transferred from the microcomputer **133** to the appropriate controller for effecting the desired control. The front camera controller **442** also includes a zoom lens control **542** which is driven by a manually operated zoom controller **642**, although those skilled in the art will be aware that providing another pan/tilt/zoom/focus controller such as **640** or **641**, in place of the manual zoom controller **642**, can enable control of the zoom lens of camera **142** through console **130**. Interfacing between the touch sensitive screen **134** and the computer **133** is a touch sensitive controller **550**. The computer **133** is also coupled through another RS-232 line with the control unit for the 10×10 video matrix switch **401**. In this fashion the computer **133** can selectively connect inputs and outputs to effect the desired control. The computer **133** is also coupled to a boot load medium **601** for IPL as should be apparent to those skilled in the art. Terminal **551**, the maintenance terminal, is interfaced to computer **133**.

Another component of the control subsystem is illustrated in FIG. **6B** which shows a trio of touch telephones **660–662**. Each telephone is coupled through associated "T" jack adapter **663–665** to an associated hold module **666–668**. The other output of the "T" jack adapter is coupled through interconnection cabling to the wide band digital communication link. The user merely dials a telephone-like number into one or more of the telephones **660**, **661** and **662** depending on the particular resources he intends to use. For example, to enable a video conference, the video feature representing number is "dialed" on telephone **660**. This signals the communication system to the requirement to allocate a video representing digital channel to the port associated with instrument **660**. This port is, of course, connected to the video component of the interconnection subsystem **70**. Similar remarks apply to the use of instruments **661**, **662**, respectively, with reference to high resolution and audio service.

FIG. **7** shows the interconnection of the motion codec **45** and high resolution subsystem to the wide band communication link uses modem pairs **701**, **703** and **702**, **704**. This allows for limited separation between subsystem terminations and communication link terminations. Those skilled in the art will realize that provision of these modems is not at all essential to the invention.

The particular wide band digital link with which the embodiment of the invention actually constructed, interfaces, associates each data port with a voice port for the transmission of signalling information. The associated voice port is terminated at a conventional telephone, and a connection between a local and remote data port is effected by dialing a number representing the desired service as described above. It should be apparent to those skilled in the art that this particular technique of associating a voice and data port is not the only method of signalling. Furthermore, it should be apparent that any other conventional technique can be used in accordance with the present invention.

The equipment referred to herein is identified by manufacturer and model in the attached Tables I–VI; Table I (audio); Table II (video); Table III (high resolution); Table IV (control); Table V (interconnect) and Table VI correlates manufacturer designations on Tables I–V with name and location.

TABLE I

AUDIO SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
303	Altec	1589B	Microphone Preamplifier (Mixer)
312	Altec	1588C	Microphone Preamplifier
304,305	COMSAT	EC-4105	Echo Canceller
301,302	Crown	PCM-6LP	Microphone
313	Di-Tech	7001	Audio Monitor/ Amplifier
		w/Option A	
		w/Option B	
311	Eventide	CD254	Digital Delay Line
	IVIE	5001	Mainframe
	IVIE	5101	Power Module
308	IVIE	5303	One-Third Octave Equalizer
306,307	IVIE	5506	6 × 2 Mixer
309	IVIE	5805	Power Amplifier
310	JBL	4301B	Room Loudspeaker
	LAMBDA	LNS-P48	48 Volt Power Supply
	w/LRA-15 Rack Adapter (Configuration 4) w/Digital Volt/Amp Meter		
	Trompeter	APC3-18	Patch Cord. Audio
	Trompeter	CH-50	Patch Cord Holder
	Trompeter	JJ-042	Patch Jack. Audio
	Trompeter	JSI-48	Patch Panel
314	TCI		Audio Codec

TABLE II

VIDEO SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
110,111	Conrac	5222Y25	Side Monitor
142	Cosmicar	50FMF1.4	50 mm Lens
401	Dynair	AO-2165A	Output Module (Audio)
401	Dynair	CC-2118A	Power Supply Service Cable
401	Dynair	CE-2190A	Module Extender
401	Dynair	FR-2100A	10 × 10 Matrix Frame
401	Dynair	MP-2110A	System Controller
401	Dynair	PS-2115C	Power Supply
401	Dynair	SCA-260A	Touch Pad Control
401	Dynair	SW-2150A	10 × 10 Switch Module (Video)
401	Dynair	SW-2160A	10 × 10 Switch Module (Audio)
401	Dynair	VO-2155B	Output Module (Video)
402	Dynair	VS-12D w/LK-1541A	Test Switcher
113	ESP	AQUA-STAR	NTSC Projector
	w/Comb Filter, horizontal shading control and optics optimized for 48" wide image		
142	Fujinon	A12X9	Zoom Lens, Auto Iris
140,141	Fujinon	H10X105RH	Zoom Lens
	Fujinon		.78X Adapter (A12 × 9)
140–143	JVC	AAC2OU	AC Adapter
140–143	JVC	KY-2000CH	Camera
440–443	JVC	RS-2000U	Camera Control Unit
143	Laird-Telemedia	4110	Slide Projector, with 3" Lens, Single Drum
143	Laird-Telemedia	2508	Control
143	Laird-Telemedia	5050	N.D. Servo
143	Laird-Telemedia	5135	Uniplexer
403	Tektronix	528 w/Option 01	NTSC Waveform Monitor

TABLE II-continued

VIDEO SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
405	Tektronix	650HR	NTSC Monitor
404	Textronix	1420 w/Option 01	NTSC Vector Scope
	Trompeter	J14	Patch Jack, Video (Normal Thru)
	Trompeter	JSI-48	Patch Panel
	Trompeter	PC-18-75	Patch Cord, Video
	Dynair	CE-0052	Module Extender
	Dynair	CE-0056	Module Extender
	Dynair	DA-5960A	Video Distribution Amplifier
	Dynair	DA-5966A	Subcarrier Distribution Amplifier
	Dynair	FR-5900A	Frame
	Dynair	PD-5941A	Pulse Distribution Amplifier
	Dynair	PS-5920A	Power Supply
	Tektronix	1470	NTSC Generator
	NEC	NETEC-X1	Motion Codec

TABLE III

HIGH RESOLUTION SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
117	ESP	—	Large Screen Display
131	Conrac	QQA14/RS	High Resolution Monitor
	Grinnell	305	Facsimile to Video Converter
120	Rapicom	HSS-44	Table Top Scanner
121	Rapicom	HSS-44	Scanner Controller
	Rapicom	HSC-44	Data Compressor
	Rapicom	CPI-44	Compressor Protocol Interface
	Rapicom	RPI-44	Reconstructor Protocol Interface
	Rapicom	HSR-44	Data Reconstructor
115	Rapicom	HSP-44	High Speed Printer

TABLE IV

CONTROL SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
130	ADI	TDC-051-Q	Teleconferencing Display/ Controller
		w/option 1	Auto-boot
		w/option 2	Maintenance Terminal
		w/option 3	Memory Block 32K
		w/option 5	Programmable Element Generator
	Creston	C-10	Wireless Controller
	SECS	—	X-Y Platform
	Texas Instruments	TI785	Portable Terminal
	Racal-Vadic	3451P	Data Modem
		S-466023	Line Cord
		S-47178	ITT Touch-Tone Telephone
		S-480727	CAC-625 Jack
		LH-50	Hold Module
		MCI Kit	T Jack Adapter

TABLE V

INTERCONNECTION SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
	AVANTI	2300	Limited Distance Modem

TABLE V-continued

INTERCONNECTION SUBSYSTEM

REF	MANUFACTURER	MODEL	DESCRIPTION
			(448 Kbps, RS-449, SBS CNS Compatible)
	AVANTI	2300	Limited Distance Modem (1.544 Mbps, RS-449, SBS CNS Compatible)

TABLE VI

ADI
Applied Dynamics International
Ann Arbor, Michigan 48104

ALTEC
Altec Corporation
Anaheim, California 92803

AVANTI
Avanti
Newport, Rhode Island 02840

COMSAT
Comsat General Telesystems
Fairfax, Virginia 22031

CONRAC
Conrac Division, Conrac Corporation
Covina, California 91722

COSMICAR
See VIDEO CORPORATION OF AMERICA

CRESTON
See VIDEO CORPORATION OF AMERICA

CROWN
Crown
Elkhart, Indiana 46514

DI-TECH
DI-TECH, Inc.
North Babylon, New York 11704

DYNAIR
Dynair Electronics, Inc.
San Diego, California 92114

ESP
Electronic System Products, Inc.
Titusville, Florida 32780

EVENTIDE
Eventide Clockworks, Inc.
New York, New York 10019

FUJINON
Fujinon Optical, Inc.
Scarsdale, New York 10583

GRINNELL
See RAPICOM

IVIE
Ivie Electronics, Inc.
Orem, Utah 48057

JBL
James B. Lansing Sound, Inc.
Northridge, California 91329

JVC
Professional Video Division
US JVC Corporation
Maspeth, New York 11378

LAIRD-TELEMEDIA
Laird Telemedia, Inc.
Salt Lake City, Utah 84115

LAMBDA
Lambda Electronics
Melville, New York 11747

NEC
Broadcast Equipment Division
NEC America, Inc.
Elk Grove Village, Illinois 60007

RACAL-VADIC
Racal-Vadic
Sunnyvale, California 94086

RAPICOM
Rapicom, Inc.

TABLE VI-continued

Santa Clara, California 95050	
SECS	
SECS, Inc.	
Long Island City, New York 11105	
TEKTRONIX	
Tektronix, Inc.	
Beaverton, Oregon 97077	
TCI	
Telecommunications, Inc.	
Gaithersburg, Maryland	
TEXAS INSTRUMENTS	
Texas Instruments, Inc.	
Houston, Texas 77001	
TROMPETER	
Trompeter Electronics, Inc.	
Chatsworth, California 91311	
VIDEO CORPORATION OF AMERICA	
Video Corporation of America	
Edison, New Jersey 08817	

Menu and Menu Sequences

Control by the conference leader is effected by touches of the touch sensitive screen **134**. The effect of any particular touch depends on how that touch is interpreted by the computer **133**. This in turn depends on the display on the display **131** at the time the touch is effected. In order to assist the conference leader in effecting the desired functions in a manner which is realizable with the equipment available to him, the display **131** proceeds in a pre-established sequence, however, the sequence can be altered by the conference leader selecting certain functions as will now be described. FIG. **8** schematically illustrates the sequence of menus which can be displayed, and the manner in which the conference leader can select the next menu to be displayed. As shown in FIG. **8**, there are nine different menus including menus C1–C6 and R1–R3. In addition, several help menus are also used, which particular help menu is displayed is determined in part by the condition of the system at the time an error is detected or help is requested.

Each of the menus includes certain descriptive information to assist the conference leader in selecting the commands to be executed as well as interpreting his commands. In addition to providing the conference leader with descriptive information, the menu also defines one or more touch sensitive areas on the screen; the location of the touch sensitive area or areas, and the response produced by touching one of those areas is again determined in connection with the particular menu being displayed. Reference is now made to FIG. **9A** to illustrate menu **C1**. This is the introduction menu; in addition to the merely descriptive information, it also identifies two touch sensitive areas on the screen, identified as **901** and **902**. With menu **C1** being displayed, the operator can either request review of procedures, by touching area **901**, or decline to review procedures by touching area **902**. If the conference leader touches area **901**, the first review menu **R1** is displayed (see FIG. **8**).

The procedure review menus include menus R1–R3 and are illustrated respectively in FIGS. 9G–9I. Referring first to FIG. **9G**, the menu includes for the most part descriptive information but does define touch sensitive areas **903–905**. Touch sensitive area **903** allows the conference leader to redisplay the previously displayed menu. Touching area **904** brings up the next review menu, in this case R2, while touching area **905** in any of the review menus R1–R3 will immediately bring up menu C2. The same three touch sensitive areas **903–905** are defined on each of the menus R2 and R3 with the same result except that in menu R3, touching either **904** or **905** brings up menu C2.

Referring to FIG. **9I**, menu R3 (which is illustrated) is in effect a preview of the master menu C3. Depicted in the information area are representations for three of the TV cameras, the large screen TV display and high resolution display on the front wall of the room, as well as the two side monitors **110** and **111** and the control console **130**. Menu R3 also illustrates a camera preset, in particular camera preset **1** (in the one o'clock position with respect to the table). Each of the movable cameras (the left and right) are presettable to one of eight preset positions or can be manually controlled to point to any other position in a manner which will be described. Of the eight presets, however, six are fixed at system installation, and two are under control of the conference leader so that he can define any position in the room as either of those two presets. It should be understood that the number of presets and the mix (how many are fixed at installation and how many are under operator control) can be varied quite readily.

Reference is now made to FIG. **9B** to illustrate the first control menu C2. The touch sensitive areas defined in menu C2 are areas **903–906**. In menu C2, touch sensitive area **903** has the same effect as did touch sensitive area **903** in menus R1–R3, namely it allows display of the previously displayed menu. However, areas **904** and **905** have a different effect. As described in the informative text of the display, the conference leader is prompted to dial up the functions he desires. When those functions are on-line, the conference leader can proceed by touching area **904**. On the other hand, the conference leader can terminate the conference by touching **905**.

Touch sensitive area **906** allows the operator to display additional information to assist him in proceeding.

Assuming the operator has proceeded beyond menu C2 by touching touch sensitive area **904**, the master menu C3 is displayed; this is shown in FIG. **9C**. This menu, in additional to schematically depicting the layout of the main room **15**, has a large number of touch sensitive areas. At the bottom of the display, the now familiar touch sensitive areas **904–906** are displayed. In addition, touch sensitive areas **907** and **908** are also displayed. The touch sensitive area **908**, if touched, causes a display of the next command menu C4. Touch sensitive area **907** provides operator control over the audio transmission function as will be explained. The operator can also control video transmission and reception through touch sensitive areas **909** and **911**. If, for example, the conference leader desires to transmit video, this is effected by touching area **911**. An image source must also be defined among the four image sources available, namely the slide projector **143**, the front camera **142**, or one of the two side cameras **140**, **141**. Each of these image sources is represented in the menu, i.e. the slide camera is represented at touch sensitive area **912**, the front camera is represented at touch sensitive area **918**, and the left and right side cameras are represented at touch sensitive areas **913**, **914**, respectively.

In addition, the operator can select a display. The conference room includes the wide screen TV display **116**, the two side monitors **110**, **111**, as well as the conference control console **130**, itself. Each of these dis-

plays is represented on the main menu C3; more particularly, the wide screen display is represented by touch sensitive area **919**, the two side monitors are represented by touch sensitive areas **915** and **916**, respectively, and the control console **130** is represented by the touch sensitive area **917**. Thus by appropriate touches, the leader can selectively transmit an image from any of the sources. He can, at that time, or later, direct the same image to any of the displays. He can also direct a received image to any unused display. In addition, the high resolution large screen display **117** is represented by the touch sensitive area **920**. The software described herein does not interact with the high resolution subsystem and this touch sensitive area **920** is useful for future modifications which allow control, of the control subsystem **60**, over the high resolution subsystem.

Before describing the reactions to various touches and touch sequences, the color of the various items in the display is pertinent since, as touches are effected, color changes to inform the conference leader of the status of any control message at any time. The background on the entire menu is gray except for the region **910** which has a white background. All the lettering is black except for the lettering within the touch sensitive area **904** which is blue. The borders of all menu elements are black. However, elements which are "pending" (that is elements which have been selected by a touch) have white borders. Accordingly, the conference leader can readily determine from the display which touch sensitive elements are pending, by merely noting that the border is white. All inactive devices, that is the cameras not originating an image or displays not displaying an image have a gray body. If any camera is active, its body takes on a distinctive color. For example, the front camera when active is green, the left camera when active is magenta, the right camera when active is cyan, and the slide camera when active is blue. When a particular camera is activated and is coupled with a particular display, the combination is said to be bridged, and the selected display takes on the color of the associated camera; accordingly, the touch sensitive areas representing displays that is **919**, **915**, and **916** can take on any of these four colors if they are bridged with one of the four recited cameras. On the other hand, the receive area **909**, when active becomes orange and if the remotely generated video signal is bridged to one of the displays, the display takes on the same orange color.

Some of the touch sensitive areas are altered when representing pending touches. These include all displays and all cameras as well as the receive and send touch sensitive areas **909** and **911**. Pending touch elements have a border which changes from black to white on first touch and from white to black when touched again.

On the other hand, other elements are immediate. For example, in FIG. 9C, touch sensitive areas **907**, **908**, **904**, **905**, and **906** are all immediate in that touching the element causes a change to the body color or a change in the display on the control console **130**. In an embodiment of the invention actually constructed, when initialized, the system comes up in a default condition in which the audio system in ON, the front camera **142** is bridged to the send function as well as to the side monitors **110**, **111**, and a remotely generated video signal is bridged to the wide screen **116**. Accordingly, the initial display of FIG. 9C represents this condition in that, initially, the front camera bridge results in touch sensitive **918** taking on a green color as well as the TV monitor representations **915** and **916** along with the send area **911**. Likewise, the touch sensitive area **919** comes up orange as is the receive area **909**. The default condition described above is a function of stored data. Thus, if desired, any other condition can be defined as a default.

In response to a single touch to any touch sensitive element which requires the building of a command sentence, that element becomes pending and the border turns white; the pending status of this element is reflected in the software in that identification of the element is placed on a stack. Retouching the element turns the border black and removes the element from the stack. The foregoing statement applies to the display representation **919**, the side monitors **915**, **916** and the send element **911**. When the control console representation element **917** is touched, the result depends on a previous touch. If no camera or remote reception had been touched, a representation of the control console display is put on a stack. If later a camera or active device is touched, the image from that device is previewed on the console and the border turns black. If an image source (a camera or reception function) had been touched, an image from that source is displayed on the control console.

In respect to the front camera, touching it turns the border white and stacks a representation in software. Any other cameras with a white border turn black and are removed from the stack. If the element **917** had been touched, an image from the front camera is displayed on the console. When retouched, the border turns black and the image is removed. The same functions are true for the side cameras **140**, **141** and the slide camera **143**. However, in addition, with respect to the side cameras **140**, **141**, touching either of these produces a display on console screen **131** the available presets for the associated camera. For example, FIG. 9C shows preset number **6** being displayed, i.e. element **921**.

In the absence of any camera being active, no presets are displayed. When a camera becomes active, the associated presets are displayed. If a preset is touched, when it is visible the border turns white, the border of any other preset which had been white turns black. The camera then automatically moves to that preset via a message generated by the computer **133**. If a camera is active, the preset takes on the color of the camera and any previously active preset turns gray. Retouching the preset turns the border black. If the controllable presets **7** or **8** are touched and the settings have not been stored, the area **904** becomes red and the camera does not move.

When the area **907** is touched, the audio system changes state. If it had been ON, the touch sensitive area **907** was green, and after touching it, it turns gray and the audio source is disabled. On the other hand, if the audio source had been disabled, then the touch sensitive area **907** would have been gray, when touched it becomes green and the audio source is enabled. Enabling or disabling the audio source is effected by a message transmitted by the computer **133** to the audio plane of the switch **401**.

If the area **908** is touched, pending touches are not effected but the menu being displayed changes to C4.

If area **905** is touched when either the area **904** is red or an error message is being displayed, the message area is reset to again display elements **907** and **908** and/or area **904** becomes green. If none of these conditions are true, then any pending touches are deactivated.

When the help area **906** is touched, the particular menu displayed depends on the condition of the area **904**. If it had been red, indicating an error, then a corresponding help menu is displayed. If the area **904** is green (indicating no previously detected error) and there are no pending touches, then a descriptive help menu is displayed. If there is at least one pending touch, then the corresponding help menu for the last item touched is displayed.

Finally, when the element **904** is touched, then all pending touches are resolved.

The resolution of pending touches is as follows. A bridge can be constructed if the pending touches:

include one and only one image source (an image source is either a camera or the receive function):

if presets are displayed, the conference leader can select or not select a preset. If no preset is selected, the current one is employed;

one or more video sinks must be touched (a video sink is considered the front screen **117**, one of the side monitors **110**, **111** or the send function).

The bridge is completed by touching touch sensitive area **904**; the computer **133** formats a message to effect the bridge. Any device in a bridge which had existed in another bridge is removed from the old one.

Any active bridge can be expanded by the addition of another display by:

touching any active device or preset in the bridge;

touching the new display;

and touching the area **904**.

An active display can be removed from the bridge by:

touching the display;

and then touching area **905**.

A complete bridge is cancelled when either the image source is touched coupled with touching of area **905** or the last active sink in the bridge is cancelled.

Everything can be cancelled by touching all active displays and following it with a touch of area **905**.

A command sentence is considered one or more pending touches followed by touching either **904** or **905**. If the pending touches do not form a logical bridge, an error will occur; area **904** will become red and an error message may be displayed.

A valid sentence can be concluded by the cancel function (element **905**) if all the pending touches were to active devices. If there is a pending message, it must first be cleared before cancelling anything in a stack.

A valid go sentence must include at least two pending touches, one of which is a camera or an active display, a single pending touch will result in an error message since the sentence is incomplete. While various colors are used, those skilled in the art will be aware that colors other than those specifically mentioned can be used to like effect.

As explained above, menu **C4** is achieved by touching the "other" element **908** in menu C3. Menu C4 is shown in FIG. **9D**. Via this menu, the conference leader can return to the dial up instruction menu C2 by touching touch sensitive area **926**, can call up one or more of the review displays by touching touch sensitive area **923**, can call up a conference termination menu by touching touch sensitive area **925** or can call up camera control menu C5 by touching touch sensitive area **922**. For this particular menu a sentence concluded by the go terminator requires one pending touch. As described in connection with FIG. **9C**, a pending touch results in stacking the element, the border of the touched element becoming white, any other white border turns black and is deleted from the stack. Accordingly, touching element **904** activates the function called for by the most previous touch. Assuming the operator has touched touch sensitive area **922**, and then **904**, menu **C5** is displayed. Menu C5 is shown in FIG. **9E**. Menu C5 includes a number of touch sensitive areas. The touch sensitive areas **907**, **903**, **904**, **905** and **906** have already been described in connection with previous menus and they have like effect. The other touch sensitive areas, however, are new. The other touch sensitive areas in menu C5 include elements **927–940**. Elements **929** through **931** control a zoom function on the active camera. Elements **936** through **939** control the focus of an active camera. Elements **932** and **933** allow selection of either the left or right cameras **140**, **141** as the active camera. Elements **934** and **935** allow the saving of a particular preset in one of the two controllable preset positions for each of the movable cameras **140** and **141**. With this menu on the display, the conference leader can select either the left or the right camera by touching either element **932** or **933**. When touched, the touched element color changes to orange, and the other, if orange, changes to white. A re-touch of an orange element turns it to white. When a camera is selected by a touch of element **932** or **933**, the image from the camera is presented on display **131** in the region **927**.

Similarly, touching one of the two preset elements **934** or **935** changes the touched element to orange and if the other had been orange, changes it to white. A re-touch of an orange element changes it to white. When an element is orange it is on the stack, otherwise it is not or removed therefrom. If the save preset legend (touch sensitive area **940**) is selected (by touching the same) after having selected a camera and a preset, the combination of camera and preset is saved.

If after selecting a camera, an element in the zoom or focus field is selected, the touched element changes color for a short time and then returns to its original color. Each touch initiates a message from the computer **133** to the appropriate controller which effects the mechanical change to zoom or focus. If an element in the zoom or focus field is touched in the absence of a camera selection, then the field **904** turns red.

Similarly, if a camera had been selected any of the 8 arrows in the field **927** can be touched. When touched, the element changes color and remains until either that element is retouched or another one of the 8 elements is touched. The computer **133** formats and sends a message to the appropriate pan/tilt controller causing camera movement in the selected direction. The field **927** of display **131** displays the conference room and touching any of the 8 arrows causes the selected camera to pan and/or tilt in the appropriate direction. To terminate the movement, any part of the element **927** is touched.

Touching the go element **904** changes the display to menu C3. Touching the back element **903** displays the previously displayed menu. The cancel element **905** or any other touch element can be used to terminate camera motion. It will also clear any error message or a red **904** field. Touching element **906** does not effect any pending touches but it will clear the red **904** field and/or an error message, and cause the display of an appropriate help menu.

Conference termination is effected via menu **C6**, which is illustrated in FIG. **9F**. As shown in FIG. **9F**, there are only 3 touch sensitive regions in the menu, **903–905**. Touching element **903** displays the previously displayed menu. Touching area **905** can be used to reset

an error message. Touching area **904** terminates the conference and re-displays menu **C1**. As described in the explanatory portion of the menu, the telephone connections previously made must also be broken. While this technique was used in an embodiment of the invention that has actually been constructed, there is no physical reason why touching the element **904** could not be used to formulate a message from the computer **133** to itself terminate the previously made connections to the wide band digital link by providing a port from the computer **133** appropriately connected.

While there are a plurality of help menus which can also be displayed, those menus contain only 2 touch sensitive areas corresponding to areas **903** and **905** of FIG. **9I**, i.e. back and cancel. The effect of touching these elements is as already explained in respect to other menus, i.e. touching the back element causes a display of the previously displayed menu, touching the cancel element cancels the display of any error message.

SOFTWARE

The software to accomplish the foregoing functions can be defined as a message passing software system in which knowledge is isolated within discrete units. The software includes:

1. Initialization and termination software,
2. Data structures that are used by the following three classes of software,
3. An executive which performs traffic management functions. Along with a dispatcher it includes various system services,
4. A set of device handler tasks (DHT) which handle hardware device interrupts; those devices can be input-only, output-only or input and output,
5. A set of application tasks (APT) which arbitrate commands, both between APT's and between an APT and a DHT. Knowledge of device control message formats exists within the APT's,
6. A set of general utility sub-routines which perform functions such as ACSII to binary, conversion, etc.

FIG. **12** is a functional representation showing the interface between several of the hardware components and the software. The hardware components include the cameras **140** and **141**, the left and right side cameras. In addition, the front camera **142** and the slide camera **143** is also depicted. However, since these cameras are fixed, the software interacts with the switch **401**, only, relative to these cameras. Other hardware which is interfaced to the software is the video matrix switch **401**. Finally, touch sensitive screen **134** communicates with the touch sensitive controller **550**. Each of these devices has a dedicated device handler task. In many cases, the device handler tasks are essentially common procedures, however they are personalized for the particular devices with which they interact. Some device handler tasks are arranged for only receiving messages, for example the device handler task **550B** associated with the touch sensitive controller **550** cooperates for information flow only from the touch sensitive controller **550** through the device handler task **550B** to other software. On the other hand, other of the device handler tasks such as those associated with the left and right side cameras **140** and **141** as well as with the video matrix switch **401** cooperate in bidirectional communication in that they both receive information from the associated hardware devices and transmit messages thereto.

At a higher level of software is the application program task. Different application program tasks are arranged to provide for different functions. For example, a single application program task handles camera control, another application program task handles the video matrix switch and a third application program task handles the touch sensitive screen and menu display as well as interpretation of commands.

FIG. **12** also shows the initialization module, an executive module and a plurality of utility procedures.

1. Initialization and Termination

This software is responsible for configuring the software system to represent the actual conference room on system initialization, and for setting the software to room standards before each conference. This function requires several global data structures to represent the system and room configuration. However, inasmuch as the function and the data supporting it are used only for initiation, and do not take part (except in the sense that they define the conference room data) in conference leader manipulations, these functions and data structures will not be described in detail.

3. Executive

The executive is a set of control data structures, the dispatcher and those system procedures which operate on the control data structures.

The control data structures are used for purposes of task execution control, mapped memory addressing and dynamic storage allocation. They contain information such as device-specific parameters, task-specific status, etc.

The dispatcher is capable of both priority and round-robin task dispatching, with any one task being designated as being in one of the two modes. While the dispatcher searches for the next task to activate, interrupts are enabled.

The system procedures (services) consist of a set of functions that may be classified under several categories; some of the services are structured so that they should only be called from either the executive or an APT or a DHT. All services are executed with interrupts disabled.

All executive routines exist in unmapped memory and include:

A. Task dispatching—Tasks are defined as either application program tasks (APT) or device handler tasks (DHT). Since DHT's are activated directly by APT's, the task dispatcher need not activate any DHT's. In addition:

a. A DHT is given control only when necessary, i.e. an inactive DHT (one not engaged in processing) is activated when it needs notification that work is available for it.
b. An APT is dispatched in turn, according to its priority when there is work for it to do.
c. An APT can not be preempted by another APT.
d. All DHT's are higher priority than the highest priority APT.
e. DHT's transmit messages only to APT's.

When the task dispatcher is entered, it searches for an APT that has work to do and is eligible for dispatching. Since the task dispatcher is entered, by definition, when no APT is executing, the routine is not initiated by a data input. The dispatcher is entered instead as a result of the completion of processing by the last dispatched task. The dispatcher initiates a search through a task

control table for the highest priority task eligible to be dispatched. If a priority ordered task is found to be eligible, it is dispatched. Otherwise, a search of round-robin tasks is initiated beginning with the task control table entry following that for the last dispatched round-robin task. The first entry encountered which reflects an eligible task causes that task to be dispatched. The search continues until interrupts/inputs to the system leading to messages to be processed by APT's cause an APT to become eligible for dispatching. In order to dispatch an APT, the dispatcher must transfer the message to the APT. If this is an initial activation, the message is found in the task input queue. If this is a reactivation, reactivation automatically returns the message. The dispatcher also maps the APT so that it is addressable. The dispatcher then executes a context switch using workspace pointer and either the entry point or the suspension address contained in the task control table entry.

The eligibility of a task for dispatching is based on both its input queue and its suspension state. Information on the suspension of a task is maintained within the task control table. A task may be suspended with either a time delay or an action delay. Another table, the action table is utilized to update the task control table whenever an action is complete. The dispatcher writes to the task control table and action control table, and initiates operation of the dispatched APT.

B. Buffer management operates on the use of a single fixed buffer size. Services are available for the dynamic allocation and release of buffers. Buffers are maintained for system usage in a buffer pool. Multiple small buffers may be linked together to form a larger structure.

C. Intertask communication—These services allow one task to communicate with another and provide for the activation of tasks which receive messages from other tasks. These services assume the existence of a dynamic storage allocation scheme.

A subset of these services (in cooperation with the dispatcher processing) allow for the transmission of a communication and either delaying the transmitting task for a time interval or until some specific action has occurred. Such a delay is accomplished via a table of predefined actions and the setting and resetting of these actions as used or unused. A common message format is used throughout the system. Since the buffer management scheme supports just one buffer size, this buffer accommodates any message or is capable of linking multiple buffers together and handling this as one unit.

D. Mapped memory management—There is a requirement to use mapped storage for different types of programs and data (with system services to provide addressability to any such storage):

a. APT's including the "main" program, its application-unique subroutines and its local data constants/values,

b. Large data structures, each of which is of interest to a subset of the application program tasks.

4. Device Handler Tasks

A DHT is that software which handles actual hardware interrupts. It is capable of initializing a specific device, starting output to the device, and handling both input and output interrupts. Although each device has its "own" DHT, the uniqueness of the DHT resides in the device-specific data associated with a DHT, and not in the actual procedural software which may be common to many DHT's. During a particular DHT's execution, interrupts of equal and lower level are disabled.

5. Application Program Tasks

An APT is defined to include the main application program, any application-unique subroutines and all local data variables/constants required. All APT's exist in mapped memory. The dispatcher must be able to determine where in mapped memory the APT resides in order to provide APT addressability. Each APT will be dispatched with its workspace pointer pointing to its own workspace. Upon completion of a particular dispatch, an APT simply transfers directly to the task dispatcher. Any protocol that must be implemented for a specific device is implemented within one APT that has responsibility for the communication with the DHT controlling the device.

6. Utility Subroutines

These are defined to be any procedures invoked by more than one APT. Included are conversion routines and other general utilities, i.e. graphics handling for menu drawing and text handling for displaying error messages. All utility procedures exist in unmapped memory.

The data structures (3) employed by the various processes are described below.

TOUCH-SENSITIVE PANEL INTERFACE

The software interface to the touch-sensitive controller **550** uses the RS232 protocol. All characters in the command are 8-bit ASCII. The message formats (defined below) employ only 3 fields, one field for each of the touch point coordinates (X and Y) and a further field as a message terminator (CR). In the embodiment actually constructed, an input from the touch sensitive controller **550** used 11 bytes, 4 for each coordinate parameter, 1 for a message terminator and 2 blank separator bytes.

VIDEO MATRIX SWITCH INTERFACE AND APT

The interface to the video matrix switch **401** is RS232 half duplex. The message formats (defined below) use an SRC field (to define the source device), a DES field (to define the destination device), an OUT field (to define the output number), a VID field (to define the input video number), an AUD field (to define the audio input number), a V & A field (to define the video and audio number) and finally a final field which is always zero. The signals to the switch **401** can be either single commands or blocks or multiple commands, or salvos, which are merely stored until all are received and then executed simultaneously. A salvo would be used for a bridge with more than one sink since a block has provisions for one source and one sink, only. The salvo NOP is a command that can be used to maintain the switch **401** in a salvo mode (receive but do not execute) without actually sending a real command. Salvo full indicates the switch **401** has filled its salvo storage space. The DES field (output number) defines the output port of switch **401**; the SRC and AUD fields designate the video and audio input ports of switch **401**, respectively. The audio output port need not be designated. Since there is only one (to the audio codec), it is implied. An input from the video matrix switch **401** may be from 1 to 7 bytes in length. The 1-byte messages allow for reset, request block, busy indication, salvo full, a nega-

tive acknowledgement, positive acknowledgement, and a tilt input. A 5-byte message indicates continuation and identifies, in its VID and AUD fields, a video and audio number. Finally, a 7-byte message is an automatic status report including in addition to message identifier (1 byte) and the VID and AUD fields, an OUT field indicating an output number. The microprocessor **133** messages to the video matrix switch **401** can be up to 7 bytes in length. The 1-byte messages allow for reset, start sequence, cancel, execute, salvo NOP, negative acknowledgement and positive acknowledgement. A 7-byte message allows an audio-video split. This message includes a 1-byte message identifier, and OUT, VID and AUD fields. Another 7-byte message is a salvo block which includes an identifier, a DES field and an SRC field with 4 required 0 byte fields. A 5-byte message allows for audio to follow video, including a message identifier, an OUT and V & A fields. Another 5-byte message is a video-only including a 1-byte message identifier, and an OUT and VID fields. The last 5-byte message is an audio-only message including a 1-byte message identifier, OUT and AUD fields. A 3-byte message allows for a status request including a 1-byte message identifier and an OUT field.

The video matrix switch APT **401A** controls the video matrix switch **401** according to the functions selected by the operator. This application task is supported by a source table and a sink table which represent the configuration of the matrix switch **401** at any time. Messages to APT **401A** are sent by the touch sensitive panel APT **550A** and the video matrix switch DHT **401B**. The input/output DHT message format is defined above. The messages received from the APT **401A** are logical commands which identify the devices which must be connected to perform the function requested by the operator. These commands take on two formats. A first format corresponds to an audio command which includes a command identifier (to differentiate audio and video commands) and either a connect or disconnect identifier. The video command may have a plurality of components, one component is an identifier (distinguishing audio from video commands) and a second required component is a source identification. In addition, there is at least one sink identifier (there may actually be multiple sink identifiers). Associated with each sink identifier is an indicator to designate whether or not the particular sink should be connected or disconnected.

At system initialization, APT **401A** initializes the switch **401** and receives a reply indicating that the switch is initialized and able to accept commands. Once operating, the APT **401A** accepts as an input all messages from the matrix switch and matrix switching commands from other software and validates its inputs. In the case of a message from other software, this APT formats the correct switch message to perform the command and outputs them to the switch **401**.

VIDEO CAMERA CONTROLLER INTERFACE AND APT

The interface (DHT's **840B** and **841B** and APT **840A**) to the video camera platform controller (including pan, tilt, zoom and focus) uses RS232; all characters are 7-bit ASCII, the last character of each command is a carriage return (CR). The first character of each command is the device address (which can be preset at each controller). A second character of each command is a message type identifier, and the last character is the CR. Various messages include **8** different fields defined as DA (device address), PAN (pan value), TILT (tilt value), ZOOM (zoom value), FOCUS (focus value), SP (slew pan—left, right or zero), ST (slew tilt—up, down or zero) and CR. The PAN, TILT, ZOOM and FOCUS coordinates are defined in radix **10** ASCII.

The interface will accept messages from the camera controllers up to **10** bytes in length. A 10-byte message defines current PAN and TILT coordinates, includes a 1-byte device address, a 1-byte message identifier, 4 bytes defining the PAN coordinate and 3 bytes defining the TILT coordinate. A 9-byte message defines current ZOOM and FOCUS coordinates including a 1-byte device address, a 1-byte message identifier, a 3-byte ZOOM coordinate, a 3-byte FOCUS coordinate. A 2-byte message from the controller includes a device address and a carriage return indicating execution of a reset. Reset indicates that the controller has lost power and regained power again.

The interface provides for messages to the controller up to 10 bytes in length. A message specifying PAN and TILT coordinates is 10 bytes long, 1 byte for a device address, 1 byte for a message identifier, 4 bytes for PAN coordinate and 3 bytes for TILT coordinate. 6-byte messages are provided for ZOOM or FOCUS coordinate settings. Each includes a 1-byte device address, 3 bytes defining the ZOOM or FOCUS coordinate, a 1-byte message identifier. A 5-byte message is provided for starting or stopping of a PAN or TILT slew. One byte is the device address, one byte is a message identifier, one byte is provided for identifying the message as starting or stopping a PAN, and starting or stopping a TILT. Finally 3-byte messages are provided for requesting PAN and TILT coordinates or ZOOM and FOCUS coordinates. Each of the 3-byte messages include a device address, and a byte to indicate whether PAN and TILT coordinates are requested or ZOOM and FOCUS coordinates are requested.

The APT **840A** provides the actions necessary to position the cameras (in all of PAN, TILT, ZOOM and FOCUS) to either preset or user specified positions; the preset positions include two optional, user defined presets per camera. This APT **840A** is supported by a camera position table (defining current PAN, TILT, ZOOM and FOCUS conditions), and a camera preset table (defining for each of the presets, all of PAN, TILT, ZOOM and FOCUS conditions) for each of the cameras **140, 141**. Messages to APT **840A** are sent by the touch sensitive panel APT **550A** and the video camera DHT **840B** or **841B**. The messages received from the DHT are identified above. The messages received from the touch sensitive APT **550A** are described below.

The messages from the touch sensitive panel APT **550A** include identifier, function code and message content portions. However, the video camera controller APT **840A** accepts only a limited set of such messages. Those messages are either initiate slew, do ZOOM, do FOCUS, go to preset position, set preset position, analyze ZOOM FOCUS return, analyze PAN TILT return or do a reset response.

In connection with initiating a slew, the message identifies the specific camera, a function code for a slew initiate function, and either or both of a PAN slew and TILT slew. In the course of processing, current slew values are obtained and replaced with values given in the command, these command values are then saved. The associated DHT message is effected to do a slew.

As will be described below, when a "do slew" message is received at a camera controller, it initiates a slew (either in PAN, TILT, or both) and motion continues until the message is removed. As will be described, the message is removed by retouching a touch sensitive area. Accordingly, an initiate slew message will initiate the appropriate motion which will not be terminated until the message is removed. When a slew command terminates, pan and tilt slewing is sent; it is followed by a request for position (to determine where the camera has stopped). The reply values are used to update position tables.

The "do ZOOM" also has four components, two identify the specific camera and the particular command. A third component is the step size of the ZOOM (either large or small), and the fourth component is the direction (either in or out). In the course of processing, the change in ZOOM desired is calculated. Based on the current ZOOM value in the camera position table and the command (in or out with large or small step), a new ZOOM position is calculated, and then checked to guarantee it is valid. Assuming it is, the associated DHT message is performed requesting the ZOOM step for the specified camera of the calculated value.

The FOCUS command is essentially identical to the ZOOM command except that of course the function code identifies a FOCUS step rather than a ZOOM step.

The go to preset position command includes three components: a camera identifier, a function code identifying the command, and the parameters identifying the preset position. In the course of the processing, the preset PAN and TILT values for the particular preset are obtained and a DHT message is output transmitting those parameters. In a separate operation, a preset ZOOM value is obtained and an associated DHT message is output. Finally, a preset FOCUS value is obtained and the DHT message transmits that information to the camera controller. Of course, the preset position parameters are obtained from the camera preset table.

The set preset position message includes three similar components, i.e. camera identification, command identification and preset value. However, in the course of processing, the only output is to write to the camera preset table (i.e. no command is actually transmitted to the camera controller).

The analyze ZOOM/FOCUS return is initiated in response to a message passed by the associated DHT. This a four-component message including device identification, a function code (identifying the command as an analyze ZOOM/FOCUS), a ZOOM parameter and a FOCUS parameter. In the course of processing, these ZOOM and FOCUS values are written to the camera position table.

Similar action occurs in response to the analyze PAN/TILT return except that of course the PAN/-TILT values are written to the current position table.

In response to a reset message passed by the associated DHT, the APT **840A** initiates the associated DHT to get the PAN/TILT and ZOOM/FOCUS values from the camera controller.

MENU MANAGEMENT

The most significant APT in connection with the control subsystem is the menu request handler which is the principle means of communication between the operator and the remaining apparatus. When the operator or conference leader touches the touch sensitive screen **134** at the location of an element displayed on the console video display **131**, the touch sensitive screen **134** and controller **550** generates a message giving coordinates of the touched point. The menu request handler **550**A receives this information and must interpret it with respect to:

the element currently being displayed at or near the touch point,

the status of the particular element touched,

other touches made before or after this particular touch.

Ultimately, the touch or touch sequence results in one or more system function routines being invoked to satisfy the request. The touch may result in a status change for the particular element and may even cause a new menu to be displayed in which case the context for interpretation of subsequent touches is changed. Touch sequences for a particular menu are specified according to a logical "grammar" which defines valid relationships between the various classes of elements on a menu (the syntax), and the interpretations or actions to take as a result of a grammatically correct sentence (the semantics). Since the element relationships may vary from menu to menu, each menu may have its own associated grammar.

In order to implement the menu request handler, a plurality of data structures are used including:

1. A menu dictionary (MDT) which contains fixed length entries defining the general characteristics of each menu, general menu status information, grammar definition, image control block, and the address of the menu control table defining the individual elements of the menu.

2. The menu control table (MCT) which contains an entry for each element on the menu. This entry includes position, status flags, syntactic class of the element (used in determining valid touch sequences), colors associated with various status conditions, the address of the display element library entry containing the command string used to draw the element and text information, and the address of system function routines to be executed when the element is touched (immediate) or used as part of a sentence (delayed).

3. A display element library (DEL) which contains command strings used to draw elements, as well as information for sub-elements such as border and body.

4. A text library (TEL) which contains text associated with various elements.

5. Entity status (EST) table containing information about entities in the system (such as the various devices, etc.) whose status transcends the menu elements which are currently displayed. Elements on several menus may refer to the same entity.

6. Element stack which is the primary control mechanism within the menu request handler. As elements are touched, they are placed on the top of the element stack. Procedures associated with the top element on the stack cause elements to be removed, added or in the case of the lexical scan procedure, completely redefined. Upon completion of each procedure, the top of the stack is checked and any procedure which is required is executed. This procedure continues until the element stack is empty or the top element is not executable, i.e. it is a sentence element or a delayed element.

The foregoing data structures enable the microprocessor **133** to draw the first menu on system initialization. Depending on operator touches then, and based on the menu actually displayed, the system can interpret the operator touches to change the status of the menu

being displayed by changing the display of one or more elements under the menu, changing the menu being displayed entirely, and/or determining and formatting messages to appropriately connected devices to change the condition of the device. For example, cameras can be turned on or off, zoom, focus, pan/tilt (this can be altered), the video matrix switch **401** can be altered so that an image from any one of the cameras can be transmitted, a received image can be directed to any one of the displays and the audio system can be enabled/disabled.

MENU ASSOCIATED SOFTWARE

The software which allows the conference leader to interface with the system, to produce the appropriate menus on the control console **130**, respond to conference leader touches and properly interpret those commands to ensure compliance with grammar to effect the desired control actions including redrawing menus includes seven functional areas, specifically:

1. Initialization;
2. Touch interpreter;
3. Menu management;
4. Message management;
5. Support routines;
6. Action routines;
7. Menu Tables.

These functional areas will be described, however a general narrative is provided to link the various functional areas.

During initialization or start-up, the menu tables are set to their default values and the first menu is drawn. The software then goes to into an inactive state waiting for a touch to be received from the touch sensitive controller **550**. Once a touch is received, it is converted into x-y menu coordinates and sent to the touch interpreter. This module (2) determines which menu element, if any, was touched. It completes its task by placing the touched element on an element stack (a buffer area reserved for this function) and setting its immediate action flag.

Next the element stack is processed. This processing function is described below.

After the element stack is processed, the software then returns to an inactive state waiting for the next touch.

The element stack processing performs the following functions:

1. If the element stack is empty, then go to line **5**.
2. Get the element on the top of the element stack.
3. If the element immediate action flag is set, then call the appropriate immediate action routine; go to line **1**.
4. If the element delayed action flag is set, then call the appropriate delayed action routine; go to line **1**.
5. If the pending menu flag is set, then draw a new menu.
6. Exit.

FIG. **10** shows this processing in typical flow chart form wherein each block of the flow chart has a reference character corresponding to the appropriate line numbers **1–6**. The particular routines called at functions **3***a* and **4***a* depend on the particular element placed on the stack as well as the current menu on the screen. Likewise, the particularly new menu drawn at function **5***a* depends on the conditions under which the pending menu flag was set, i.e. the particular menu on the screen and the circumstances under which that flag was set.

1. Initialization

This function is performed each time the first menu (i.e. the menu shown in FIG. **9**A) is drawn. During this initialization, all menu tables (defined below) are reset to their default values, all active equipment is disconnected and all counters are reset. The initialization function is handled by the following procedures:

INTMHR
MINIT
SINIT

2. Touch Interpreter

All screen touches are sent to the touch interpreter module. The touches are converted to the touched element number. The touch controller **550** provides to the software the X and Y coordinates of the touch. By comparing the touch coordinates with the particular menu on the screen, the software can determine whether or not a particular element on the menu has been touched. If the touch location did not correspond to any element, the touch is ignored. If the touch corresponds to an element, but that element for some reason is considered insensitive, the touch is also ignored. Under other circumstances, the particular touched element identification is placed on the element stack. During this process, the element stack is scanned and all active action routines are called in the proper order. The touch interpreter module employs the following procedures:

CCTSPI
FINDEL

3. Menu Management

All functions concerning the drawing of the menus, changing of the individual menu element appearances (color of body and border, etc.) fall into the menu management module. The procedures employed by this module are:

DRMENU
GDELAD
LHERE
RDMENU
DREL
DELEM
CBORD
CBODY
CTEXT
ZAPOUT

4. Message Management

As described above, the software is compartmentalized and information is passed from one modular procedure to another via messages. Accordingly, one component of the software handles message management. In addition, the message management module contains a library of all messages which is displayable on the conference leader's CRT **131**. This module consists of the following procedures:

GRMST
ERRDSP
ERRERS
GMSGAD
MSGDSP

5. Support Routines

The support routines are or can be used by any procedure within the software system. Generally, the criteria

used for a procedure's inclusion as a support routine is that it is used by two or more procedures within different modules. The following procedures are included as support routines:

SLCTME	COMPRS
PREVUE	GMADDR
STDFLT	MNEXT
FINDIT	TOUCH
EXECIT	ESTADD
BACK	MHRMAP
HELP	GACTAD
SRTES	GMCTAD
LEXSCN	GTELAD
RESET	CHELEM
ZAPCAM	REFSTK
LSENDS	

6. Action Routines

The system action routines implement all of the functions provided by the menus. Each touchable menu element has associated with it an immediate action routine (to be executed immediately upon its being touched) and it may also have a delayed action routine. The delayed action routine will be executed only if its delayed action flag is set. This flag may be set by immediate action routines or by other delayed action routines. The following procedures are included in the action routine module:

IAR001–IAR008
IAR010
IAR011
IAR013–IAR028
I19A00
RSTPST
DAR001–DAR004

7. Menu Tables

The menu tables are part of the data structure with which the procedures listed above are run. The menu tables are used to describe menus (content and format), maintain current status of all menu elements and maintain status of all teleconference equipment. The menu tables are:

MDT
MCT
CIT
EST
DEL
TEL

Before describing the procedures in detail, the format and content of the six tables referred to above will first be described.

MENU DICTIONARY TABLE (MDT)

The Menu Dictionary Table contains one entry for each menu. Each element within an MDT entry is explained in the following paragraphs.

Field	Description
MDID	Menu number. MDID contains the identification number of the menu.
MDPM	Previous menu number. MDPM is used to maintain a link backward to the previous menu drawn.
MDNM	Next menu number. This field contains the menu number (MDID) of the menu which will normally be drawn after this menu. In other words, it is the forward menu link.

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Field	Description
MDNMM	Next menu modified. This field is used by the system when it needs to alter the normal menu sequence.
MDICB	Menu location. MDICB is not currently used by the system actually constructed but may contain a flag indicating the current location of the menu.
MDNEL	Number of menu elements. Field MDNEL contains the number of menu control table elements required to describe this menu.
MDRFFU	Menu flags. This field is not currently used by the system actually constructed.
MDHELP	Help menu number. MDHELP contains the menu ID (MDID) of the general help menu associated with this menu. Menu number MDHELP will be drawn when the menu help key is touched.
MDMCT	Menu MCT address. Field MDMCT contains the address of the first menu control table element for this menu.

MENU CONTROL TABLE (MCT)

The Menu Control Table contains a set of elements for each menu defined in the Menu Dictionary Table. Each MCT element defines some portion of the menu to which it is assigned. Each element within an MCT entry is explained below.

Field	Description
MCID	MCT element ID number. This field contains the element ID.
MCCST	Current status. MCCST is used to maintain and track the current physical attributes of the element. Each bit in MCCST corresponds to an attribute. Attributes are border, body, insensitive, inhibit and text. Each can be on or off.
MCNST	Next status. The system uses this field to set the next (pending) status of the element, each attribute has a bit. By comparing this field to the current status field the system knows which attributes have changed.
MCDST	Default status. This field contains the default (initial) status of the element. The attributes contained in the default status govern how the element will be initially drawn and treated by the system. The bits within the status byte are set or reset according to which attributes are on or off.
MCSC	Syntactic class. Field MCSC contains the class of the element. This field is used to determine the syntactic correctness of a string of touched elements.
MCDEL	Del ID number. This field contains the ID number which corresponds to the shape of this element. MCDEL is used as an entry to table DEL (Display Element Library). A brief review of FIG. 9C indicates a variety of shapes of elements which can be drawn.
MCRFFU	This field is not currently used by the system actually constructed and is reserved for future use.
MCEID	Entity ID. This field contains a number which the system uses to access this elements entity record. Generally only touchable elements have non-zero MCEID fields.
MCIACT	Immediate action routine. Field MCIACT contains the number of the immediate action routine to be executed immediately after this element has been touched.
MCDACT	Delayed action routine. Field MCDACT contains the number of the delayed action routine to be executed for this element when its delayed action flag is set.
MCCON	On color. MCCON contains the color which will be used to fill the element when it is on. If this field is set to black, then the color in the

-continued

Field	Description
	element entity record will be used as the on color.
MCCOFF	Off color. MCCOFF contains the color which will be used to fill the element when it is off.
MCCUR	Current color. This field always contains the current color of the element.
MCCTXT	Text color. This field contains the color in which the element's text will be drawn.
MCHELP	Help menu number. Field MCHELP contains the menu ID (MDID) of the menu (if any) which will provide additional information on the use or functioning of this element.
MCTSZE	Text size. This field governs the size of the element's textual characters. Three sizes are allowed, normal, twice normal and three times normal.
MCXHR	X coordinate. Field MCXHR will be the X coordinate of the upper left corner of the region in which the menu element will be drawn.
MCYHR	Y coordinate. Field MCYHR will be the Y coordinate of the upper left corner of the region in which the menu element will be drawn.
MCTEX	Text ID number. This field contains the Text Library's index of the text string for this element.

ENTITY STATUS TABLE

The Entity Status Table (EST) maintains additional information on important menu elements. Criteria for inclusion of an element into the EST is varied. Any item (such as the mike key **907**) whose status must be known across several menus should be represented by an entity. Any element which represents something physical and is capable of action should also have an entity entry. Actually, any element can be represented in this table is the user has some reason for it. This table also contains sufficient information so that conflicting touches can be recognized and corrected. Entity record elements are described below.

Field	Description
ESID	Entity ID. This field contains a number to identify the entity. This is the number which links these records to the menu control table.
ESTYPE	Entity type. Field ESTYPE contains as assigned type value for this field. It is primarily used to differentiate control entities from controlled entities.
ESCB	Entity controlled by. ESCP is used by the system to link controller entities (a camera) to the controlled entities (a monitor).
ESCOLR	Active color. This field is used to assign an on color to controller entities. Entities which are controlled will assume different ESCOLRS as they are controlled by different controllers.
ESFON	On flag. This field contains a 1 when the entity is active (on) and a zero when it is off.
ESFPRE	Field ESFPRE contains a 1 when the entity is present and a zero when it is not present. When ESFPRE is off (contains a zero) the entity will not be drawn on the menu.
ESOFD	On flag default. This field contains the default value for the ESFON field.
ESPFD	Present flag default. This field contains the default value for the ESFPRE field.
ESFLD 1 ESFLD 2 ESFLD 3	Entity specific values. These fields are used to maintain information specific to the entity. The user may store any values in these fields needed by the action routines to make their functions simpler.
ESINIT	Initialization value. This field is set from the Conference Initialization Table and is used to pre-configure the master menu (conference room).
ESCONF	Entity conflict word. Each controlling entity has a unique power of two conflict value. Controlled entities have conflict values equal to the sum of conflict values of their possible controllers.

DISPLAY ELEMENT LIBRARY

The Display Element Library (DEL) contains the definition of all element shapes used in the menus. Since each DEL entry is variable in length, an element index is also maintained in the DEL. The items within each DEL entry are described below.

Field	Description
DEXTOL	X tolerance. This value determines the X-axis extent of the touch sensitive zone surrounding an element. The touch zone is rectangular in shape and has DEXTOL points in the X direction.
DEYTOL	Y tolerance. This value determines the Y-axis extent of the touch sensitive zone surrounding an element. The touch zone is rectangular in shape and has DEYTOL points in the Y direction.
DENSE	Number of sub-elements. Each element may consist of several sub-elements. A sub-element may be a border, body or another type. This field contains the number of such sub-elements.
DERFFU	This field is not currently used by the system actually constructed and is reserved for future use.
DECLAS	Sub-element class. This field contains the sub-element class. A border is class one, a body is class two and if neither a border or body the class is set to three.
DEXFIL DEYFIL	X-fill, Y-fill. The point (DEXFIL, DEYFIL) is the coordinate where filling (coloring) of the element begins. These coordinates are based on the element origin being the MCT values (MCXHR, MCYHR).
DEXTXT DEXTYT	X text coordinate, Y text coordinate. The point (DEXTXT, DEYTXT) is the point around which the text of the element is centered horizontally.
DEGS	The final DEL record entry is the graphic string which describes the element's shape.

TEXT ELEMENT LIBRARY

The Text Element Library (TEL) contains an index table (TEX) which has pointers to each text element within the table. Each text element consists of three parts which are described below.

Text Length

This field contains the length (in bytes) of the text string.

Text String

This field contains the string of text to be drawn. A pound sign imbedded within the text will cause a line feed/carriage return, thus causing the next character to be under the first character of the string. Text strings in the embodiment actually constructed must not exceed **512** characters in length.

Text String Terminator

This field must contain the command string terminator character.

CONFERENCE INITIALIZATION TABLE

The Conference Initialization Table (CIT) contains information which is specific to each teleconference

installation. This information consists of camera presets (both location and number), master menu equipment defaults and a corporate logo. The fields within the CIT are described below.

Camera Presets

The first section of CIT data concerns the cameras and their presets. For each camera there is one data word containing the number of presets for this camera. After this data word follows three data words for each preset assigned to this camera. The first two words contains the menu coordinates for the preset and the third word contains the color of the background on which the preset will be drawn. After each set of presets, the next camera record appears.

Master Menu Defaults

The next set of CIT data contains the master menu default commands. These commands are entered as a string of entity ID's in the same format as if you were touching the elements.

Corporate Identification (LOGO)

Following the master menu default commands may be one DEL-like entry defining an element to be drawn on the first menu. This entry has a structure identical to any display element library entry. It is used to personalize the menu of FIG. 9A by producing user identification in the blank region.

TOUCH INTERPRETER

Having discussed the data structures, reference is now made to FIG. **11** which shows the system response to a touch of the touch sensitive screen. Function F1, in response to a touch, first transforms the touch coordinates (X, Y) to display coordinates and then searches for the element touched using MCT and DEL. This function is performed by a process FINDEL. By reference to the MCT and DEL, the system can determine if an element on the menu was touched by comparing the element's display coordinates (and tolerance) with the display coordinates of the touch. The data tables also determine whether the element is sensitive or insensitive to a touch. At the completion of the processing, function F2 determines if the element touched was found (the system assumes that an insensitive element was not found). Accordingly, if no touched element was found, the system returns, i.e. no response is made to the touch. On the other hand, if at function F2 it is determined that a sensitive touched element has been located, then function F3 places the element on top of an element stack ES and sets the immediate action flag. As shown in FIG. **11**, the element stack may include a number of entries, each succeeding entry is placed on the top of the stack, and certain of the processes as described below will pop the stack (i.e. delete the top entry, and move every other entry up one location). Each entry in the element stack includes three important components, first the element ID and two flags, a delayed action flag and an immediate action flag. As is described in function F3, when an element is placed on the stack, its immediate action flag is set.

That terminates the processing shown in FIG. **11** and the succeeding processing has already been explained in connection with FIG. **10**.

To give a few brief examples to illustrate operation of the system, let us assume that the system is initialized, and the menu being displayed is the initial menu (shown in FIG. 9A). Let us also assume that at the time the menu is displayed the operator does not desire to review procedures and therefore proceeds to touch element **902** (NO). As a result of the processing shown in FIG. **11**, when the element (902) is found, it is placed on the element stack with its immediate action flag set. In the course of the processing of FIG. **10**, function **3** finds the immediate flag set and therefore function **3***a* calls the corresponding immediate routine. That immediate action routine (IAR002) sets the parameter PDMENU as the next or second menu and the element stack is reset. Thereafter, function **5** finds the pending menu set and thus function **5***a* calls the process draw new menu (DRMENU, the procedure CCTSPI sets parameter RQMENU to PDMENU and then calls DRMENU). Accordingly, as a result of that touch, the next menu (shown in FIG. **9B**) is drawn. At that point, assuming that the appropriate connections are established, the operator can merely touch element **904**. The FIG. **11** processing proceeds just as before except now the identification of element **904** is placed on the element stack with its immediate flag set. The processing of FIG. **10** produces a call to the appropriate immediate action routine (IAR004). This procedure first pops the stack, i.e. removes the element **904** from the element stack, then checks to see if there is a pending error message. If there is, procedure GRMST is run, on the other hand the procedure MNEXT is run to get the next menu number. The parameter PDMENU is set to the next menu number. In the course of processing of FIG. **10**, function **5**, seeing the pending menu set, calls DRMENU to draw the new menu, i.e. the master menu shown in FIG. **9C**. FIG. 9C does not show the different colors of the different elements in the menu, nor does it illustrate the manner in which the defaults affect the menu. For example, assuming that the front camera (represented at the element **918**) is selected under default to send, then the color of the camera represented at **918** and the color of the send element **911** are common. Similarly, if we assume that under a default condition, the received image will be located on the front display represented at **919**, then the color of the receive element **909** and the color of the front display **919** will be identical.

At this point, let us assume that the operator desires, instead, to transmit the image from the left camera (represented in the menu at **914**) and to locate the image that is being transmitted on the front screen represented at **919**, and at the same time display the image being received on the side displays represented at **915**, **916**. The operator could proceed by first cancelling the default conditions and then establishing the conditions that are desired. However, that is not necessary. He can for example, touch elements **914**, **919**, **911** and **904**. This will, as will be explained, turn on the camera represented at **914**, place its image on the display represented at **919** (and cancel the image previously present there) and transmit that image (and impliedly cancel the transmission from the camera represented at **918**). He can then, in addition, touch elements **915**, **916** (selecting the side monitors), the element **909** (to indicate that the received image is to be displayed on the touched monitors) and then touch element **904** to implement the command.

Following our example, when the operator touches element **914**, the processing shown in FIG. **11** will be performed to place a representation of element **914** on the element stack and set its immediate action flag.

Function 3*a* in FIG. **10** will call the appropriate immediate action routine. The immediate action routine associated with a camera is IAR011. This procedure performs a number of functions. Firstly, it runs the procedure SLCTME. SLCTME examines the element stack to see if the element on top, i.e. the most recently touched element, conflicts (a first touch mutually exclusive of a second, i.e. two sources) with any other element on the stack. If a conflict is found, then it is deleted.

After eliminating any conflicting touches (including a retouch of the same camera), the procedure ESTADD is run. This procedure obtains the entity status table address. Thereafter, the procedure TOUCH is run. The procedure provides for changing the border of an element to reflect its now-touched status. For example, if the element border had been on and it is touched, the element border is turned off, and vice versa. Following manipulation of the border display, the procedure COMPRS is run to eliminate duplicate touches. Then, the menu is redrawn to reflect the new status.

Accordingly, a single touch of the element **914** results in placing it on the element stack with its immediate flag set, and the immediate action routine provides for eliminating any prior conflicting touches on the stack and changing the menu to reflect the touched status of the element **914**.

In our example, we further assume that the operator had also touched the send element **911**. The processing of FIG. **11**, in response to this touch, firstly puts the send element on the top of the element stack and sets its immediate action flag. The routine called in response to this touch checks for conflict and then reverses the color of the border.

Finally, the operator touches the go element **904**. The immediate action routine for this element is IAR008. The first step in the procedure is to pop the stack, i.e. remove the representation of the go key **904**, leaving the previous touches in the order in which they were touched. Assuming there are no error messages and the stack is not empty, then the procedure LEXSCN is run.

This procedure first runs COMPRS. This procedure is used to remove all double touches from the stack. Thereafter, the procedure SRTES is run. The procedure sorts the element stack by the syntactic class (field MCSC) of its elements. This is done so that the lowest syntactic class element will be on the top of the stack. This is required to ensure that sources are processed first.

After running SRTES the stack is examined. The first test effected is to check if the syntactic class of the top element is 2 and the number of elements in the stack is 1. If these conditions are true, an error is detected and a particular error message is selected and a procedure (GRMST) is run to display the error.

On the other hand, if the syntactic class of the element is not 0, then a procedure ESTADD is run to obtain the entity status table address. Once determined, the field ESCB is examined. Ordinarily, a source is a camera. However, a source can be a sink if the particular sink is presently controlled by a source. In that event, the controlling source becomes the (implied) source. Accordingly, if two sinks are identified without a source, an invalid command may be declared unless at least one of the sinks is presently controlled by a source. For this reason, the CB field of EST may be checked. Assuming the LEXSCN routine does not detect any errors, i.e. it verifies the syntactic correctness of the sentence that has been constructed, then the parameter LEXRC is returned at 0. This enables IAR008 to set the delay flag of the top element of the stack. With the delay flag set, then function 4*a* (FIG. **10**) calls the appropriate delayed action routine.

The delayed action routine, to make a source-sink connection is DAR001.

The processing in DAR001 begins by running the procedure GMSGAD. This procedure gets the message address of a specified request block message; in this case a connect message. The processing then sets a parameter SOURCE to the top menu stack element. The prior running of SRTES and COMPRS assures that first there are no conflicting elements, and more particularly in this case, there is one and only one image source. If there had been more than one source which had not been eliminated as a double touch, then the running of LEXSCN would not have indicated that the element stack was appropriate. Finally, the running of SRTES sorts the stack such that the top element is the source. The processing sets the next display condition for the border of that element as off. As described above, when the element is pending the border is on, and when the connection desired by the operator is made the border turns off. It is the processing here which assures that the border will be off after the appropriate connections have been made.

Thereafter, the processing writes the entity status for the element its status as being on. The color of the particular element is selected and then the next element in the stack is processed, by popping the first element or source off the stack.

The processing thereafter ensures that the color of the next element on the stack matches the color of the source element and ensures that its entity status table reflects its condition as on. The next condition of the body is set to off.

Thereafter, if the source element touched was a camera, then the parameter PRESET is set true if a preset was also touched, and false if it was not touched. The processing then loops through to write in the entity status table the field ESTCB, ESTFON, ESTFPRE. The procedure ZAPOUT is run to erase the image of the preset in the display. This loop is repeated for each preset that had been displayed.

At the conclusion of the processing, the procedure LSENDS is run.

This latter procedure ensures that all active sources have at least one active destination. Alternatively, the procedure ensures that all active destinations have an active source. If either of these conditions is violated, the procedure turns off the equipment and then changes the menus so that it will reflect the current state of all equipment.

With the message parameters determined, SYSREQ directs it to be sent by the appropriate DHT.

Whenever the master menu (shown in FIG. 9C) is displayed and one of the movable cameras (represented at elements **914** or **913**) is touched, the associated immediate action routine (IAR011) checks the number of presets available for the camera (found in FLD1 in the camera's entity status table). This information is written into the menu control table for the camera. Thereafter, each of the presets is displayed.

Once the presets are displayed, the operator can position the camera to any selected one of the presets by merely touching the associated preset. The immediate action routine implementing touching of a preset key is

IAR014. This routine allows only one preset to be touched at a time, if a second preset is touched, then the first preset is turned off. When IAR014 is run, it sends a message to the camera control to go to the selected preset. This is effected prior to the time the operator touches the sentence terminator element 904 or go key.

If the desired video image is not available by pointing the camera to any one of the presets (and in an embodiment of the invention which has actually been constructed, 6 presets are considered defaults and are always available—for each camera) the operator can manually position the camera using the teleconferencing control system. This is effected by the menu shown in FIG. 9E. This menu is reached, from the main menu (shown in FIG. 9C) by touching the other touch element 903. This tests the parameter PDMENU to the "menu of menus", and the procedure reset RESET is run to eliminate all pending touches and the element stack is reset. When the routine is completed, the "menu of menus" is provided on the display; this is shown in FIG. 9D. With this menu displayed, the operator can proceed to the manual control menu by pressing touch element 922 invoking IAR005.

That action will provide on the display the camera positioning menu shown in FIG. 9E. With this menu, the operator can select either the left or the right camera by selecting touch element 932 or 933. Once a camera is selected, the operator can alter the zoom conditions with the touch elements 928–931, vary the focus parameters with the touch elements 936–939, move the camera in pan or tilt coordinates by selecting one of the arrows in the touch field 927. When the camera is properly positioned, the operator can either leave it there or store the position as one of two available presets by selecting either the touch element 934 or 935.

When either of these two latter touch elements is touched, it is of course placed on the stack and the immediate action routine executed is IAR019. In accordance with this proceeding, the display is first altered so that all the elements shown on the display are turned off. Thereafter, any camera motion in effect is terminated. Thereafter, the touched camera is turned on and the APT 840A is initialized. Thereafter, the selected camera is connected to the control terminal display (via immediate action routine IAR019A) so that the video image produced by the camera can be checked by the operator. Then the menu is redrawn to indicate which camera is on, i.e. one of the two camera element representations 932 or 933 is illuminated in the appropriate color to indicate the camera which has been selected.

If at this point in time the operator desires to alter the zoom parameter of the camera he has selected, he operates one of touch elements 928–931. The immediate action routine associated with one of these keys is IAR023. The first function here is to check that a camera has previously been selected. If a camera has been selected then a zoom message is constructed. To construct the zoom message, the camera's present zoom parameter is checked and then a table is entered depending on the particular zoom element touched to determine the desired zoom parameter by summing the present zoom parameter and the increment. When the desired zoom parameter is determined, the message is transmitted. Finally, the menu is redrawn so that the zoom key is on. After a predetermined period, the menu is redrawn so that the zoom key is off. This provides feedback to the operator to indicate that the selected zoom step has been effected.

The operational response to selection of a focus control is essential identical to that described above except that the immediate action routine employed is IAR024.

If the operator desires to alter the camera positioning in terms of pan/or tilt, one of the arrows shown in the field 927 is touched. This calls the immediate action routine IAR025.

The processing effected here first checks if a camera has been touched; absence of a preceding camera touch is in error condition which produces a display of an error message. Otherwise, the camera slew message format is obtained. Thereafter, the system determines if the camera is already in motion and this is a stop message. If that is the case, then the off value is put into the message and sent. On the other hand, if this is the first touch, i.e. the operator desires to initiate a pan/or tilt, then the slew message value is obtained depending on the touched key, and the message is transmitted. As described, the first touch will initiate pan/tilt movement which will continue until such time as a second touch is effected.

Once camera motion has been initiated, the operator can terminate that motion by selecting any touch element on the menu. For example, if the operator selects the go element 904, camera motion will also be terminated and the next menu will be displayed. The immediate action routine effecting this is IAR026.

From the foregoing, it should be apparent that the invention provides a teleconference control system which can be used by relatively unskilled operators. The processsor 133, its associated software and the touch sensitive controller 550 provide the system with a control flexibility which cannot be duplicated by any fixed control panel. More particularly, the operator is relieved of the burden of knowing the correct sequence in which an action must be implemented, because the sequence is inherent in the menus and the menu sequence. The operator is further relieved of the burden of remembering the rules for altering camera position, bridging sources and sinks, etc. Again, these rules are inherent in the software; if the operator violates one of the rules and/or attempts to initiate an impossible or inconsistent command, the intelligence inherent in the software will prevent the attempt and in most cases indicate by means of an error message, the particular error that has occurred. To give a few brief examples, for example if the operator selects mutually exclusive devices, i.e. he touches two different sources in a single command sentence, the system will automatically eliminate the first touched source on detection of the touch of a second source. If the operator attempts to initiate a command sentence without the necessary components, at least one source, one sink and the message terminator, the system will refuse to proceed. However, the system is also flexible enough so that unnecessary exactness is not required. For example, if the operator desires to add a new sink to a previously existing bridge, he need only identify, in addition to the display sought to be added, any element of the preexisting bridge.

Not only does the processor 133 respond to appropriate touches for formatting information to control the devices (e.g., the matrix switch 401 and the movable cameras 140 and 141), but in addition provides the operator with feedback by altering the status of the display 131. Accordingly, applicants have provided, for the first time, a relatively simple teleconferencing system which is capable of use by relativley unskilled operators and yet provides effective teleconferencing in provid-

ing to the conference participants the feeling of a lack of distance separation between them, notwithstanding their actual physical separation.

We claim:

1. A teleconferencing system adapted to be connected by a wide band digital communication link for allowing relatively unskilled operators to control a teleconference; comprising at least a pair of teleconferencing site means for transmitting and receiving audio and video representing digital signals therebetween, each said site means comprising:

at least a pair of controllable video source means for deriving a video signal from controllable regions of the associated site,

audio signal source means for deriving an audio signal from the associated site,

at least a pair of video displays for controllably displaying either locally or remotely generated image,

audio transducer means responsive to a remotely generated audio signal for generating perceptible sound,

interface means for coupling digital representations of locally generated audio and video signals to said communication link and for coupling digital representations of remotely generated audio and video signals from said communication link,

control means including a digital microprocessor and video matrix switch means with plural video inputs and outputs for controllably coupling at least a locally generated video signal to said interface means and for controllably coupling locally and/or remotely generated video signals to said video displays,

said control means, including a control video display and touch sensitive screen for controlling said video source means and video matrix switch means in response to touches on said touch sensitive screen by an operator, said control means including:

logic means for interpreting commands initiated by operator touches of said touch sensitive screen and for thereafter implementing said commands if elements of said commands are consistent with each other and with available resources, and message formatting means responsive to said logic means for formatting digital messages destined for said video source means and said video matrix switch means,

whereby unskilled operators can control said teleconferencing site means.

2. The apparatus of claim 1 wherein each of said video source means includes:

a motor driven platform for motion in pan and tilt directions,

a motor driven lens controller for altering camera lens parameters in zoom and focus,

a camera controller for operating said motor driven platform and lens controller in response to digital messages from said message formatting means.

3. The apparatus of claim 1 wherein said video matrix switch means includes a video switch matrix controller responsive to messages from said message formatting means for selectively making or breaking conductive connections between input and output terminals of said video matrix switch means.

4. The apparatus of claim 1 in which said logic means includes:

menu drawing means for outputting video signals to said control video display for depicting a current menu as one of a plurality of menus,

menu handler means responsive to an operator touch and to data representative of a current menu and to data representative of prior touches for:

(a) initiating redrawing of said current or a different menu, and/or

(b) outputting a message to one or more selected devices, selected from the group consisting of video source means, or video matrix switch means, or

(c) storing data representative of said operator touch.

5. The apparatus of claim 4 in which said logic means includes:

lexical scan means initiated by a selected touch to examine stored data representative of prior touches for determining logical consistency of said prior touches and for outputting either:

(a) an error message indicating logical inconsistency, or

(b) device control messages to one or more devices to control said devices to conform to a logically consistent sequence of touches.

6. The apparatus of claim 5 in which said logic means includes means for retrievably storing:

a menu dictionary table with an entry for each menu, each entry defining forward and reverse linkages to other menus, a quantity of elements within a menu and a linkage to a menu control table,

a menu control table including an entry for each menu, each entry including a number of elements including said menu, each element including data definitive of element attribute current and pending status, a link to a display element library, a link to immediate and delayed action routines, data definitive of elements syntactic class and data definitive of element coordinates within said menu,

an entity status table with an entry for selected menu elements, each entry including data definitive of element type and a link defining controller elements,

a display element library with an entry for each elemental shape including data representing a number of sub-elements, sub-element class, coordinates representing element location and a string for element display.

7. The apparatus of claim 5 in which said logic means includes:

means for building an element stack including touch responsive means to identify a touched element and means for storing a representation of that element in a stack including means for setting an immediate action flag associated with said element on said stack,

means for examining said stack for running an immediate action routine in response to a set immediate action flag associated with a top element on said stack.

8. The apparatus of claim 7 in which said logic means includes:

a set of immediate action routines associated with different system elements, said immediate action routines representing physical devices effecting removal from said stack data representative of any identical elements.

9. The system of claim 1 wherein said logic means includes:

first means responsive to a touch on said touch sensitive screen for generating a digital signal representing coordinates of said touch,

second means responsive to an indication of present menu display for identifying a touched element on said menu and for passing a representation thereof to an element stack means,

element stack means for stacking in sequential order element representations passed from said second means and thereby maintaining an element stack,

terminator touch responsive means responsive to a selected touch for scanning said element stack to:

eliminate doubly touched elements,

sort said elements into an order determined by element function,

and for ensuring that said stack represents no more than one video source, and at least one video sink if a video source is present,

said message formatting means responsive to said terminator touch responsive means for formatting said messages.

10. The apparatus of claim 9 in which said logic means includes:

bridging means to associate all elements on said element stack on successful operation of said terminator touch means, and

menu drawing means to redraw a menu after successful operation of said terminator touch responsive means with associated element represented by a common color.

11. The apparatus of claim 1 in which said logic means includes:

camera selection touch means responsive to a touch in one of two touch areas to select one of said cameras,

zoom touch means responsive to a subsequent touch in one of a plurality of touch areas for determining a corresponding zoom parameter and passing said zoom parameter to said message formatting means.

12. The apparatus of claim 11 in which said logic means further includes:

focus touch means responsive to a touch subsequent to a camera selection touch in one of a plurality of focus touch areas for determining a corresponding focus parameter and passing said touch parameter to said message formatting means.

13. The apparatus of any of claims 11 or 12 in which said logic means further includes:

pan/tilt touch means responsive to a touch, subsequent to a camera selection touch, in one of a plurality of pan/tilt touch areas for

determining a pan/tilt direction and passing said pan/tilt direction to said message formatting means but only if a camera selected by said camera selection touch is not in motion.

14. The apparatus of claim 13 in which said pan/tilt touch means selects a stop motion message for passing to said message formatting means, in response to a touch in any of a plurality of touch responsive areas, subsequent to a camera selection touch, and while a camera selected by said camera selection touch is in motion.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,516,156 Page 1 of 195

DATED : May 7, 1985

INVENTOR(S) : Fabris et al

It is certified that error appears in the above—identified patent and that said Letters Patent is hereby corrected as shown below:

On the title page, Item (75) should read:

The inventors are Alfonso V. Fabris, Oakton; Robert M. Strickland, Jr.; John T. Toth, both of McLean; Janice N. Keenan, Vienna; Thomas L. Hahler, Falls Church; Michael Rahrer; Michael Rohrer, both of Reston, all of Va.; Alan E. Vinciguerra, Germantown; Catherine A. Muir, Cabin John, both of Md.

The following paragraph should be inserted at Col. 1, between "Field of the Invention" and "Background Art":

-Appendix

Appended to the specification and incorporated by this reference is an appendix including pages A-1 to A-193, comprising a Programming Design Language (PDL) description of those portions of the software which are related to

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,516,156

DATED : May 7, 1985

INVENTOR(S) : Fabris et al

It is certified that error appears in the above—identified patent and that said Letters Patent is hereby corrected as shown below:

operator input, menu management and display, and formatting of output commands of an embodiment of the invention actually constructed.-

The attached appendix should be appended to the patent.

Signed and Sealed this

Tenth Day of *September 1985*

[SEAL]

Attest:

Attesting Officer

DONALD J. QUIGG

Acting Commissioner of Patents and Trademarks - Designate

APPENDIX

```
DATA
      SCALAR  CURRMA,          [CURRENT MENU MDT ADDRESS]
              RQBID,           [RQB REQUEST NUMBER]
              MSGID,           [MESSAGE REQUEST NUMBER]
              MCADDR,          [CURRENT MENU MCT ADDRESS]
              MEADDR,          [CURRENT ELEMENT MCT ADDRESS]
              DEADDR,          [CURRENT ELEMENT DEL ADDRESS]
              ESADDR,          [CURRENT ELEMENT EST ADDRESS]
              TLADDR,          [CURRENT ELEMENT TEL ADDRESS]
              MDTLEN,          [LENGTH OF MDT ENTRY]
              MCTLEN,          [LENGTH OF MCT ENTRY]
              ESTLEN,          [LENGTH OF EST ENTRY]
              RQMENU,          [REQUESTED MENU NUMBER]
              PDMENU,          [PENDING MENU NUMBER]
              ERRMSG,          [NUMBER OF PENDING MESSAGE]
              ERRFLG,          [FLAG INDICATING ERROR PENDING]
              LEXRC,           [RETURN CODE FROM LEXICAL SCANNER]
              CAMTCH,          [TOUCHED CAMERA MCT ELEMENT ADDRESS]
              CAMLOP,          [TOUCHED CAMERA - NUMBER OF PRESETS]
              CURPRE,          [TOUCHED CAMERA - CURRENT PRESET NO.]
              PRVFLG,          [FLAG TO INDICATE PREVIEW ACTIVE]
              STKBTM,          [ADDRESS OF ELEMENT STACK BOTTOM]
              STKTOP,          [ADDRESS OF TCP ELEMENT ON STACK]
              C03DRW,          [MENU C3 DRAWN FLAG]
              MENUAD,          [SAVE AREA FOR MENU MDT ADDRESS]
              ICB,             [CURRENT LIGHT ICE ADDRESS]
              STACK: INTEGER   [ADDRESS OF ELEMENT STACK]
```

```
MENU DICTIONARY TABLE

        ARRAY   MDT (1:19) OF MDT-ENTRY
        RECORD  MDT-ENTRY       [MENU DICTIONARY TABLE]
                .ID,            [MENU IDENTIFICATION NUMBER]
                .PM,            [PREVIOUS MENU ID]
                .NM,            [NEXT MENU ID]
                .NMM,           [NEXT MENU ID (MODIFIED)]
                .ICB,           [CURRENT MENU LOCATION]
                .NEL,           [NUMBER OF ELEMENTS IN MENU]
                .HELP,          [MENU ID OF HELP MENU]
                .RFFU,          [RESERVED FOR FUTURE USE]
                .MCT: INTEGER   [MENU MCT ADDRESS]
```

```
MENU CONTROL TABLE

        ARRAY   MCT (1:SUM OF MENU ELEMENTS) OF MCT-ENTRY
        RECORD  MCT-ENTRY           [MENU CONTROL TABLE]
                .ID,                [ELEMENT ID]
                .CURRENT,                   [CURRENT STATUS OF ELEMENT]
                        ..BORDER            [1=ON, 0=OFF]
                        ..BODY
                        ..INSENSITIVE
                        ..INHIBIT
                        ..TEXT
                .NEXT,              [NEXT STATUS OF ELEMENT]
                        ..BORDER            [1=ON, 0=OFF]
                        ..BODY
                        ..INSENSITIVE
                        ..INHIBIT
                        ..TEXT
                .DEFAULT,           [DEFAULT STATUS OF ELEMENT]
                        ..BORDER            [1=ON, 0=OFF]
                        ..BODY
                        ..INSENSITIVE
                        ..INHIBIT
                        ..TEXT
                .SYNTAX,            [SYNTAX CLASS]
                .DEL,               [DEL ID]
                .RFFU               [RESERVED FOR FUTURE USE]
                .EID,               [ENTITY ID]
                .IACT,              [IMMEDIATE ACTION ROUTINE]
                .DACT,              [DELAYED ACTION ROUTINE]
                .COLOR,             [ASSIGNED COLORS]
                        ..ON
                        ..OFF
                        ..CURRENT
                        ..TEXT
                .HELP,              [HELP MENU ID]
                .TXTSZE,                    [TEXT SIZE]
                .XHERE,             [X HERE COORDINATE]
                .YHERE,             [Y HERE COORDINATE]
                .TEXT: INTEGER      [TEL ID]
```

```
ENTITY STATUS TABLE

      ARRAY   EST (1:ESTENT) OF EST-ENTRY
      RECORD  EST-ENTRY          [ENTITY STATUS TABLE]
              .ID,               [EST ID]
              .TYPE,             [EST TYPE]
              .CB,               [CONTROLLED BY]
              .COLR,             [COLOR]
              .ON,               [ENTITY ON INDICATOR]
              .PRESENT,          [ENTITY PRESENT INDICATOR]
              .ONDEFAULT,        [ON FLAG DEFAULT]
              .PREDEFLT,         [PRESENT FLAG DEFAULT]
              .FIELD1,           [ENTITY SPECIFIC VALUE 1]
              .FIELD2,           [ENTITY SPECIFIC VALUE 2]
              .FIELD3,           [ENTITY SPECIFIC VALUE 3]
              .INIT,             [INITIAL DEFAULT FIELD]
              .CONFLICT: INTEGER      [CONFLICT WORD]
```