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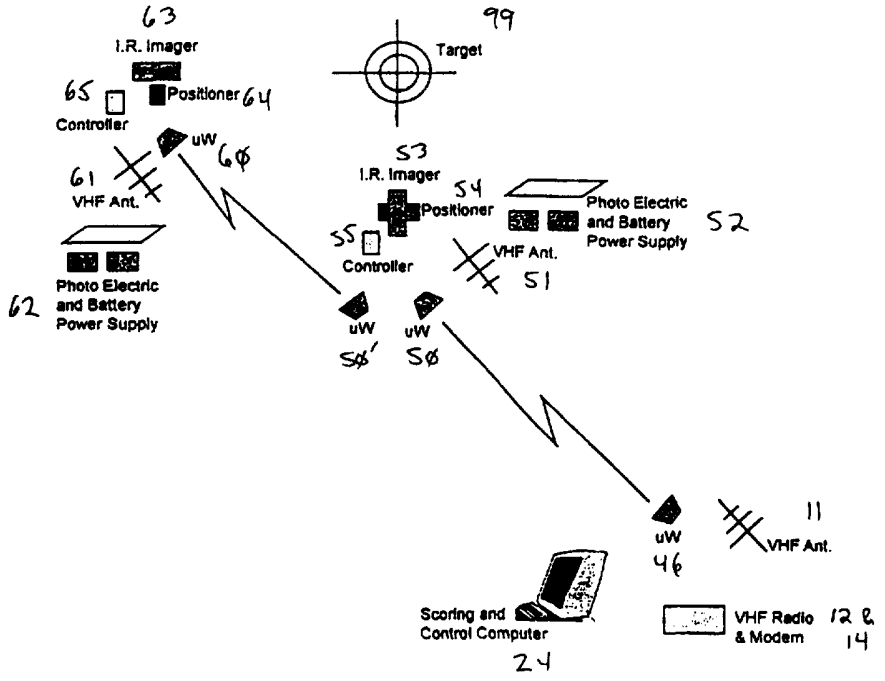

(57) Abstract

A military range scoring system with a plurality of imagers (53, 63) capable of viewing reference points and impact points for ordinance aimed at the reference points, imager position controllers (54, 64), and data processors (98) and video monitors (82) for processing and viewing data received from said imagers; and communication links (12, 14, 11, 46, 60, 61, 51) between the components. The imagers are preferably infrared or near-infrared, and the system manually and/or automatically scores impacts by digital signl processing of imager data.

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MILITARY RANGE SCORING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing of Provisional Application Serial No. 60/018,849, entitled *"Tactical Range Infrared Scoring System"*, filed on May 30, 1996, the specification of which is incorporated by reference.

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BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

The present invention relates to scoring systems for military ranges.

Background Art:

The armed services are required to continuously train and test the capability of troops to accurately and effectively deliver various types of ordinance to targets under battlefield conditions. Current methods used by the various services are limited in scope and capability. The shift to more extensive use of nighttime engagements has heretofore required the use in training of low level explosives (spotting charges) to determine points of impact. These charges are expensive and present both safety and environmental hazards. Many types of munitions cannot at present be scored in training scenarios.

The prior art in this area includes the following: U.S. Patent No. 4,155,096, to Thomas et al, relates to laser bore-sighting of sensors. U.S. Patent No. 4,222,564, to Alan et al, relates to vibration sensing of impacts. U.S. Patent No. 4,315,689, to Goda, relates to simulated firings of sight-guided missiles employing painting of the target with laser light for a period of time. U.S. Patent No. 4,333,106, to Love, relates solely to airborne targets. U.S. Patent No. 4,349,838, to Daniel, relates to laser bore-sighting of sensors. U.S. Patent No. 4,350,881, to Knight et al, relates to detection of the pressure wave of a projectile. U.S. Patent No. 4,439,156, to Marshall et al, relates to simulated environments and weapons firings. U.S. Patent No. 4,622,458, to Boeck et al, relates to a system which determines trajectories of objects employing a plurality of mobile data acquisition systems connected to a central station. U.S. Patent No. 4,478,581, to Goda, relates to simulation of firings of ballistic ammunition using lasers. U.S. Patent No. 4,611,993, to Brown, relates to a system requiring a vertical projection screen. U.S. Patent No. 4,689,016, to Eichweber, relates only to simulations of firearms. U.S. Patent No. 4,695,256, to Eichweber, relates only to firearms simulations requiring a retro-reflector. U.S. Patent No. 4,739,329, to Ward et al, relates to a system requiring radar. U.S. Patent No. 4,955,812, to Hill, relates only to firearms simulations. U.S. Patent No. 5,025,424, to Rohrbaugh, relates to sensing of shockwaves. U.S. Patent No. 5,228,854, to Eldridge, relates to a pure simulation system. U.S. Patent No. 5,359,920, to Muirhead, relates to detection of radio frequencies generated by impacts. U.S. Patent No. 5,432,546, to Cargill, relates to a sensor attached to the projectile itself. Finally, U.S. Patent No. 5,521,634, to McGary, relates to an algorithm for compressing image data in a target sensing system.

The present invention provides a scoring system capable of detecting and reporting delivery of a wide variety of ordinance in real time under daytime and nighttime conditions. Once calibrated, the system is straightforward to set up and use, including automatic selection of targets.

SUMMARY OF THE INVENTION (DISCLOSURE OF THE INVENTION)

The present invention is of a military range scoring apparatus comprising: a plurality of imagers capable of viewing a plurality of reference points and impact points for ordinance aimed at the reference points; a remote imager controller and a processor for processing and viewing data received from the imagers; and control information and data communicating devices for interchange between the imagers and the remote imager controller. In the preferred embodiment, the controller and processor comprises a video monitor and the data comprise video images calibrated for angular displacement across a horizontal axis. A device to measure the calibrated angular displacement between the reference point and the impact point without a requirement for detailed survey data is preferably employed, as is a device for calculating the displacement (X and Y and/or azimuth and distance) between the reference point and the impact point. The data communicating devices may including microwave, radio, fiber optic line, and wire line. The controller preferably comprises a positioner used to aim an imager at a reference point by changing azimuth and elevation of the imager. A database of reference points and imager locations allows rapid and accurate calculation of impact points. The imagers are preferably sensitive to infrared radiation, and preferably are capable of sensing laser radiation used to target and guide smart weapons. The imagers may include flux gate compasses used to sense imager horizontal pointing angle, to allow accurate horizontal positioning and status information provided to the controller, as well as inclinometers

used to sense imager vertical pointing angle, to allow accurate vertical positioning and status information provided to the controller. The controller preferably includes a computer storing imager pointing, setup, and calibration data for multiple reference points, and means for setting imager parameters including field of view, zoom, focus, sensitivity, and contrast. The system preferably employs a computer for automatically scoring proximities of impact points to reference points and a device causing the controller to direct imagers to point at a reference point, reading back calibration data from the imagers, and entering the calibration data into scoring calculations so that manual calibration is not required. The processor includes a video image digitizer and a digital signal processor for determining angular offsets and scoring an impact point from the digitized video image, which can detect multiple impacts and score impact points without user intervention, as well as storage and retrieval mechanisms for the digitized video images.

A primary object of the present invention is to provide a scoring system capable of detecting and accurately reporting delivery of a wide variety of ordinance.

Another object of the present invention is to provide a scoring system capable of functioning under both daytime and nighttime conditions.

A primary advantage of the present invention is that it provides for automatic selection of targets.

Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon

examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the specification, illustrate several embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating a preferred embodiment of the invention and are not to be construed as limiting the invention. In the drawings:

Fig. 1 is a flowchart of the top-level functionality provided by the preferred scoring system of the invention;

Fig. 2 is a flowchart of the mission preparation function of the scoring system;

Fig. 3 is a flowchart of the scoring and report function;

Fig. 4 is a schematic of the preferred controller of the invention;

Fig. 5 is a schematic of an exemplary scoring system deployed and in use;

Fig. 6 is a schematic of the long range infrared imager preferred for use in the system;

Fig. 7 is a schematic of the long range laser infrared imager preferred for use in the system;

Fig. 8 is a schematic of the preferred imager site of the invention;

Fig. 9 is a schematic of the preferred scoring position of the invention;

Fig. 10 is a window of the preferred software enabling input and selection of a mission;

Fig. 11 is a window of the preferred software enabling settings for targets;

Fig. 12 is a window of the preferred software showing mission information and a real-time view of the target area while a mission is in progress, including functions to control imagers, select targets, and carry out scoring;

Fig. 13 is a window of the preferred software enabling setup of imager parameters;

Fig. 14 is a window of the preferred software enabling setup of target parameters;

Fig. 15 is a window of the preferred software enabling setup of the communications interface between the computer and the video digitizer;

Fig. 16 is a window of the preferred software enabling control of display characteristics of the digitized video on the computer screen;

Fig. 17 is a window of the preferred software enabling control of position and refresh rate of digitized video on the computer screen;

Fig. 18 is a window of the preferred software enabling mission creation and naming;

Fig. 19 is a window of the preferred software enabling mission selection from a panel of previously created missions;

Fig. 20 is a window of the preferred software enabling selection of ordinance;

Fig. 21 is a window of the preferred software enabling selection of method of ordinance delivery;

Fig. 22 is intentionally omitted;

Fig. 23 is a trace view of the bottom of the preferred configuration of the remote controller mother board of the invention;

Fig. 24 is a trace view of the top of the preferred configuration of the remote controller mother board of the invention;

Fig. 25 is a schematic of the preferred compass controller and video data inserter of the invention;

Fig. 26 is a bottom trace diagram for Fig. 25;

Fig. 27 is a schematic of the preferred mother board of the invention;

Fig. 28 is a continuation schematic from Fig. 27;

Fig. 29 is intentionally omitted; and

Figs. 30-34 are schematics of the wiring harness connections for video, microwave, power, imager, and pan and tilt subsystems, respectively, that connect to the controller ports of Fig. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(BEST MODES FOR CARRYING OUT THE INVENTION)

The present invention is of an ordinance scoring system employing, preferably, both optical and thermal imagers which can operate in multiple lighting conditions. The imagers sense visible light, near infrared, infrared, and military laser designators simultaneously with the ability to overlay each onto the others. The output of the sensor is a video-like presentation displaying different energy levels rather than light levels. By sensing the energy levels of each object in the field of view, the imager works as well in the absence of light as it does in visibly bright conditions. Accordingly, the sensor will operate under all day and night ambient conditions and can detect the impact of every type of ordinance now in use as well as a laser spot designator illuminating targets for smart weapons. The sensor can also track the "fly in" path of many weapons that are adequately heated by air resistance during delivery.

The present invention also incorporates a control system which, when calibrated, will automatically position the imager on any selected target with high azimuth and inclination accuracy, such as of 0.05° error or less. The miss distance between the target and the weapon impact can then be calculated using multiple sensor azimuth triangulation or single sensor azimuth and inclination differences.

The operator interfaces to the scoring system through a computer, preferably an IBM-PC compatible system running a Windows (trademark of Microsoft Corporation) operating system. During normal operations, scoring ordinance and repositioning the system to different targets is accomplished by a simple series of two or three clicks of the mouse, trackball, touch screen, or like input device.

The video from the sensor or sensors is digitized and displayed on the same computer screen used to control the system's operation and to score the weapon. The video can be frozen at the point of ordinance impact to allow very accurate cursor positioning and scoring. The digitized video can be saved and retrieved on a frame-by-frame basis and re-processed, if required. The use of digital signal processing on the digitized video facilitates the implementation of automated scoring methods. A fully automated version of the invention senses the moment of impact and scores its location with no operator intervention.

Referring to Figs. 1-3, these provide flowcharts of the high level logic of the scoring and control computer **24** of the invention, which is shown in Fig. 5. The preferred controller, diagramed on Fig. 4, comprises microcomputer **10**, supplied by power **16** and power supply voltage regulators, filters, and reset circuitry **18**. Via serial port **22**, the microcomputer communicates with modem **14** to provide two-way communication with the scoring and control computer via radio transceiver **12** and antenna **11**. Serial port **20** provides communication to flux gate compass and inclinometer **36**, which provides both digital **26** and analog **28** inputs back to the microcomputer. Communication with microwave units **38**, video switcher and control **40**, imager control **42**, and pan and tilt control **44** is provided via analog input **28**, buffered analog input **30**, buffered digital output **32**, and power driver **34**.

Fig. 5 illustrates a typical system of the invention. Scoring and control computer **24** receives via microwave **46** and communicates via VHF radio antenna/modem **12,14,11** to, in this case, two imaging sites sending transmissions by microwave **50,60** and receiving communications by VHF antennas **51,61**. Each site comprises a system controller **55,65**, photoelectric and battery power supply means **52,62**, a positioner **54,64**, and an infrared imager **53,63**. The imagers at the sites are controlled by the system controller on commands from the scoring and control computer as needed to observe target(s) **99**.

Fig. 6 illustrates a long range infrared imager system of the invention, with controller **55**, positioner **54**, infrared imager **53**, compass position sensor **56**, and sunshade **57**. Fig. 7 illustrates a second type long range laser infrared imager system of the invention, with controller **65**, positioner **64**, infrared imager **63**, compass position sensor **66**, and sunshade **67**. Fig. 8 illustrates an imager site, showing the interconnections to and the central role of the controller **65**, with the photoelectric generator, regulator, and batteries **62**, VHF antenna **61**, microwave antenna **60**, flux gate compass and inclinometer **69**, infrared imager **63**, and pan and tilt positioner **68**. Fig. 9 illustrates a scoring position, with scoring and control computer **88**, preferably having high speed and high resolution graphics controller **90**, high speed video digitizer and overlay processor **92**, high capacity digital video storage and playback system **94**, interface controller **96**, 166 MHz or faster Intel Pentium, Pentium Pro, or Pentium II processor **98**, large format high resolution monitor **82**, keyboard **84**, and mouse/trackball **86**. Input is received from microwave unit **81** and video switch and processor **83** and output is through VHF antenna **87**, VHF transceiver **89**, and control modem **91**. Optionally, video input may be simultaneously stored on VHS format video recorder **85** or the like.

Software, such as that disclosed in the provisional patent application from which priority is claimed, is employed to control the entire system during a mission. Figs. 10-21 illustrate the types of screens useful in any software according to the invention. Attention is particularly drawn to Fig. 12, which illustrates one embodiment of the main control screen during a mission. In this example, two remote imagers are being viewed and controlled simultaneously, while other setups will allow varying numbers of imagers. Specialized hardware useful in the present invention are shown in Figs. 23-34.

The following are preferred requirements of the integrated controller for infrared imager sites of the invention:

Power Input:

Imager Power	12VDC 2A
Pan&Tilt Power	12VDC to 28VDC 2A
Controller power	12VDC 0.18A
Radio Power	12VDC 0.06A Receive
	12VDC 0.90A Transmit
Auxiliary Power	220VDC/AC 10.0A

Position Control

Azimuth Motor Control	Variable from 0% to 100%
Azimuth Motor Drive	6VDC to 28VDC 2A
Elevation Motor Control	Variable from 0% to 100%
Elevation Motor Drive	6VDC to 28VDC 2A

Position Sensing

Coupled Potentiometer	1.5°	Resolution from Rotational Stop
	1.0°	Inclination from Horizontal
Standard Compass	1.0°	Resolution from Magnetic North
	1.0°	Inclination from Horizontal
High Resolution Compass	0.1°	Resolution from Magnetic North
	0.1°	Inclination from Horizontal

Imager Control

Power	Off On (switchable)
Cool Down	Status Indication Reportable
Sensitivity	-5VDC to +5VDC (continuously variable)
Field of View	Narrow or Wide (switchable)
Electro-optical Zoom	X1 X2 X4 or continuous zoom (switchable)
Width Calibration	-5VDC to +5VDC (absolute sewing)
Phase Calibration	-5VDC to +SVDC (absolute setting)
Contrast	Low Medium High (switchable) or
	-5VDC to +5VDC (continuously variable)
Polarity	Black Hot / White Hot (switchable)
Focus	Wide FOV Near / Far (relative setting)
	Narrow FOV Near / Far (relative setting)
Case Temperature	Status Indication Reportable

Control Addressability

Discrete Addresses	225 individually addressable controllers
Broadcast	To all 225 controllers at the same time
Group Address	25 assignable subgroup addresses

Preset Locations

Stored Presets	50 presets stored in non-volatile memory
Download	Real time down load of Azimuth, Elevation, Field of View, Contrast, Polarity, Sensitivity, and Focus

Status (read back when a bi-directional communication link is used)

The following status conditions may preferably be read back on command: Azimuth, Elevation, Field of View, Contrast, Polarity, Sensitivity, Focus, Power Supply Voltage, Temperature, Ambient Light Condition, User Designated Alarm Conditions

Communications Link

Direct Interface	RS-232
	RS-422/485 (optional)
Modem (optional)	Internal 300 Baud to 2400 Baud
Radio (optional)	VHF or UHF Transceiver

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above, are hereby incorporated by reference.

CLAIMS

What is claimed is:

1. A military range scoring apparatus comprising:

a plurality of imagers capable of viewing a plurality of reference points and impact points for ordinance aimed at the reference points;

remote means for controlling said imagers and for processing and viewing data received from said imagers; and

means for communicating control information and data between said imagers and said remote means.

2. The apparatus of claim 1 wherein said remote means comprises a video monitor.

3. The apparatus of claim 1 wherein said data comprise video images calibrated for angular displacement across a horizontal axis.

4. The apparatus of claim 1 additionally comprising means to measure a calibrated angular displacement between the reference point and an impact point without a requirement for detailed survey data.

5. The apparatus of claim 1 additionally comprising means for calculating a displacement between the reference point and an impact point, wherein said displacement is selected from the group consisting of X and Y displacement and azimuth and distance displacement.

6. The apparatus of claim 1 wherein said communicating means comprise means selected from the group consisting of microwave, radio, fiber optic line, and wire line.

7. The apparatus of claim 1 wherein said controlling means comprise a positioner used to aim an imager at a reference point by changing azimuth and elevation of said imager.

8. The apparatus of claim 1 additionally comprising a database of reference points and imager locations to allow rapid and accurate calculation of impact points.

9. The apparatus of claim 1 wherein said imagers comprise imagers sensitive to infrared radiation.

10. The apparatus of claim 9 wherein said infrared imagers comprise means for sensing laser radiation used to target and guide smart weapons.

11. The apparatus of claim 1 wherein said imagers comprise flux gate compasses used to sense imager horizontal pointing angle, to allow accurate horizontal positioning and status information provided to said controlling means.

12. The apparatus of claim 1 wherein said imagers comprise inclinometers used to sense imager vertical pointing angle, to allow accurate vertical positioning and status information provided to said controlling means.

13. The apparatus of claim 1 wherein said controlling means comprises a computer storing imager pointing, setup, and calibration data for multiple reference points, and means for setting imager parameters including field of view, zoom, focus, sensitivity, and contrast.

14. The apparatus of claim 1 additionally comprising computer means for automatically scoring proximities of impact points to reference points.

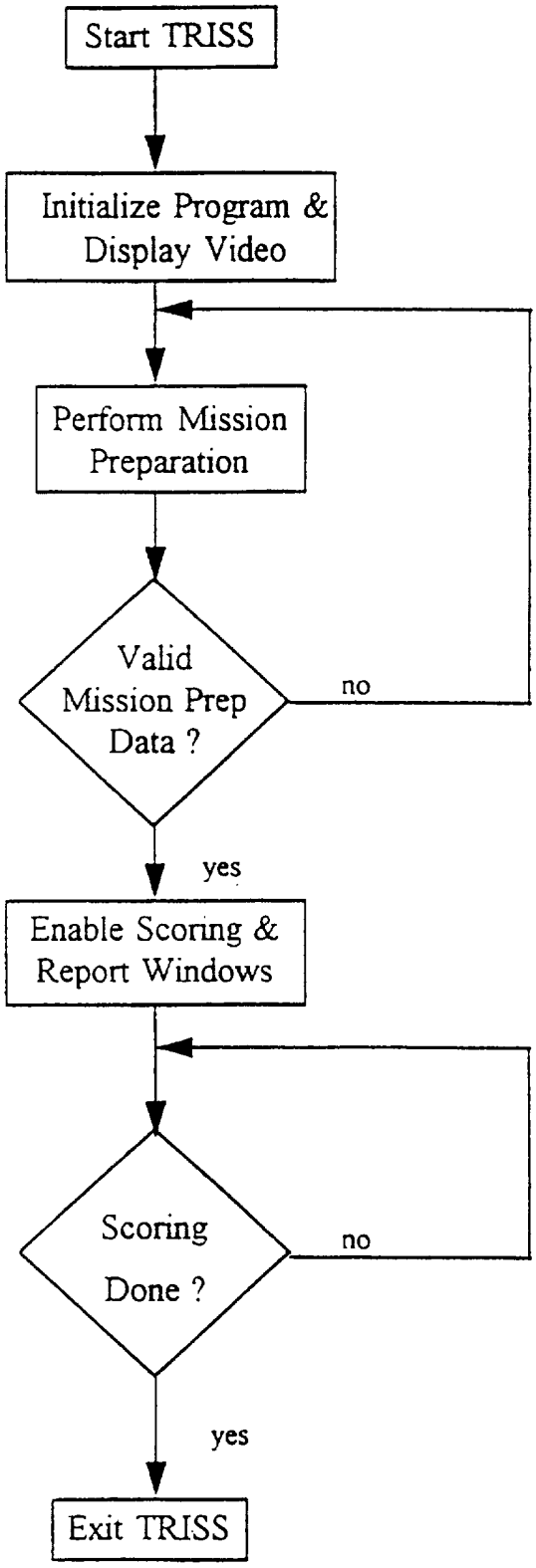
15. The apparatus of claim 14 wherein said computer means comprises means to cause said controlling means to direct imagers to point at a reference point, means to read back calibration data from said imagers, and enter said calibration data into scoring calculations so that manual calibration is not required.

16. The apparatus of claim 1 wherein said means for viewing data comprises means for digitizing a video image.

17. The apparatus of claim 16 wherein said processing means comprises digital signal processing means for determining angular offsets and scoring an impact point from said digitized video image.

18. The apparatus of claim 17 wherein said digital signal processing means comprise means for detecting multiple impacts and scoring impact points without user intervention.

19. The apparatus of claim 16 additionally comprising means for storing and retrieving said digitized video image.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Valid Mission Prep Data ?
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Enable Scoring & Report Windows
Scoring Done ?
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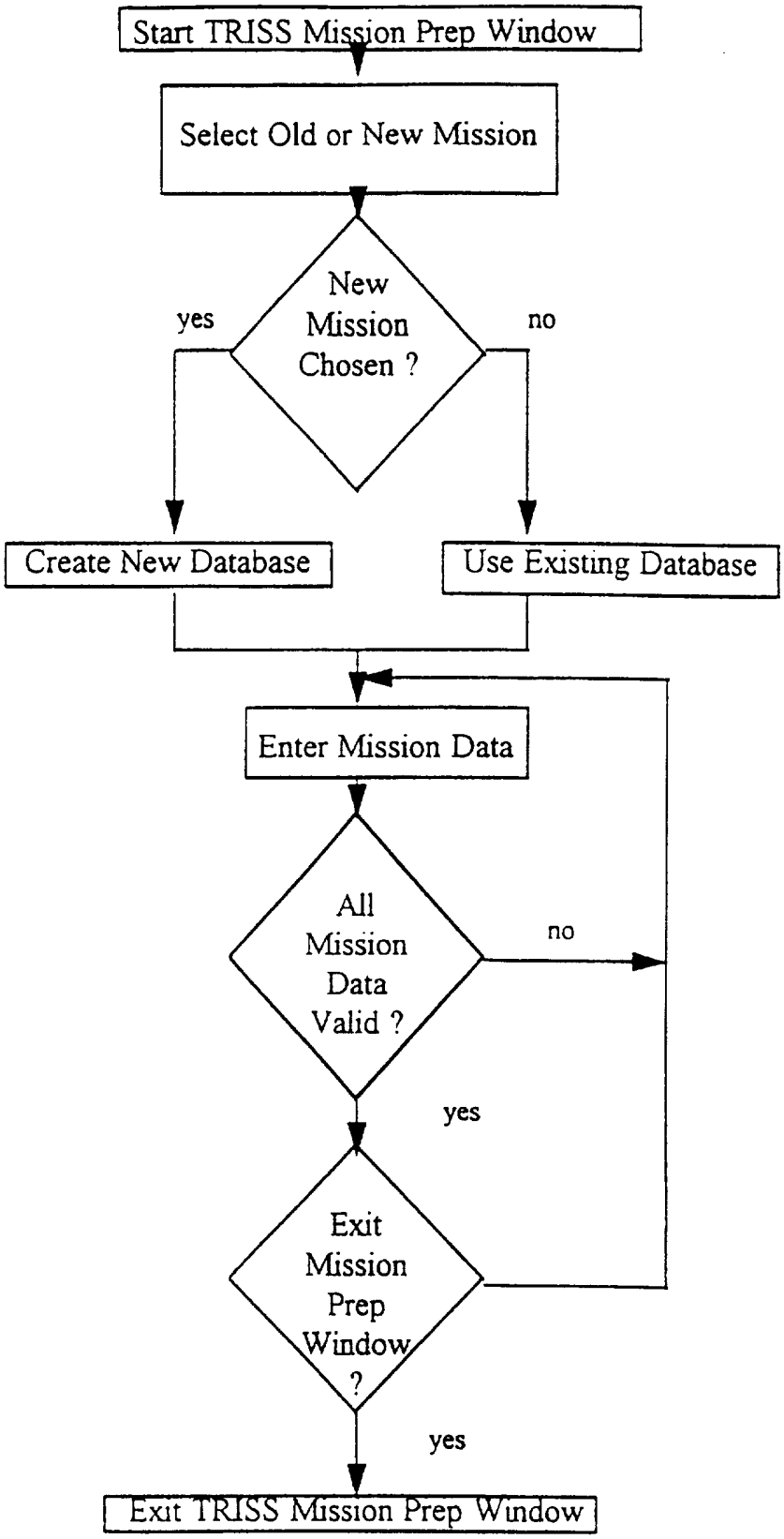
yes
Exit TRISS

Fig. 1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New Mission Chosen ?
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Use Existing Database
Enter Mission Data
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yes
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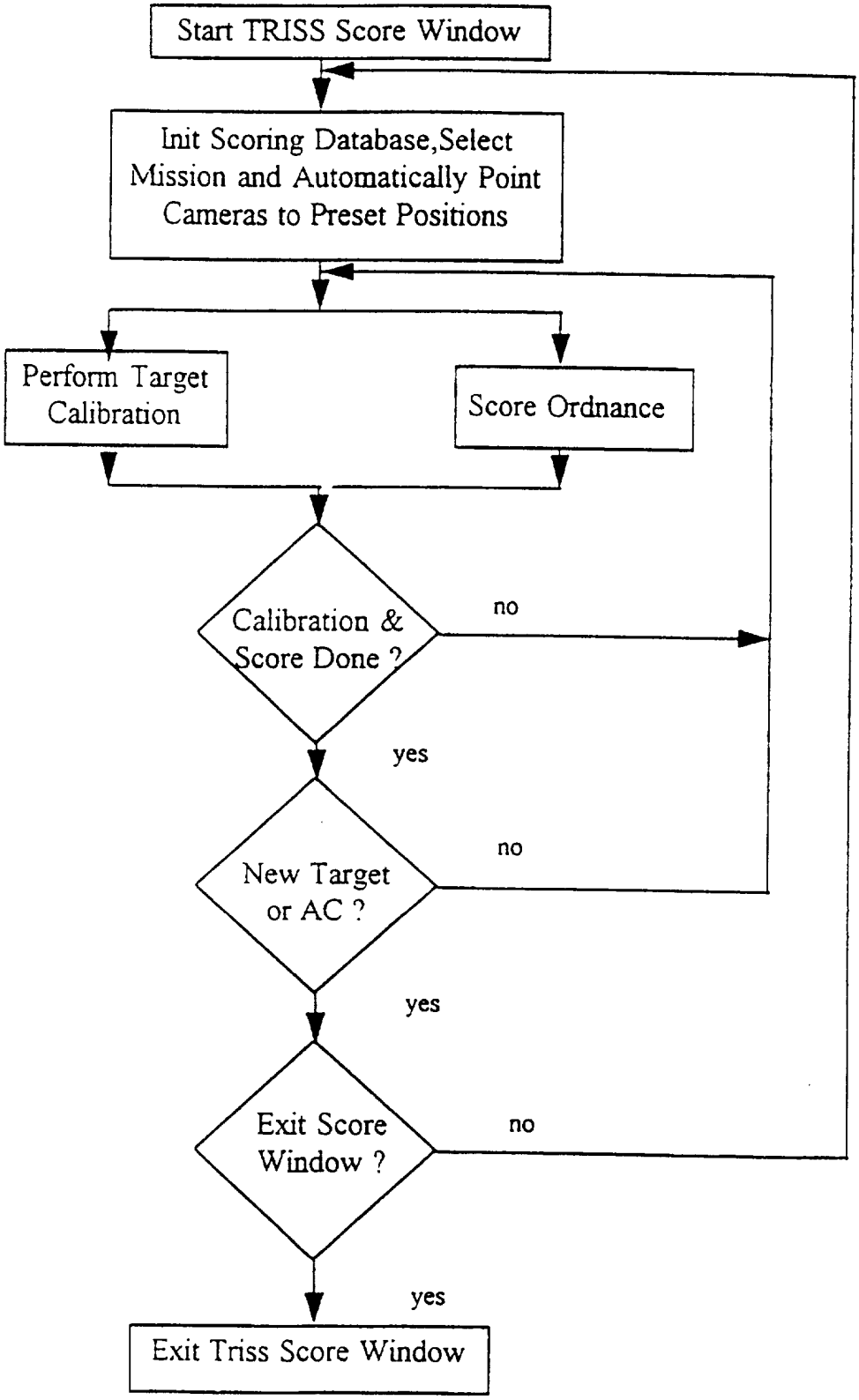
Exit TRISS Mission Prep Window

Fig. 2


Start TRISS Score Window
Init Scoring Database,Select Mission and Automatically Point Cameras to Preset Positions
Perform Target Calibration
Score Ordnance
Calibration & Score Done ?
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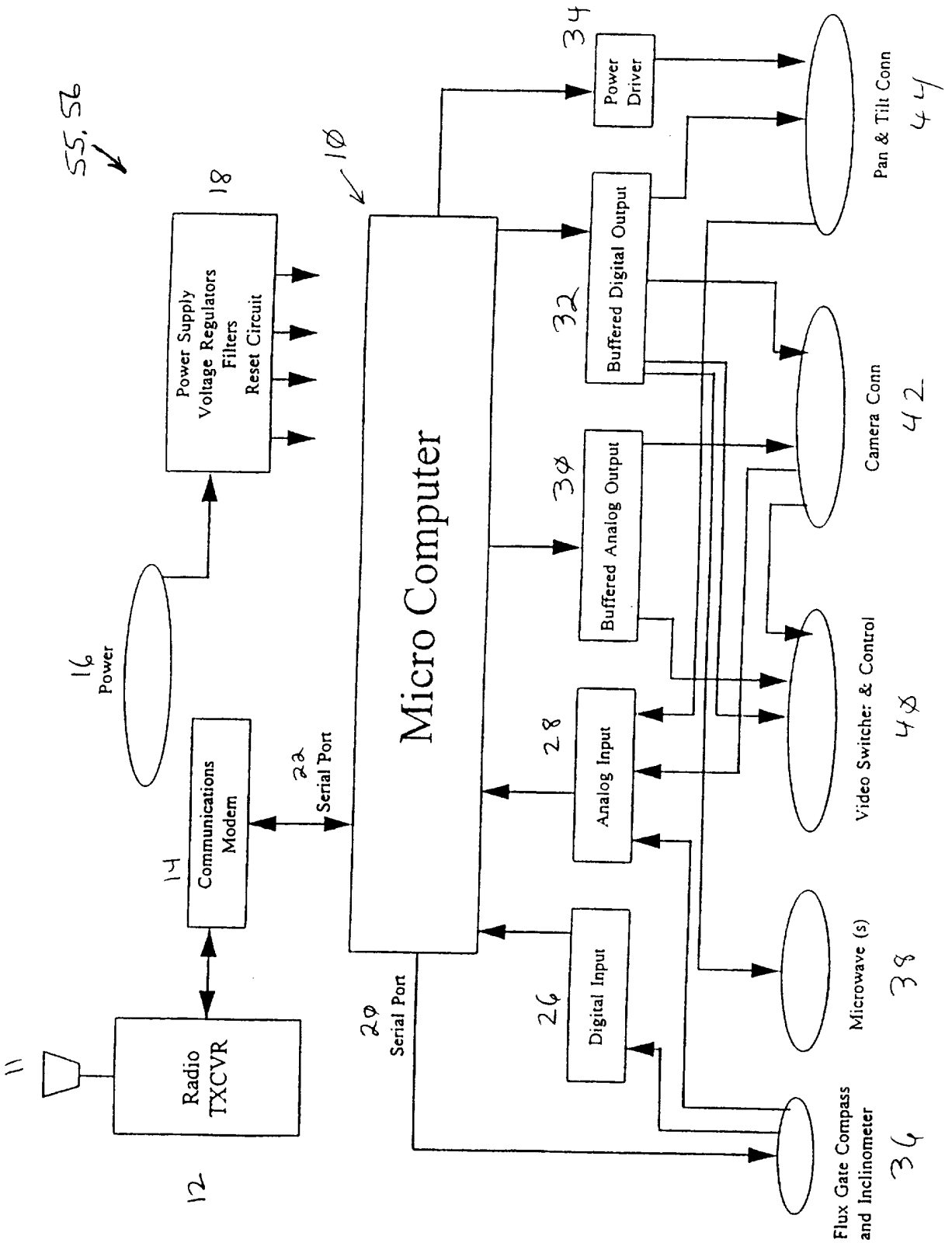
yes
New Target or AC ?
no
yes
Exit Score Window ?
no
yes
Exit Triss Score Window

Fig. 3


55, 56
10
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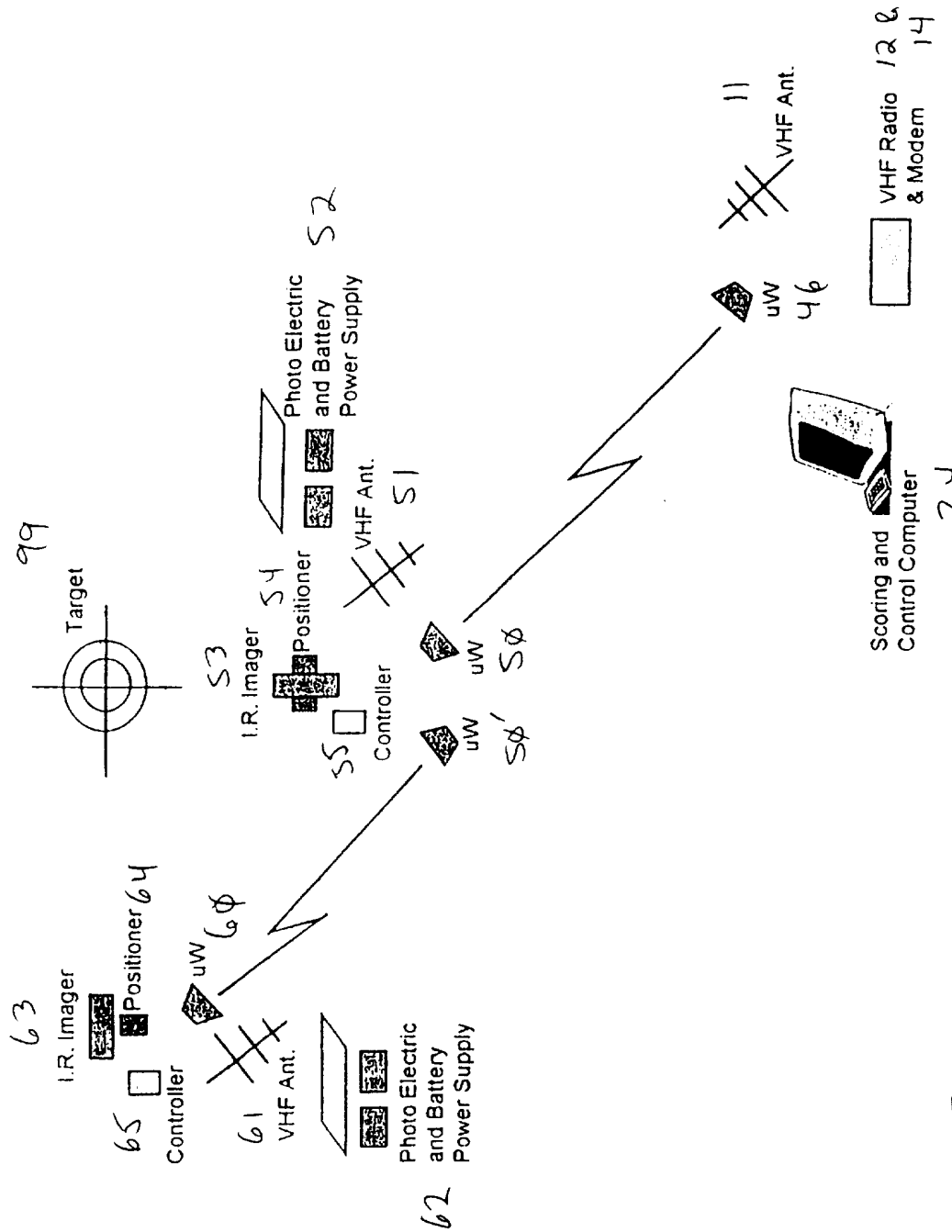
18
Power Supply
Voltage Regulators
Filters
Reset Circuit
16
Power
14
Communications
Modem
22
Serial Port
11
Radio
TXCVR
12
20
Serial Port
34
Power
Driver
32
Buffered Digital Output
30
Buffered Analog Output
28
Analog Input
26
Digital Input
Pan & Tilt Conn
44
Camera Conn
42
Video Switche: & Control
48
Microwave (s)
38
Flux Gate Compass
and Inclinometer
36

Fig. 4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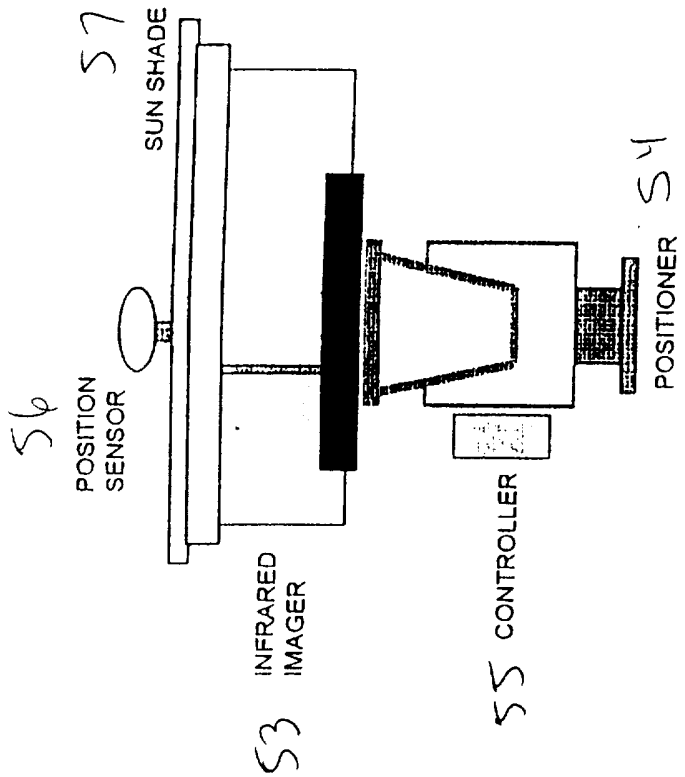
Target
63
I.R. Imager
Positioner 64
65
Controller
61
VHF Ant.
62
Photo Electric and Battery Power Supply
uW 60
53
I.R. Imager
54
Positioner
55
Controller
Photo Electric and Battery Power Supply
52
VHF Ant.
51
uW
uW
50'
50
11
VHF Ant.
uW
46
VHF Radio & Modem
12 & 14
Scoring and Control Computer
24

Fig. 5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57
SUN SHADE
53
INFRARED IMAGER
55
CONTROLLER
54
POSITIONER

Fig. 6

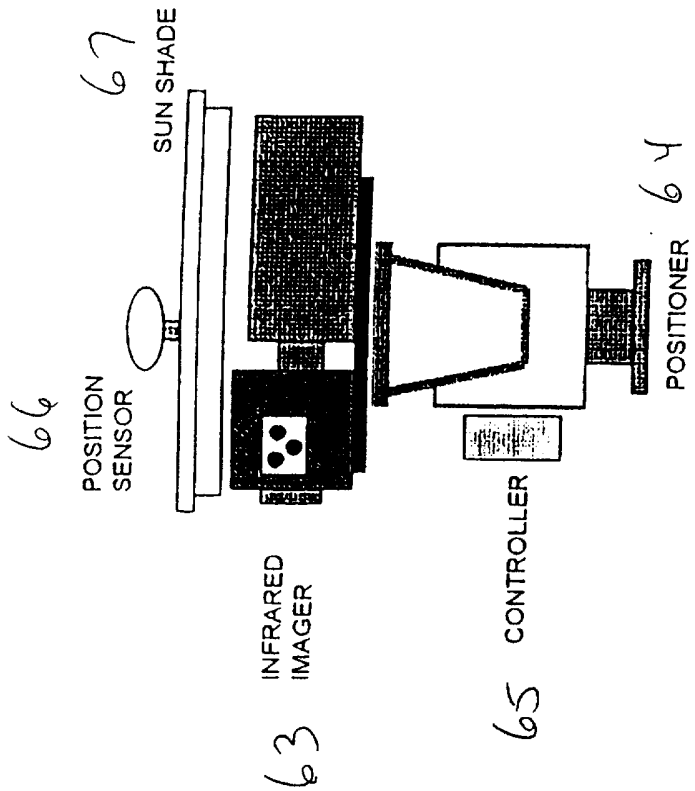
66
POSITION SENSOR
67
SUN SHADE
63
INFRARED IMAGER
65
CONTROLLER
64
POSITIONER

Fig. 7

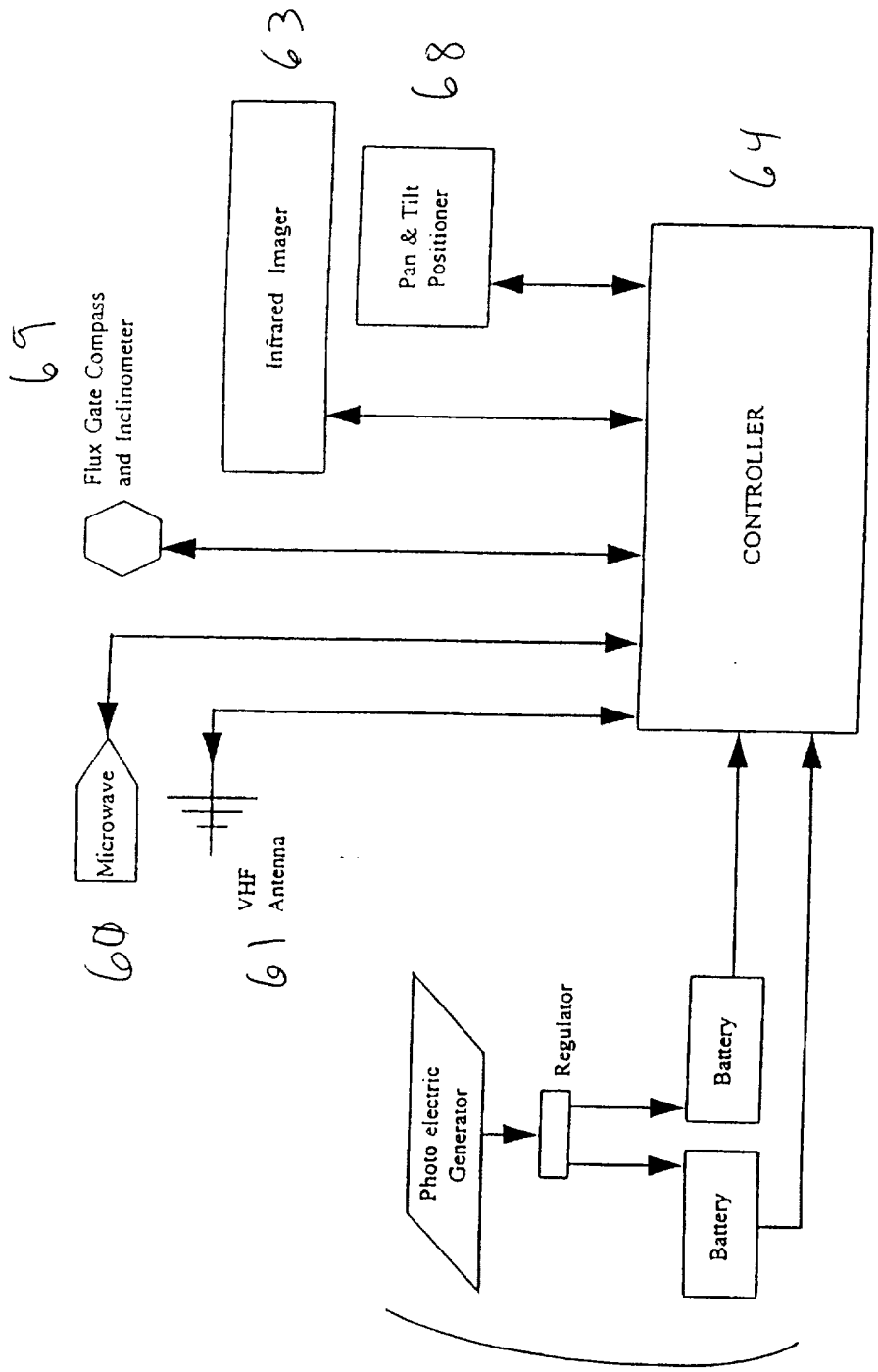
63
68
64
67
Infrared Imager
Pan & Tilt Positioner
CONTROLLER
Flux Gate Compass and Inclinometer
Microwave
VHF Antenna
60
61
Photo electric Generator
Regulator
Battery
Battery
62

Fig. 8

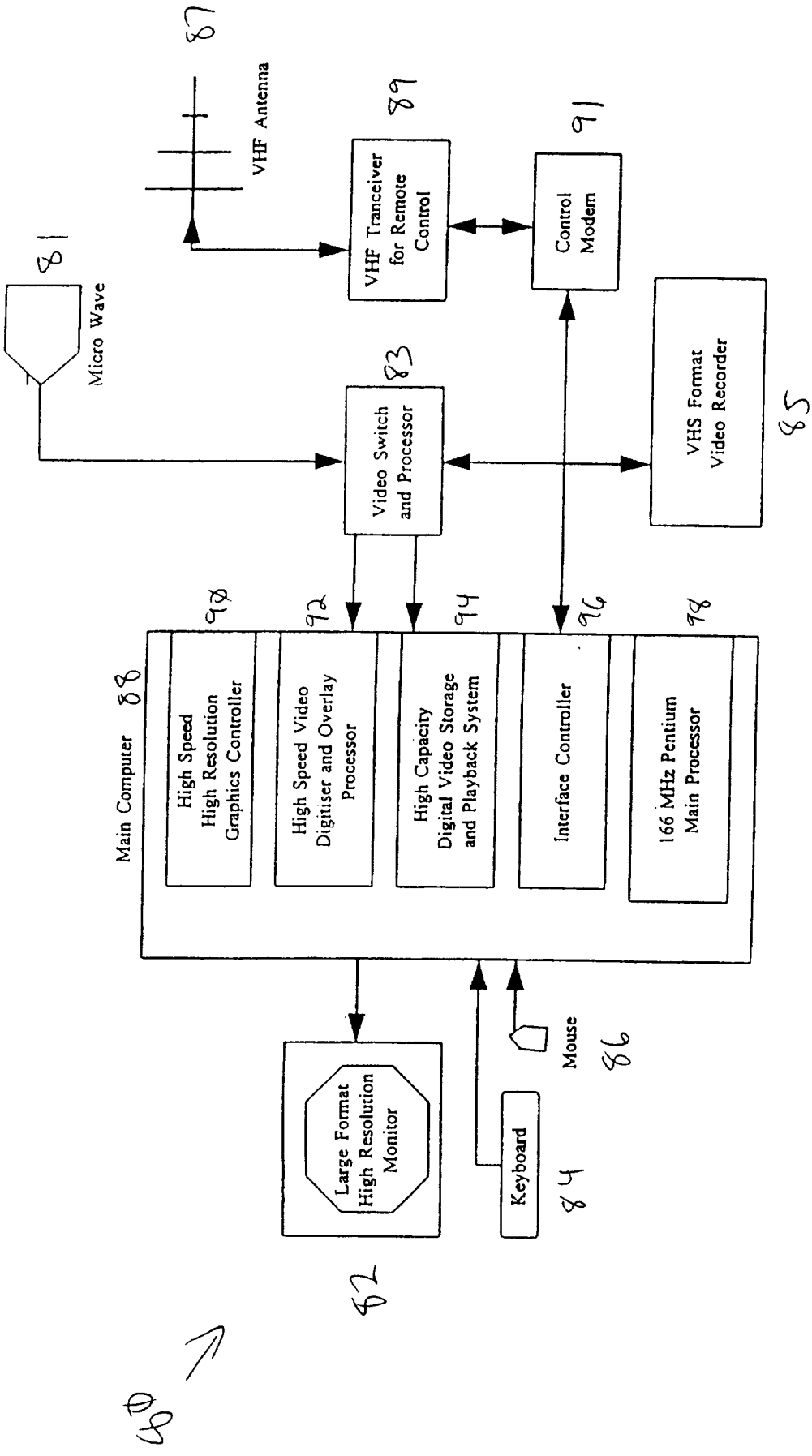
60
87
VHF Antenna
89
VHF Tranceiver for Remote Control
91
Control Modem
81
Micro Wave
83
Video Switch and Processor
VHS Format Video Recorder
85
Main Computer 88
90
92
94
96
98
High Speed High Resolution Graphics Controller
High Speed Video Digitiser and Overlay Processor
High Capacity Digital Video Storage and Playback System
Interface Controller
166 MHz Pentium Main Processor
Large Format High Resolution Monitor
62
Keyboard
84
Mouse
86

Fig. 9

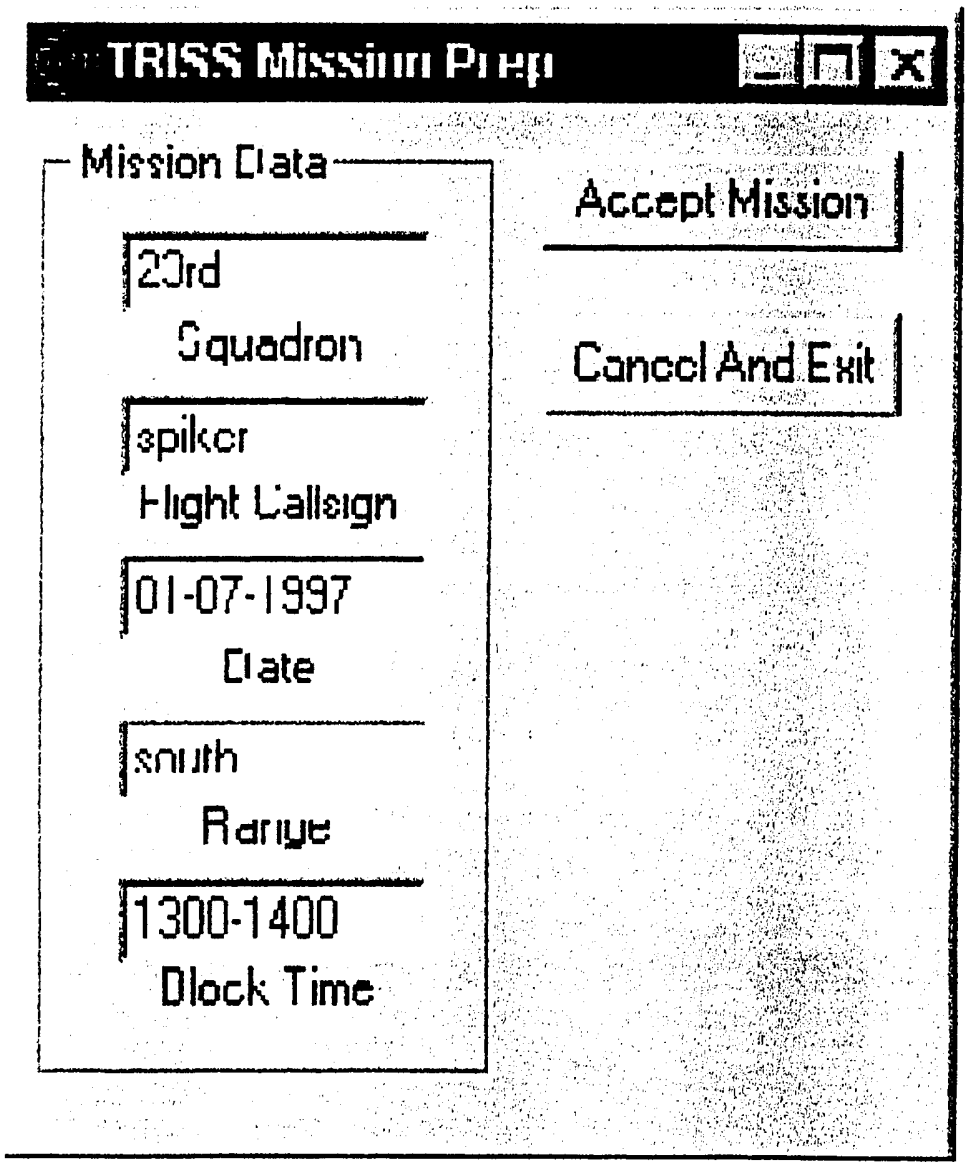
TRISS Mission Prep
Mission Data
23rd
Squadron
spiker
Flight Callsign
01-07-1997
Date
south
Range
1300-1400
Block Time
Accept Mission
Cancel And Exit

Fig. 10

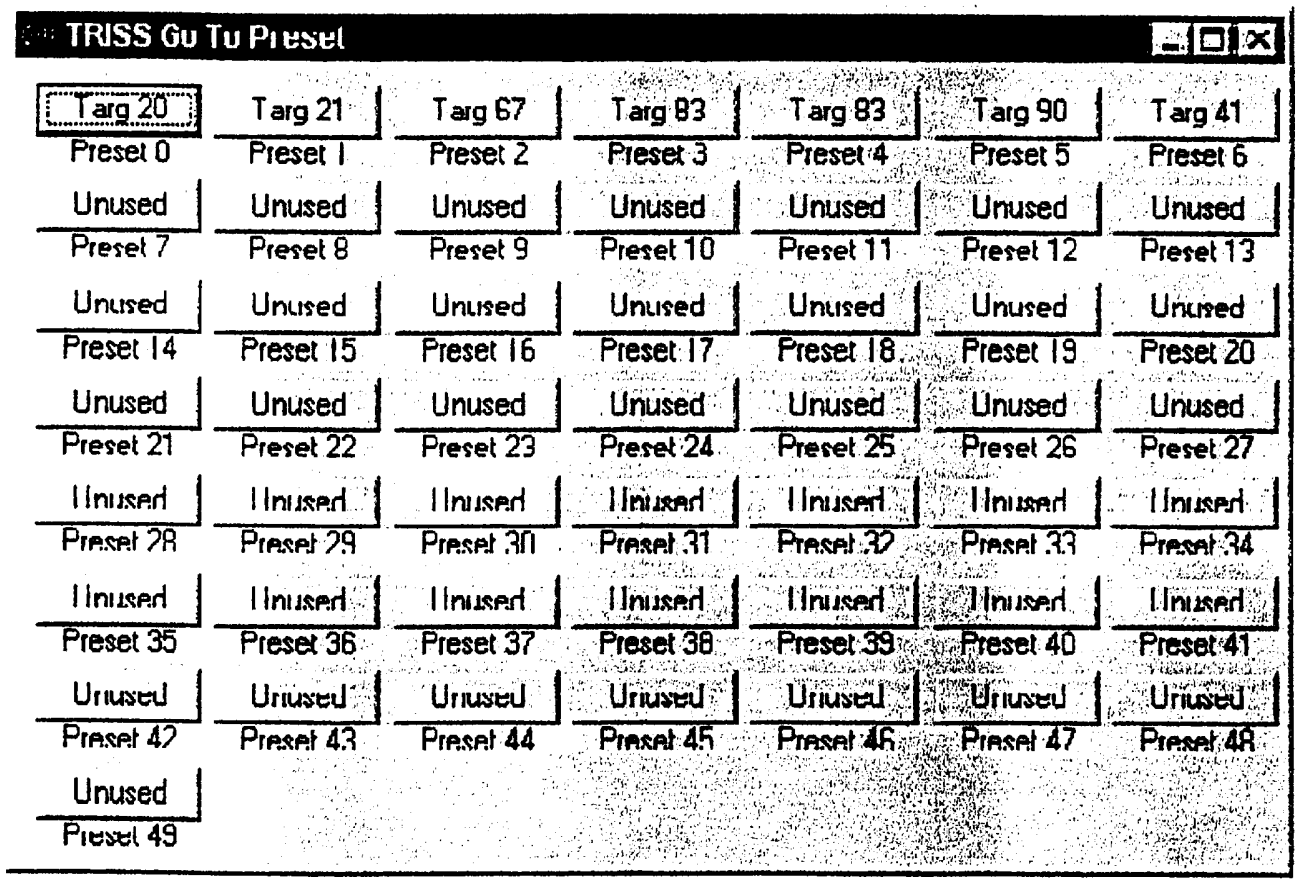
TRISS Go To Preset
Targ 20
Targ 21
Targ 67
Targ 83
Targ 83
Targ 90
Targ 41
Preset 0
Preset 1
Preset 2
Preset 3
Preset 4
Preset 5
Preset 6
Unused
Preset 7
Preset 8
Preset 9
Preset 10
Preset 11
Preset 12
Preset 13
Preset 14
Preset 15
Preset 16
Preset 17
Preset 18
Preset 19
Preset 20
Preset 21
Preset 22
Preset 23
Preset 24
Preset 25
Preset 26
Preset 27
Preset 28
Preset 29
Preset 30
Preset 31
Preset 32
Preset 33
Preset 34
Preset 35
Preset 36
Preset 37
Preset 38
Preset 39
Preset 40
Preset 41
Preset 42
Preset 43
Preset 44
Preset 45
Preset 46
Preset 47
Preset 48
Preset 49

Fig. 11

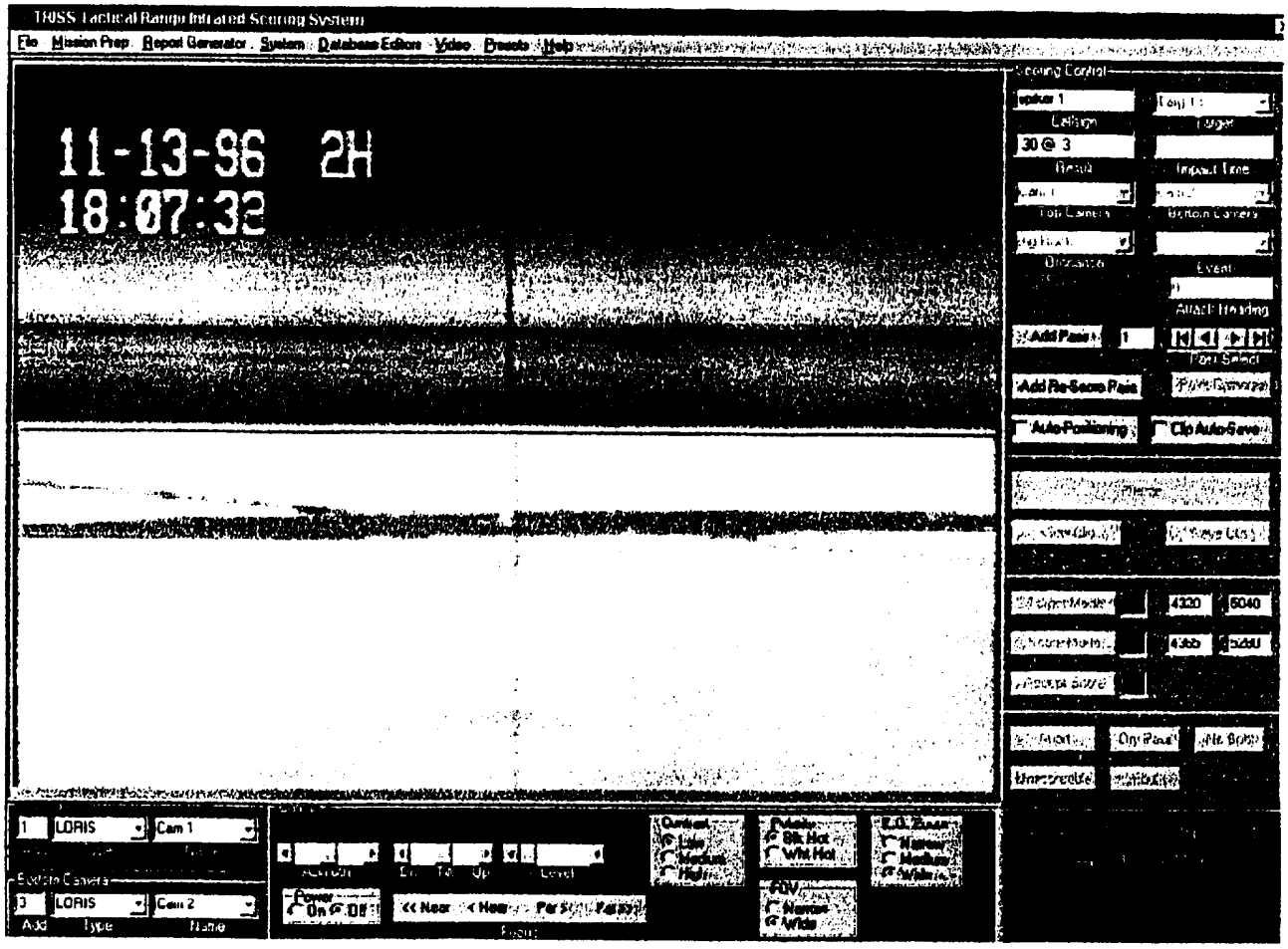
TRSS Tactical Range Integrated Scoring System
File Mission Prep Report Generator System Database Editor Video Presets Help
11-13-96 2H
18:07:32
Scoring Control
Add Pass
Add Re-Score Pass
Auto Positioning
Clip Auto-Save
LORIS
Cam 1
Cam 2
Add
Type
Name
Power
On Off
Near
Far
Wide

Fig. 12

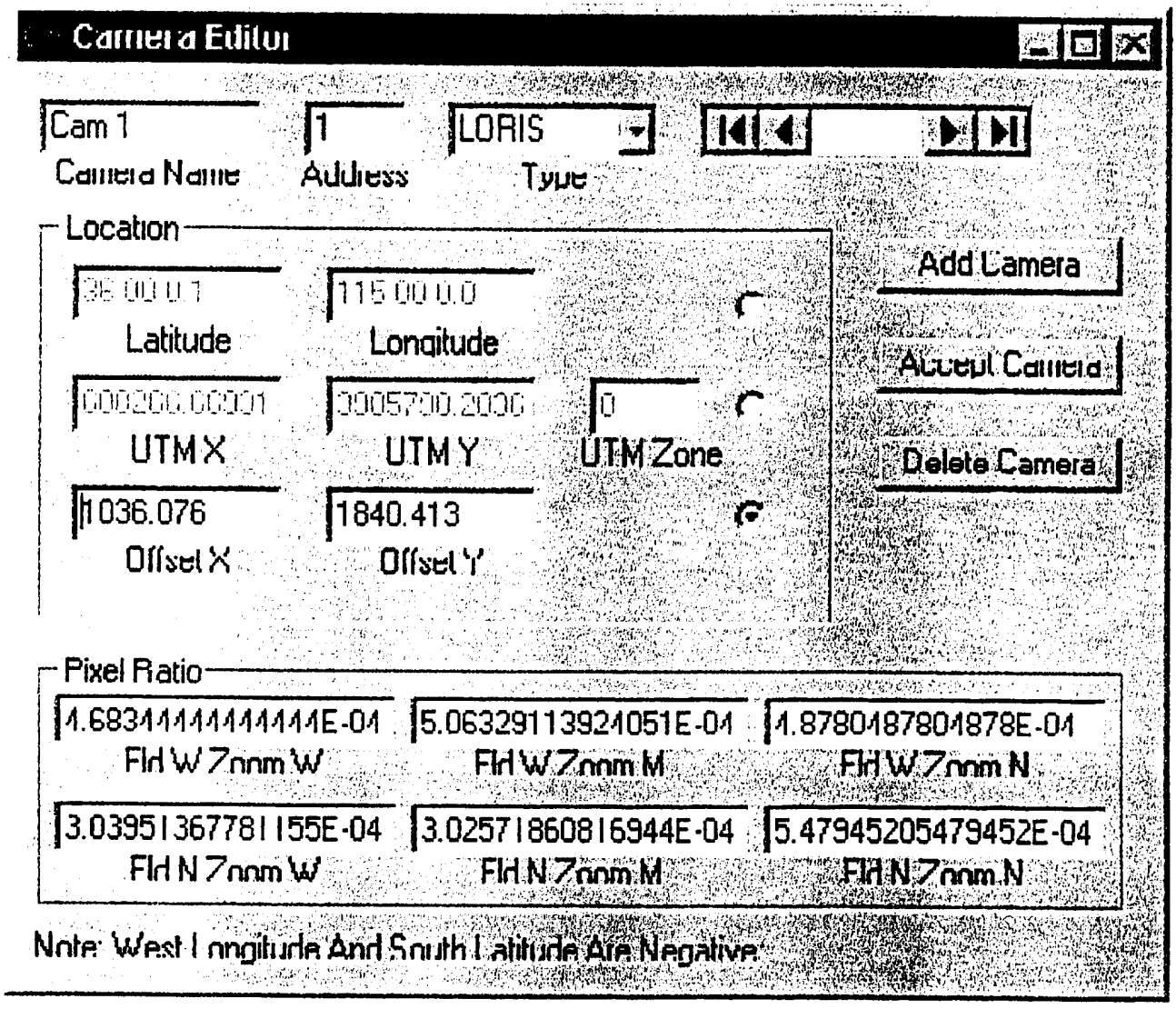
Camera Editor
Cam 1
Camera Name
1
Address
LORIS
Type
Location
Latitude
Longitude
UTM X
UTM Y
UTM Zone
1036.076
Offset X
1840.413
Offset Y
Add Camera
Accept Camera
Delete Camera
Pixel Ratio
1.68314111111111E-01
Fld W Znnm W
5.06329113924051E-01
Fld W Znnm M
1.87804878048781E-01
Fld W Znnm N
3.03951367781155E-04
Fld N Znnm W
3.02571860816944E-04
Fld N Znnm M
5.47945205479452E-04
Fld N Znnm N
Note: West Longitude And South Latitude Are Negative

Fig. 13

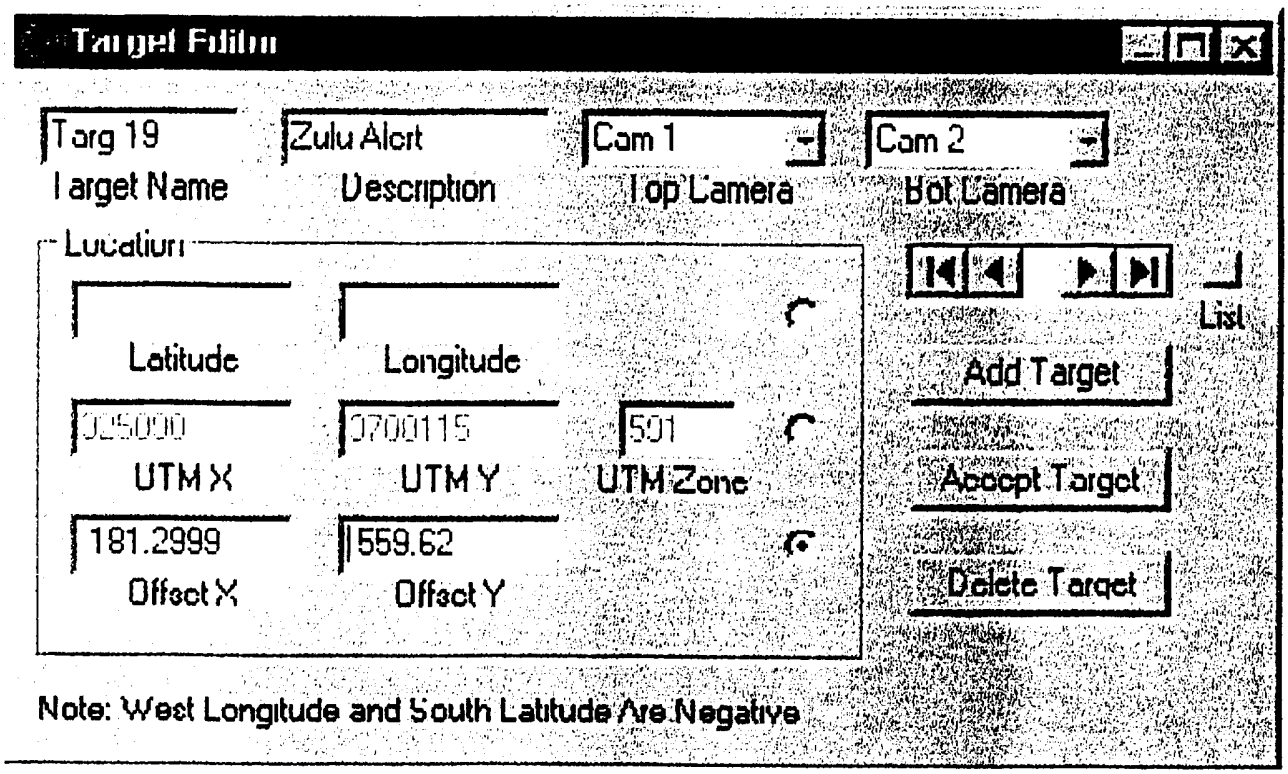
Target Editor
Targ 19
Target Name
Zulu Alert
Description
Cam 1
Top Camera
Cam 2
Bot Camera
Location
Latitude
Longitude
UTM X
UTM Y
UTM Zone
181.2999
Offset X
559.62
Offset Y
List
Add Target
Accept Target
Delete Target
Note: West Longitude and South Latitude Are Negative

Fig. 14

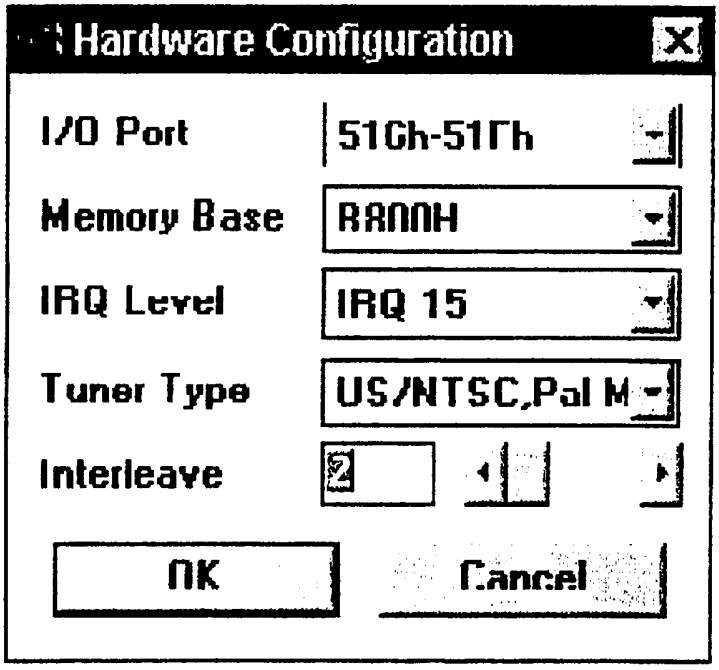
Hardware Configuration
I/O Port
510h-51Fh
Memory Base
R8000H
IRQ Level
IRQ 15
Tuner Type
US/NTSC,Pal M
Interleave
2
OK
Cancel

Fig. 15

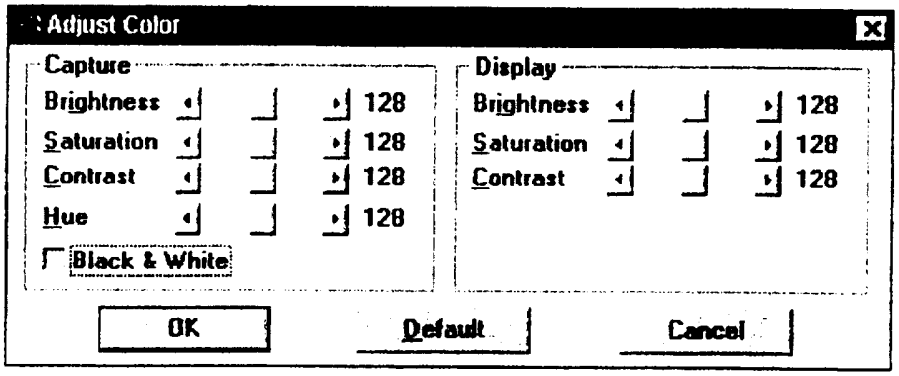
Adjust Color
Capture
Brightness 128
Saturation 128
Contrast 128
Hue 128
Black & White
Display
Brightness 128
Saturation 128
Contrast 128
OK
Default
Cancel

Fig. 16

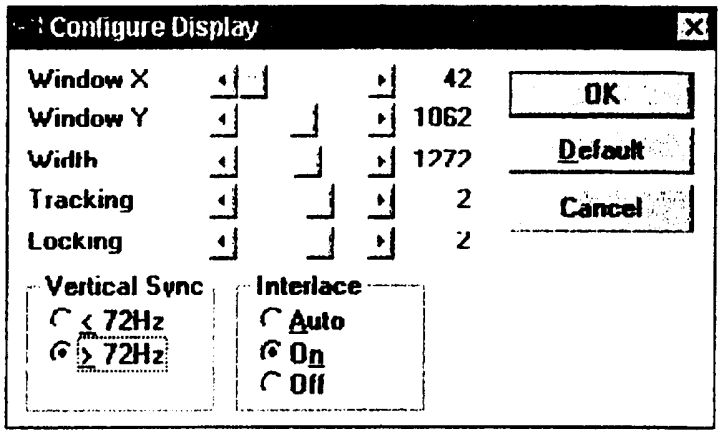
Configure Display
Window X
Window Y
Width
Tracking
Locking
42
1062
1272
2
2
OK
Default
Cancel
Vertical Sync
< 72Hz
> 72Hz
Interlace
Auto
On
Off

Fig. 17

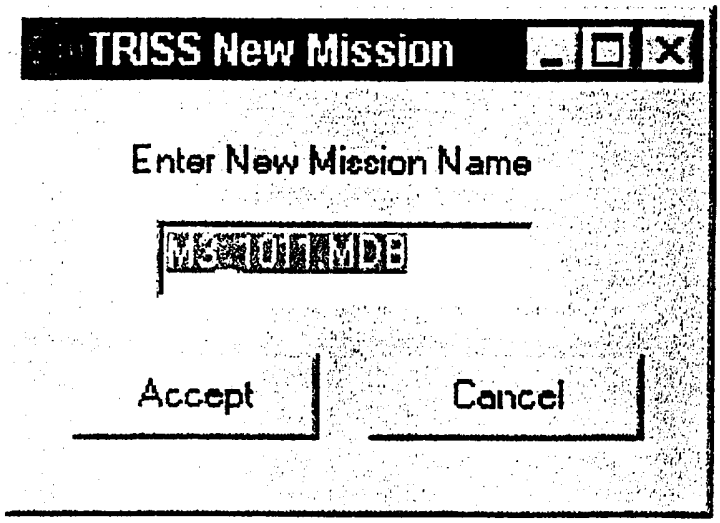

Fig. 18

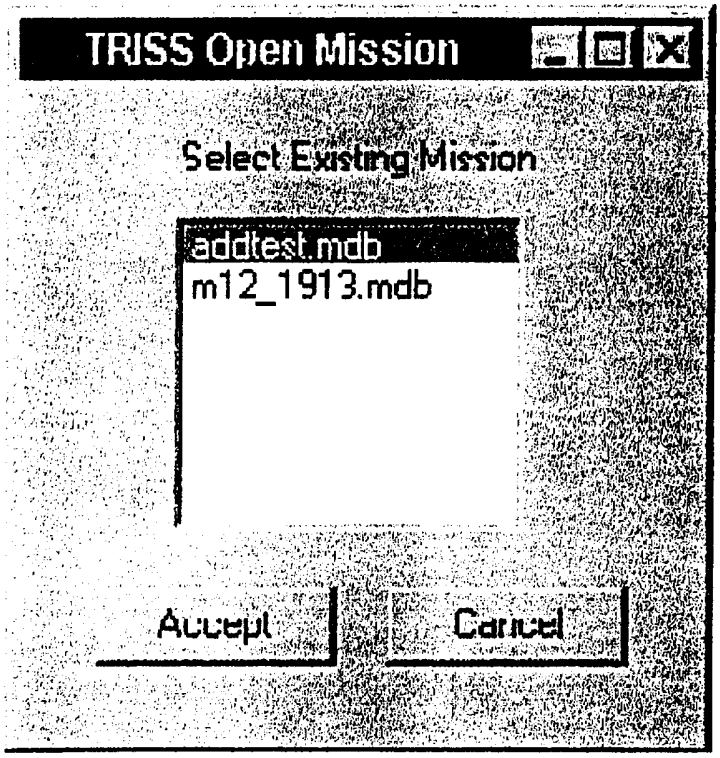
TRISS Open Mission
Select Existing Mission
addtest.mdb
m12_1913.mdb
Accept
Cancel

Fig. 19

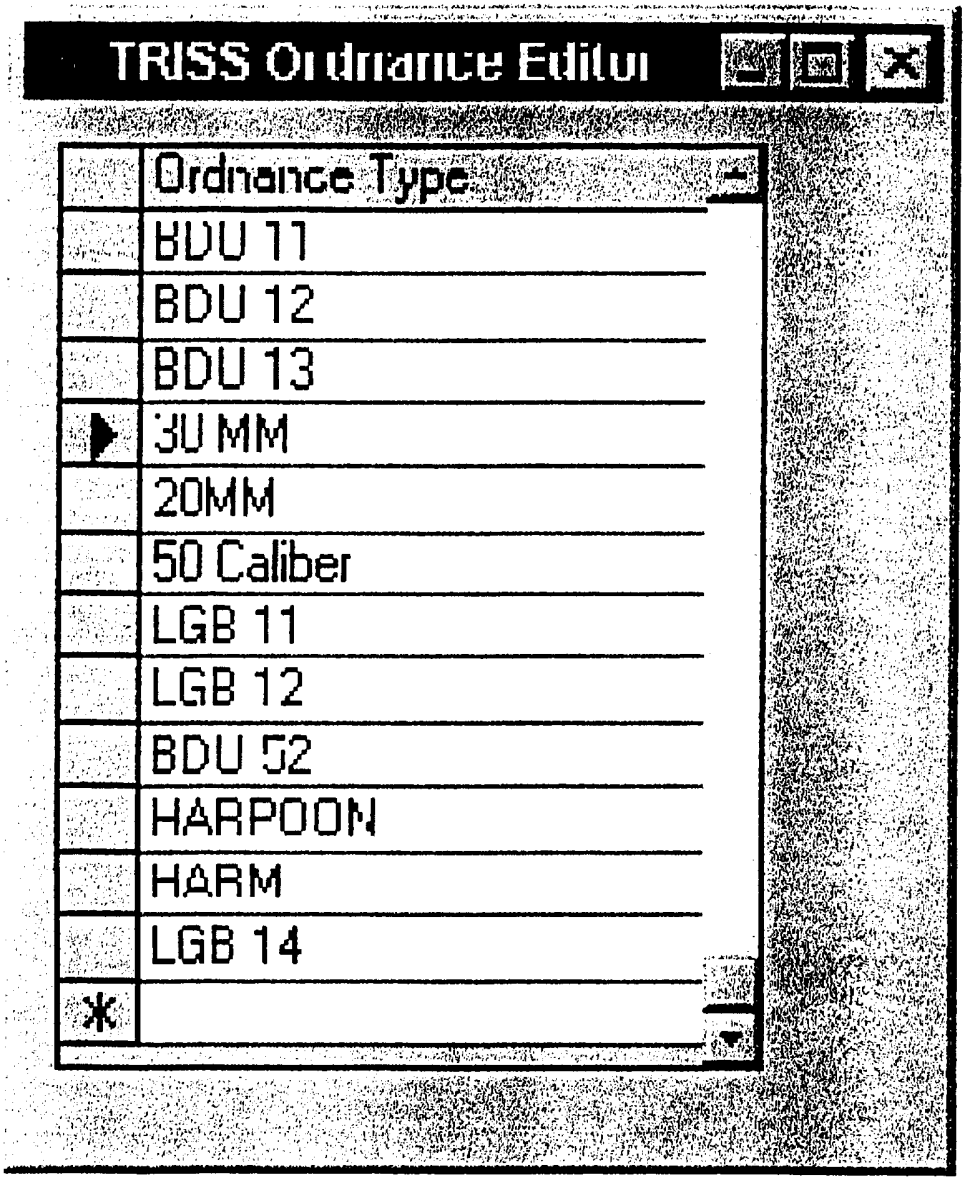
TRISS Ordnance Editor
Ordnance Type
BDU 11
BDU 12
BDU 13
30 MM
20MM
50 Caliber
LGB 11
LGB 12
BDU 52
HARPOON
HARM
LGB 14

Fig. 20

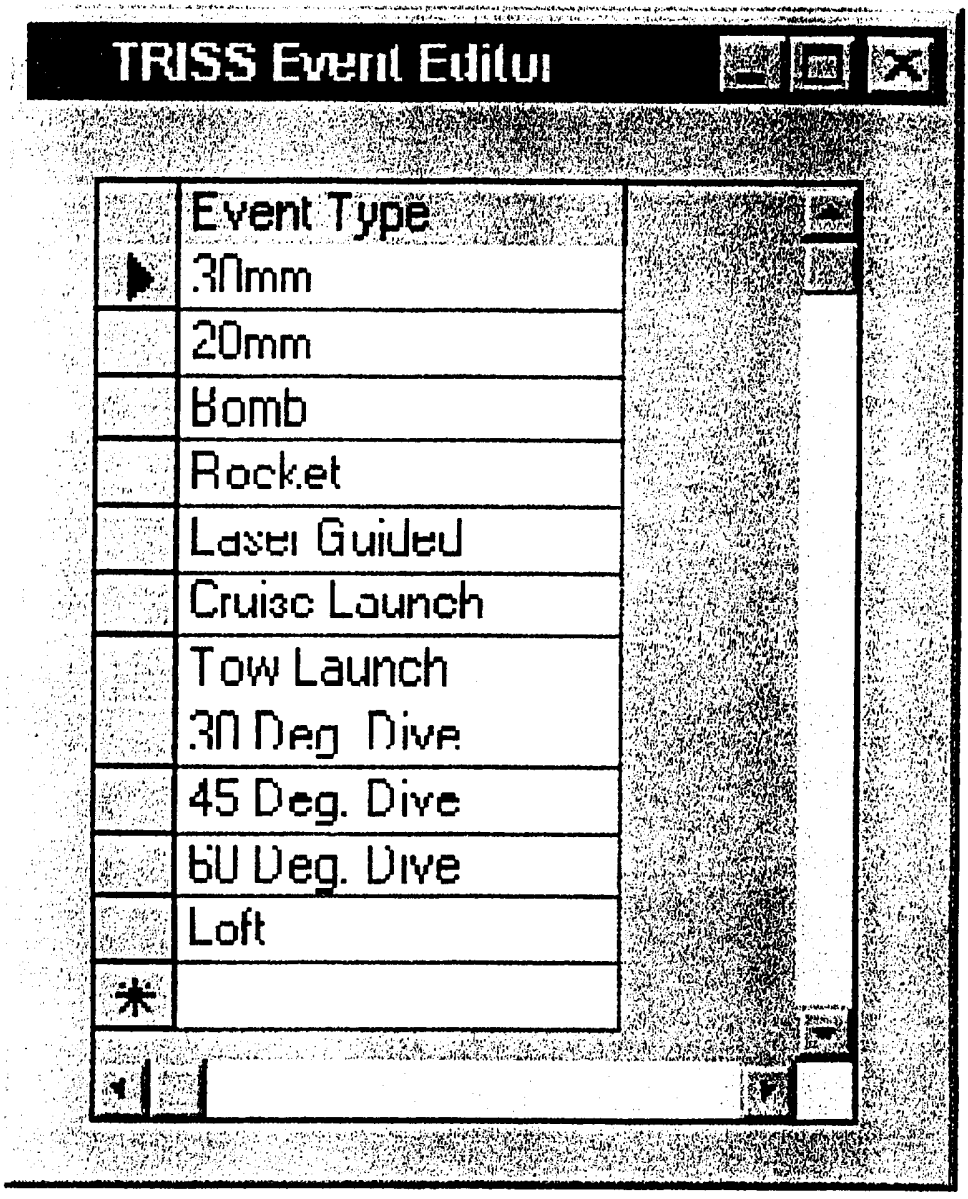
TRISS Event Editor
Event Type
30mm
20mm
Bomb
Rocket
Laser Guided
Cruise Launch
Tow Launch
30 Deg. Dive
45 Deg. Dive
60 Deg. Dive
Loft

Fig. 21

[FIGURE INTENTIONALLY OMITTED]

Fig. 22

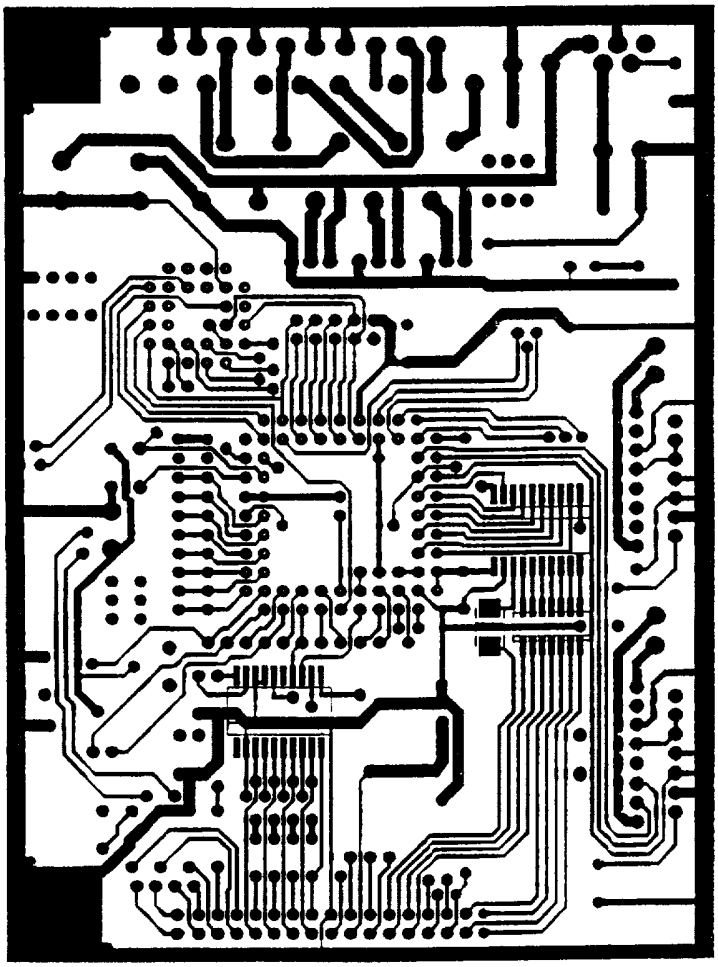

Fig. 23

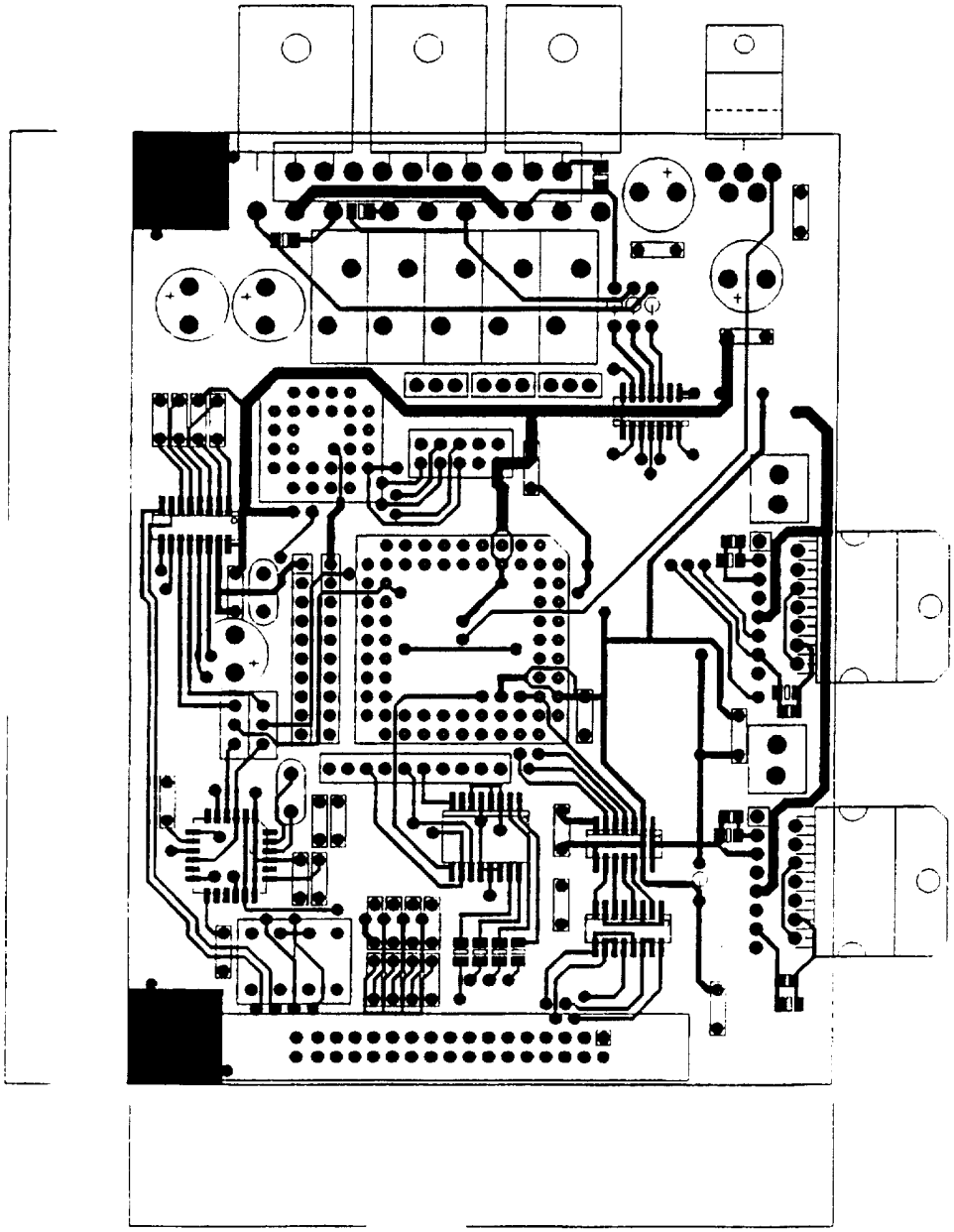

Fig. 24

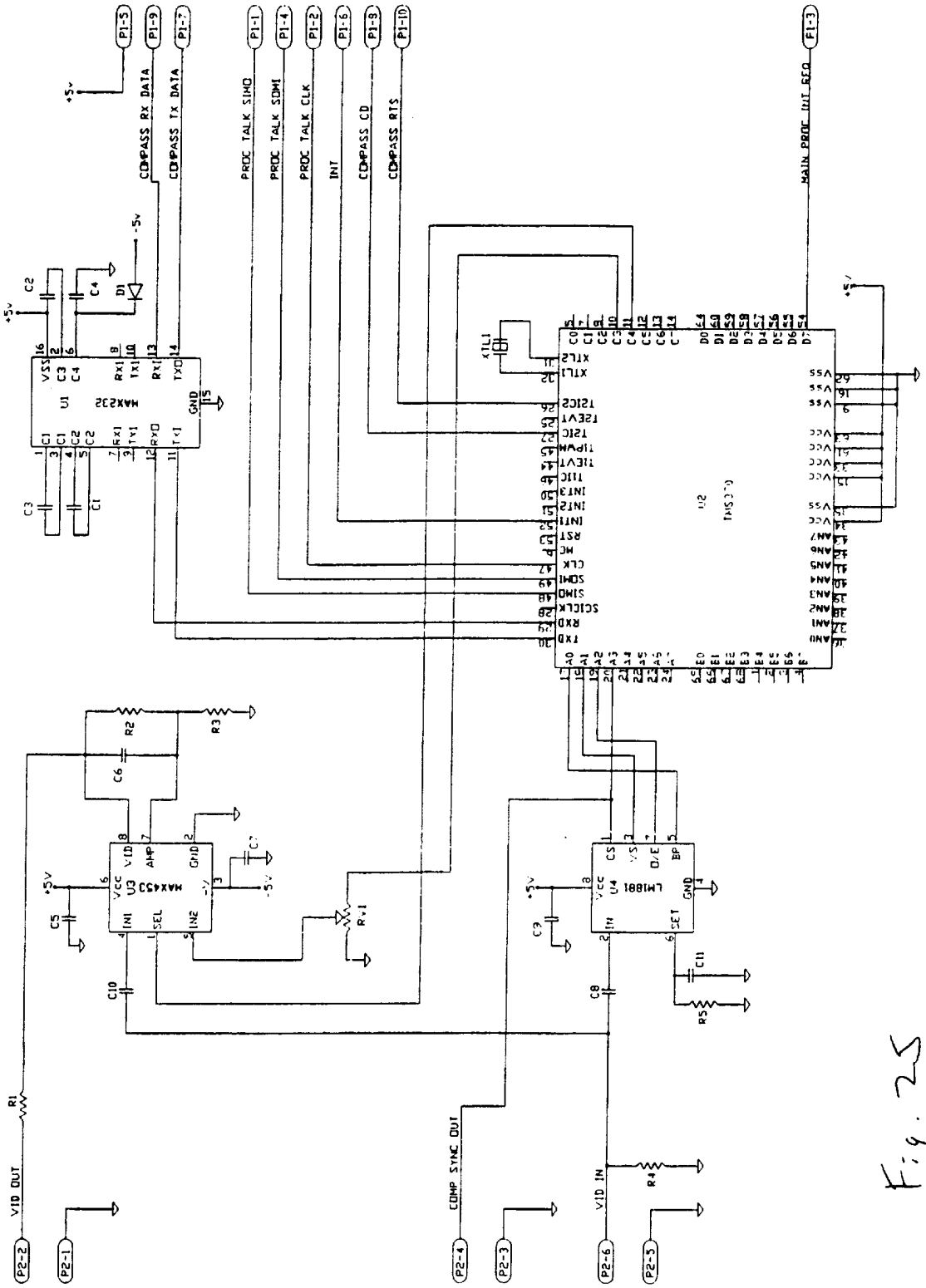
P1-5
P1-9
P1-7
P1-1
P1-4
P1-2
P1-6
P1-8
P1-10
P1-3
+5v
COMPASS RX DATA
COMPASS TX DATA
PROC TALK SIMO
PROC TALK SOMI
PROC TALK CLK
INT
COMPASS CD
COMPASS RTS
MAIN PROC INT REQ
D1
C2
C4
C3
C1
MAX232
U5
VSS
GND
R1
R2
R3
C6
C7
C5
C10
MAX453
U3
VID
AMP
GND
Vcc
INI
SEL
IN2
-V
RV1
C9
C11
C8
R5
R4
LM1881
U4
CS
D/E
BP
SET
VID OUT
VID IN
COMP SYNC OUT
P2-2
P2-1
P2-4
P2-3
P2-6
P2-5

Fig. 25

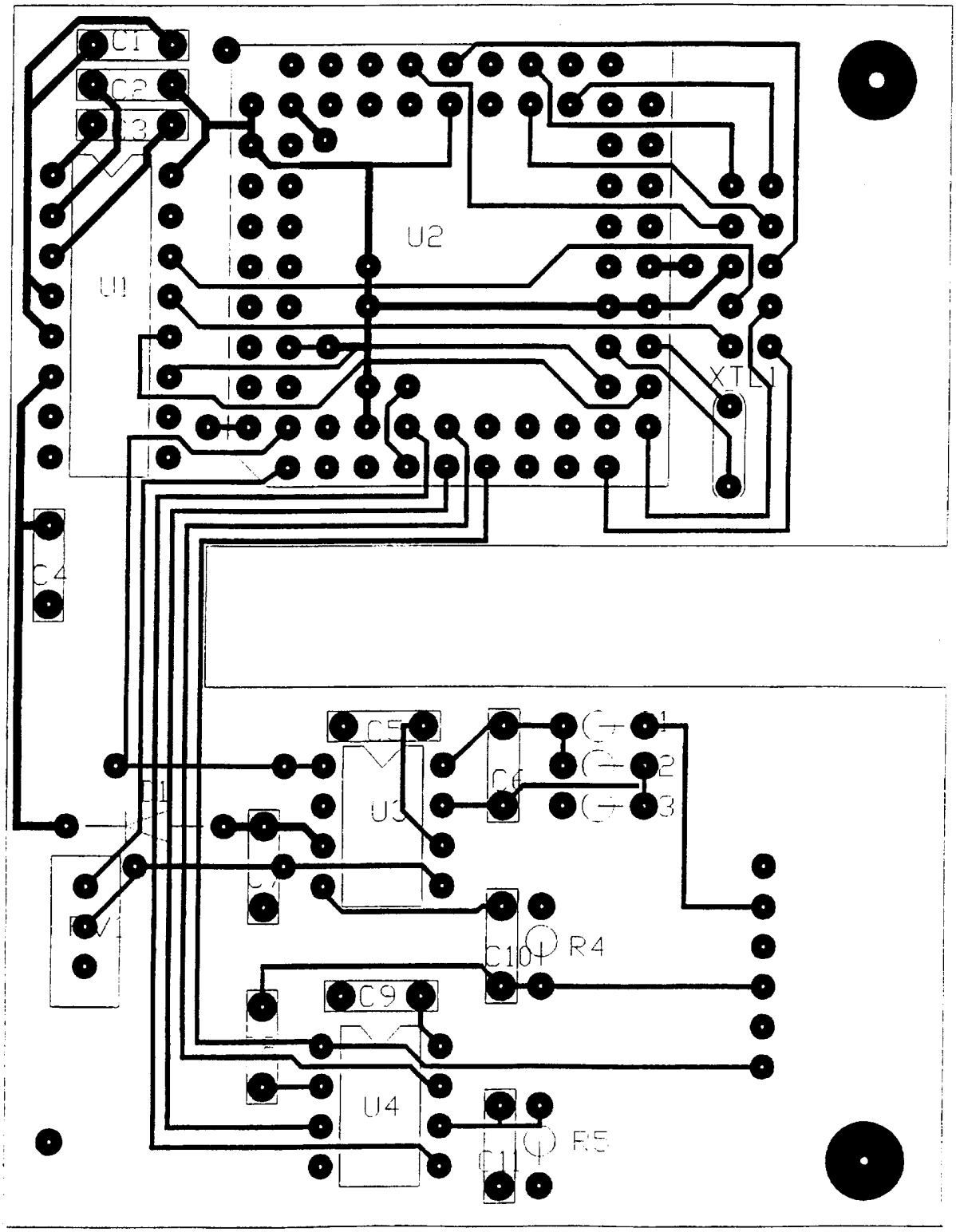

Fig. 26

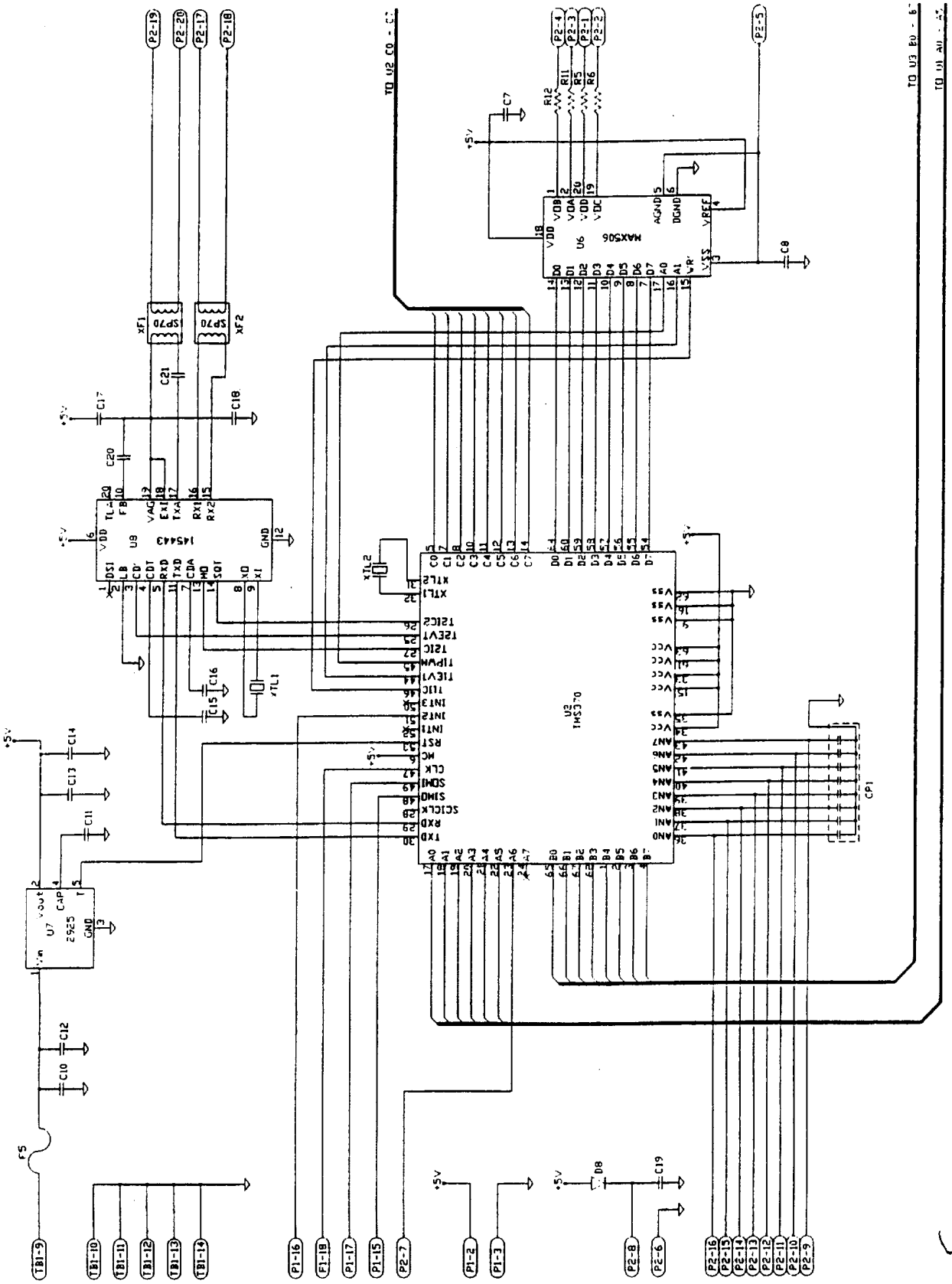

Fig. 27

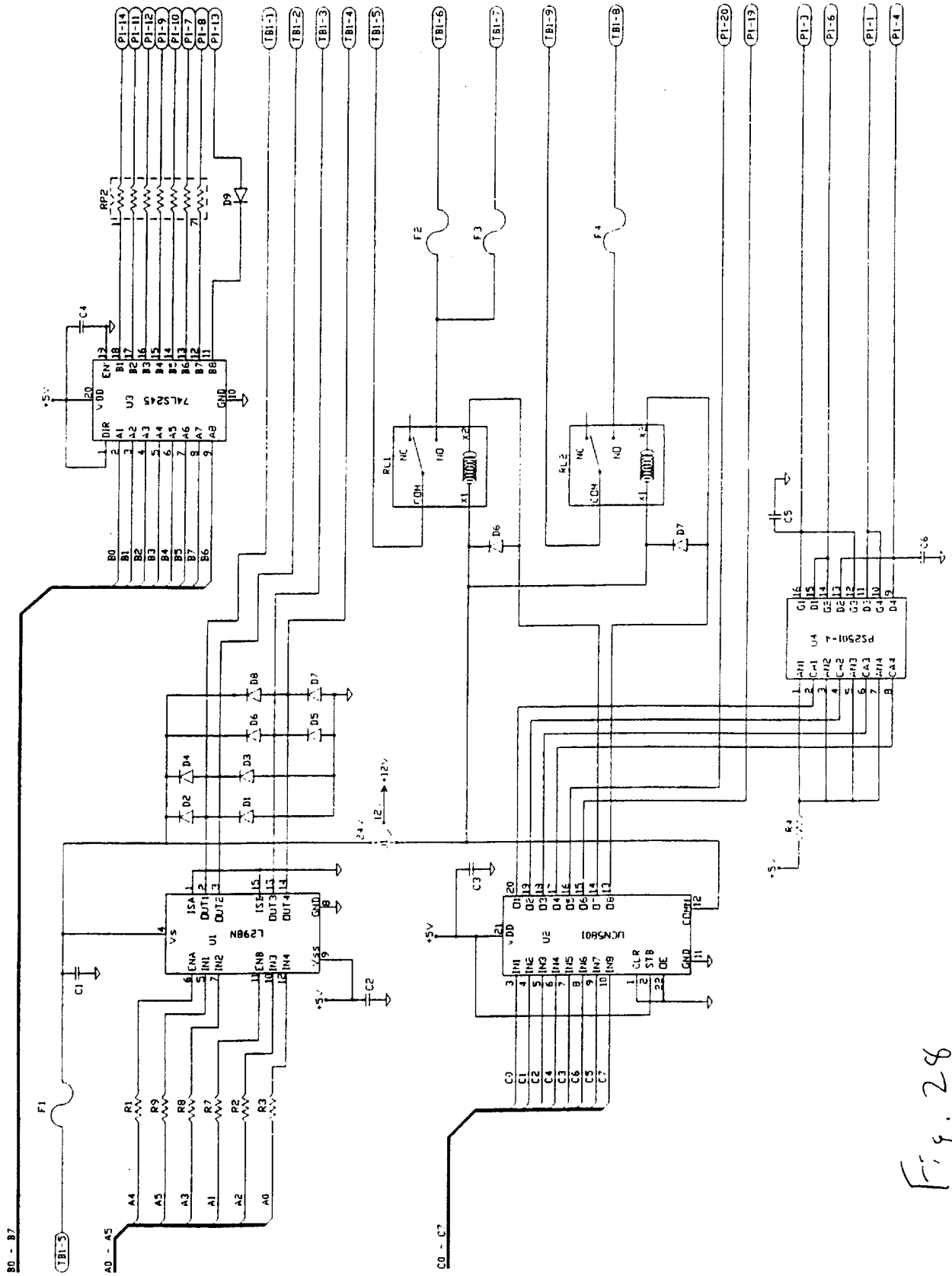
P1-14
P1-11
P1-12
P1-9
P1-10
P1-7
P1-8
P1-13
TB1-1
TB1-2
TB1-3
TB1-4
TB1-5
TB1-6
TB1-7
TB1-9
TB1-8
P1-20
P1-19
P1-3
P1-5
P1-1
P1-4
RP2
D9
C4
74LS245
U3
F2
F3
F4
RL1
RL2
D6
D7
C5
C6
PS2501-4
U4
D8
D5
D4
D3
D2
D1
+12V
C3
LCN5801
U2
L298N
U1
ISA
OUT1
OUT2
ISB
OUT3
OUT4
GND
VS
VSS
ENA
IN1
IN2
ENB
IN3
IN4
C1
C2
F1
R1
R9
R8
R7
R2
R3
B0 - B7
A0 - A5
C0 - C7

Fig. 28

[FIGURE INTENTIONALLY OMITTED]

Fig. 29

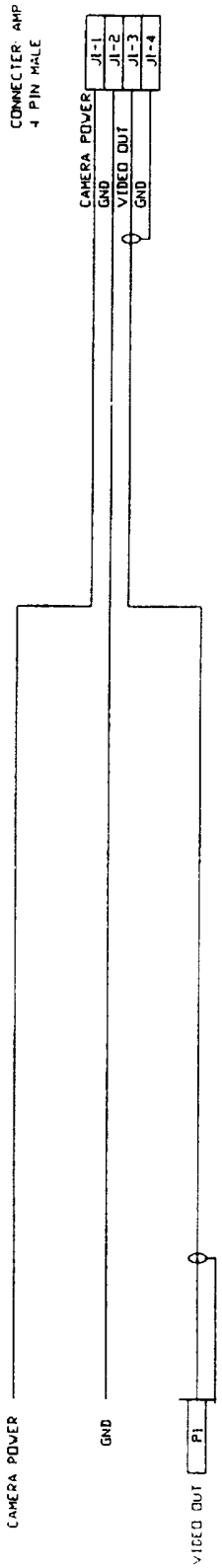
CONNECTER AMP
4 PIN MALE
J1-1
J1-2
J1-3
J1-4
CAMERA POWER
GND
VIDEO OUT
GND
CAMERA POWER
GND
P1
VIDEO OUT

Fig. 3J

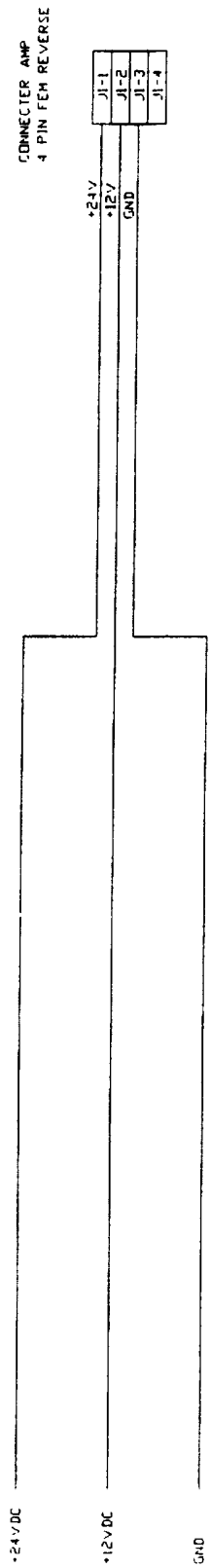
CONNECTER AMP
4 PIN FEM REVERSE
J1-1
J1-2
J1-3
J1-4
+24V
+12V
GND
+24VDC
+12VDC
GND

Fig. 31

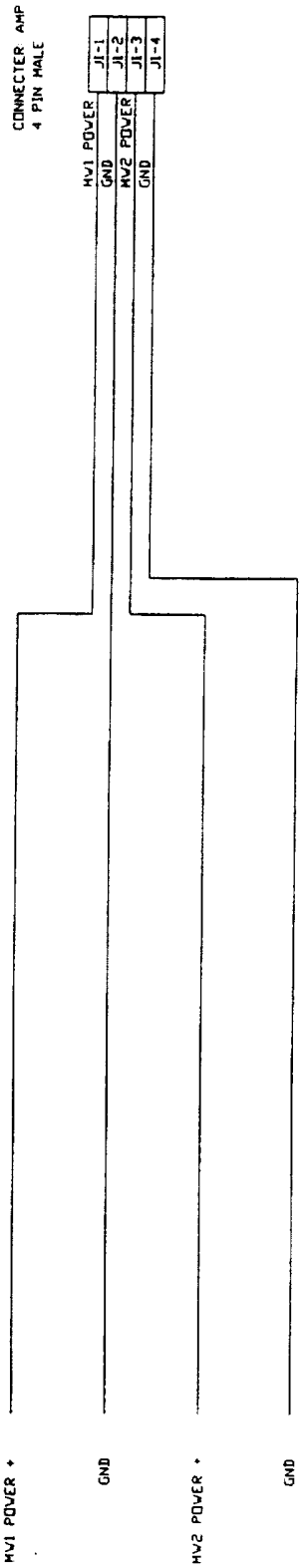
CONNECTER AMP
4 PIN MALE
J1-1
J1-2
J1-3
J1-4
HV1 POWER
GND
HV2 POWER
GND
HV1 POWER +
GND
HV2 POWER +
GND

Fig. 32

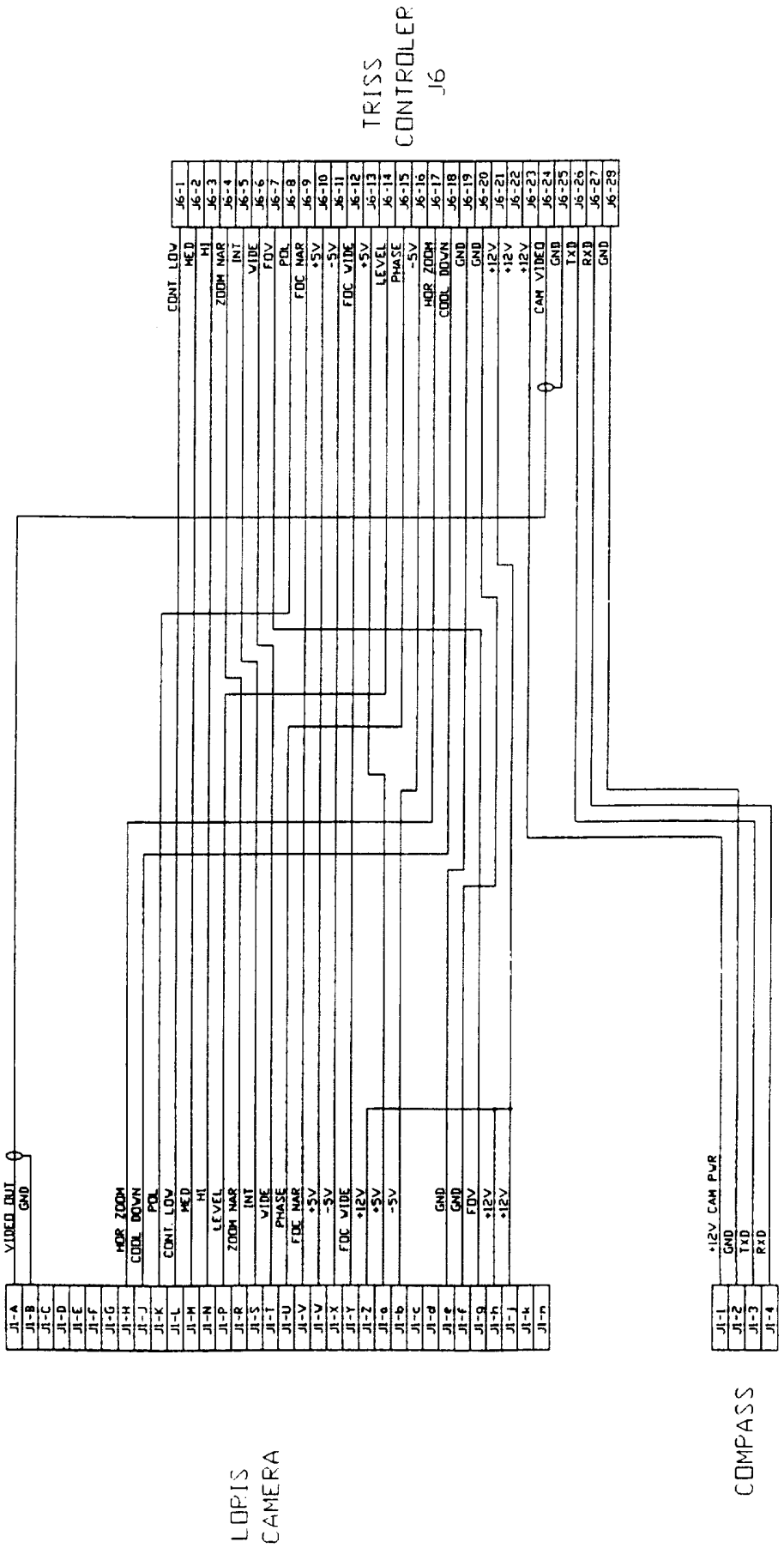
TRISS
CONTROLER
J6
J6-1 CONT LOV
J6-2 MED
J6-3 HI
J6-4 ZOOM NAR
J6-5 INT
J6-6 VIDE
J6-7 FOV
J6-8 POL
J6-9 FOC NAR
J6-10 +5V
J6-11 -5V
J6-12 FOC VIDE
J6-13 +5V
J6-14 LEVEL
J6-15 PHASE
J6-16 -5V
J6-17 HOR ZOOM
J6-18 COOL DOWN
J6-19 GND
J6-20 GND
J6-21 +12V
J6-22 +12V
J6-23 +12V
J6-24 CAM VIDEO
J6-25 GND
J6-26 TXD
J6-27 RXD
J6-28 GND
LOPIS
CAMERA
J1-A VIDEO OUT
J1-B GND
J1-C
J1-D
J1-E
J1-F
J1-G
J1-H HOR ZOOM
J1-J COOL DOWN
J1-K POL
J1-L CONT LOV
J1-M MED
J1-N HI
J1-P LEVEL
J1-R ZOOM NAR
J1-S INT
J1-T VIDE
J1-U PHASE
J1-V FOC NAR
J1-V +5V
J1-X -5V
J1-Y FOC VIDE
J1-Z +12V
J1-a +5V
J1-b -5V
J1-c
J1-d GND
J1-e GND
J1-f FOV
J1-g +12V
J1-h +12V
J1-J
J1-K
J1-n
COMPASS
J1-1 +12V CAM PWR
J1-2 GND
J1-3 TXD
J1-4 RXD

Fig. 33

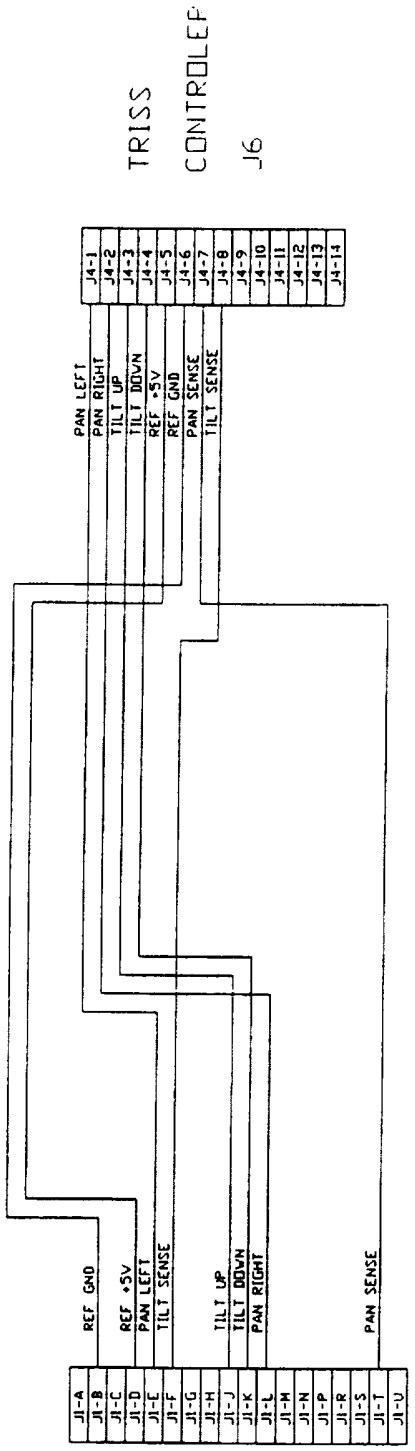
TRISS
CONTROLER
J6
J4-1
J4-2
J4-3
J4-4
J4-5
J4-6
J4-7
J4-8
J4-9
J4-10
J4-11
J4-12
J4-13
J4-14
PAN LEFT
PAN RIGHT
TILT UP
TILT DOWN
REF +5V
REF GND
PAN SENSE
TILT SENSE
J1-A
J1-B
J1-C
J1-D
J1-E
J1-F
J1-G
J1-H
J1-J
J1-K
J1-L
J1-M
J1-N
J1-P
J1-R
J1-S
J1-T
J1-U
REF GND
REF +5V
PAN LEFT
TILT SENSE
TILT UP
TILT DOWN
PAN RIGHT
PAN SENSE
OPT-90
FAN & TILT
UNIT

Fig. 34