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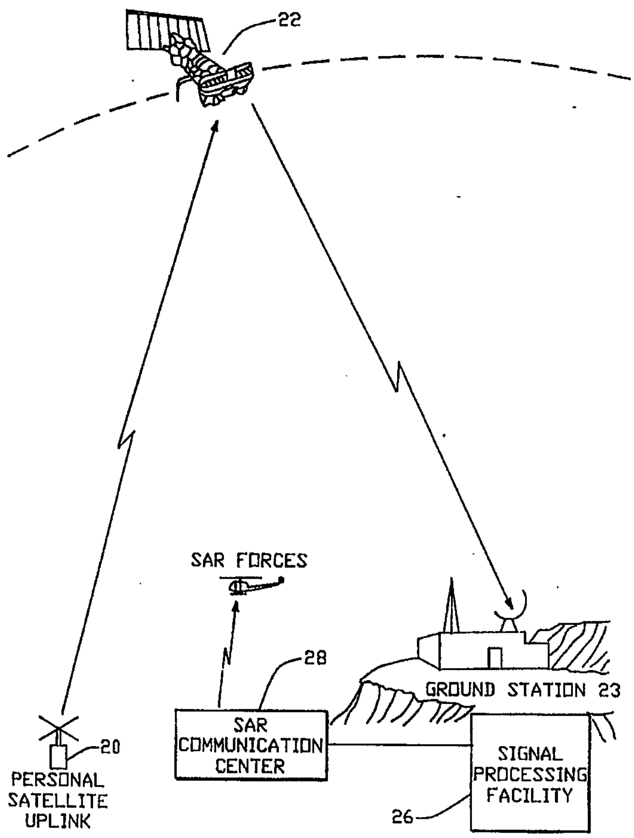
(54) Title: PERSONAL SATELLITE LINK WITH USER IDENTIFIER

(57) Abstract

A personal satellite link (20) including a memory that stores a user identifier. The user identifier provides an index into a database (56) that contains a set of user information corresponding to the user of the personal satellite link. The personal satellite link (20) includes a transmitter (40) having circuitry that generates a radio frequency uplink signal that carries the user identifier, which is relayed through a satellite system (22) to a ground station signal processing facility (26) which indexes the database (56). The location of the user is determined by the satellite (22) and is forwarded to search and rescue forces, along with the personal information.



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PERSONAL SATELLITE LINK WITH USER IDENTIFIER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention pertains to the field of satellite communication systems. More particularly, this invention relates to a small personal satellite link that can be worn on the person and that includes an uplink world-wide personal locating and access to a user database.

Art Background

One existing satellite system designed to assist in search and rescue operations is known as the COSPAS (space system for the search of vessels in distress) - SARSAT (search and rescue satellite aided tracking) system. The COSPAS-SARSAT system is an international satellite system for search and rescue established and operated by Canada, France, Russia, and the U.S.A. The COSPAS-SARSAT system was initially set up for the detection and location of an aircraft crash or of a maritime distress.

The COSPAS-SARSAT system includes a set of COSPAS spacecraft and a set of SARSAT spacecraft that orbit the earth in a relatively low polar orbit. The COSPAS-SARSAT system employs distress beacons to provide alert and location data to the proper rescue coordination centers based upon the position on land or water of the distress beacon.

Unlike the Global Position Satellite (GPS) system discussed below, the COSPAS-SARSAT system determines global location by measuring the Doppler shift in a distress signal emitted by a distress beacon. The Doppler shift indicates the relative motion between an individual spacecraft and the distress beacon. The Doppler shift information along with an identifier code emitted by the distress beacon and time stamp information is transmitted by the individual spacecraft to a ground station. The ground station uses the information to determine the global location of the distress beacon. Typically, the ground station uses the global location of the distress beacon to contact the appropriate local authorities to undertake a search and rescue mission.

The COSPAS-SARSAT system has the advantage of relatively low cost because the information carried by the distress signal emitted by the distress beacon contains only a brief bitstream for relay by the satellites to ground stations. For example, distress beacons contained on maritime vessels typically transmit only the name of the vessel along with a home port for the vessel.

Such a limited information bitstream simplifies the electronics contained within the distress beacons and the electronics carried aboard the spacecraft, which thereby reduces the overall cost and complexity of the system. Unfortunately, such a limited amount of information available in the bit stream necessarily limits the information available for undertaking an appropriate rescue mission.

Another satellite system that enables world-wide location is known as the Global Positioning Satellite (GPS) system. Unfortunately, the GPS system requires that complex electronics be contained in an earth station transceiver because a GPS receiver must be capable of accessing numerous orbital GPS satellites simultaneously. Such a complex transceiver is usually expensive and cumbersome, and is therefore unsuitable for activities such as backpacking or skiing.

SUMMARY AND OBJECTS OF THE INVENTION

One object of the present invention is to provide a personal satellite link.

Another object of the present invention is to provide a personal satellite link that enables system operators to access a user pre-defined database to accommodate emergency operations.

A further object of the present invention is to provide a personal satellite link that enables world-wide locating.

Another object of the present invention is to provide a lightweight direct transmission link to an orbital satellite wherein the satellite link can be worn as conveniently as a wristwatch or carried inconspicuously by the user.

These and other objects are provided by a personal satellite link which includes a memory that stores a user identifier code for the personal satellite link. The user identifier code provides an index into a database that contains a set of user information corresponding to the personal satellite link. The personal satellite link includes a transmitter having circuitry that generates a radio frequency uplink signal that carries the user identifier. The user identifier is relayed through a satellite system to a ground facility that provides access to the data base according to the user identification.

Other objects, features, and advantages of the present invention will be apparent from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described with respect to particular embodiments thereof and references accordingly made to the drawings in which:

Fig. 1 illustrates a pair of COSPAS-SARSAT satellites and a personal satellite link;

Fig. 2 illustrates the personal satellite link for use in a search and rescue (SAR) application;

Fig. 3 illustrates communication between the personal satellite link, a COSPAS-SARSAT satellite spacecraft, and a signal processing facility;

Fig. 4 illustrates the radio frequency uplink signal generated by the personal satellite link;

Fig. 5 is a block diagram of the personal satellite link;

Fig. 6 illustrates the microprocessor in the personal satellite link that provides a unique user identifier for the personal satellite link;

Fig. 7 illustrates the modulator of the personal satellite link;

Fig. 8 illustrates the frequency synthesizer of the personal satellite link;

Fig. 9 illustrates the power amplifier of the personal satellite link;

Fig. 10 illustrates the battery subsystem of the personal satellite link;

Fig. 11 illustrates the data encoding employed by the personal satellite link;

Figs. 12 and 13 illustrate two possible form factors for the personal satellite link which show relative configurations for the antenna, the electronics, and the battery.

DETAILED DESCRIPTION

A personal satellite link is disclosed that functions as a satellite earth station with an uplink capability to provide world-wide location and access to a user database. The personal satellite link provides a lightweight direct link to orbital satellites permitting the transmission of digital messages. The personal satellite link can be worn as conveniently as a wristwatch or incorporated with other equipment. One application of the personal satellite link, namely life saving, uses the uplink capability as described below.

Fig. 1 illustrates a pair of COSPAS-SARSAT satellites 22 and 24 and a personal satellite link 20. The personal satellite link 20 may also be referred to as a personal satellite earth station or ground station. The personal satellite link 20 is shown positioned at a point on the earth and the COSPAS-

SARSAT satellites 22 and 24 orbit the earth in a polar orbit of approximately 850 km in altitude. Each of the COSPAS-SARSAT satellites 22 and 24 orbit the earth in approximately 44 minutes.

The personal satellite link 20 transmits a relatively stable uplink signal that includes a digital message. The COSPAS-SARSAT satellites 22 and 24 measure the Doppler shift in the uplink signal and recover the encoded digital message. The recovered information is transmitted through a downlink to a ground station that is provided for processing signals from the personal satellite link 20. The ground station uses the encoded digital message including a user identification code to access a user pre-defined data base.

Fig. 2 illustrates the personal satellite link 20 for use in a search and rescue (SAR) application. In such an application, a user in distress (not shown) activates the personal satellite link 20 which emits a radio frequency signal uplink signal that includes a digital message generated by the personal satellite link 20.

The radio frequency uplink signal is received by the satellite 22 which is in view of the personal satellite link 20 in this example. The satellite 22 measures the Doppler shift of the radio frequency uplink signal. The satellite 22 also recovers the digital message contained in the radio frequency uplink signal. The satellite 22 internally stores the recovered digital message along with a time tag and the measured Doppler shift of the uplink signal generated by the personal satellite link 20.

The satellite 22 has the capability to immediately transmit the Doppler shift, time tag, and recovered digital message to a ground station such as a ground station 23. Alternatively, the satellite 22 stores the information until an appropriate ground station such as the ground station 23 is in view and then transmits the stored Doppler shift, time tag, and digital message to the ground station 23 through a downlink.

In one embodiment, the downlink from the satellite 23 to the ground station 23 is a direct transmitter-receiver arrangement. In another embodiment, the downlink includes a transmission path between the satellite 22 and another satellite (not shown) which is positioned in a geosynchronous equatorial orbit of the earth. In this embodiment, the geosynchronous satellite relays the Doppler shift, time tag, and digital message from the satellite 22 to the ground station 23.

In one embodiment, the ground station 23 includes a signal processing facility 26 on-site. In another embodiment, the ground station 23 transfers the Doppler shift, time tag, and digital message received via the downlink to a signal processing facility 26 managed by system operations for the personal satellite link 20 in a remote location. In such an embodiment, the Doppler shift, time tag, and digital message may be transferred to the remote signal processing facility 26 via a wide variety of communication channels including common-carrier links such as telephone or data links which may include land-line, microwave, or other satellite links.

The signal processing facility 26 employs the user identifier contained in the digital message transmitted by the personal satellite link 20 to access a database that contains pre-defined user information for the distressed user of the personal satellite link 20. In a search and rescue application, the pre-defined user information may include, for example, the user's blood type and medical history, as well as information that specifies particular authorities or persons to contact upon activation of the personal satellite link 20.

In other embodiments, the personal satellite link 20 can track a stolen car or locate a lost child. The personal satellite link 20 can be combined with addressability to provide world-wide point to point communication such as paging and other messaging services.

The signal processing facility 26 uses the Doppler shift information in conjunction with the time tag information from the satellite 22 to determine the global position of the personal satellite link 20. A discussion of the conversion of doppler time shift and time tag information into global position is found in COSPAS-SARSAT publications including C/S T.002, entitled *"COSPAS-SARSAT Local User Terminal Performance Specification and Design Guidelines,"* September 1993 and C/S T.005, entitled "COSPAS-SARSAT LUT Commissioning Standard," December 1993, which are incorporated herein by reference.

The signal processing facility 26 transfers the global position of the personal satellite link 20 along with the user-defined information from data base to a search and rescue communication center 28. The search and rescue communication center 28 then dispatches the appropriate search and rescue forces to the distressed user of the personal satellite link 20.

Fig. 3 illustrates communication between the personal satellite link 20, the satellite spacecraft 22, and the signal processing facility 26 of the ground station 23. The personal satellite link 20 contains a 406 megahertz transmitter 40. The transmitter 40 generates a relatively stable radio frequency uplink signal that contains a digitally encoded user identifier that identifies the user of the personal satellite link 20. Table 1 describes the characteristics of the transmitter 40.

Table 1:

Parameter	Value
RF Signal:	
Carrier frequency	406.025 ±0.005 MHz
Frequency stability:	
•Short term	≤ 2 x 10^{-9} /100 ms
•Medium term	
-Mean Slope	≤ 1 x 10^{-9} /minute
-Residual freq. variation	≤ 3 x 10^{-9}
Power output	5 W ±2 dB
Data encoding	Bi-phase L
Modulation	Phase modulation of ±(1.1) radians peak
Failure mode	Continuous transmission of carrier not to exceed 45 s
Digital Message:	
Repetition Period	50 s ±5%
Transmission Time	440 ms (short message) 520 ms (long message)
CW Preamble	160 ms
Digital Message	
•short message	112 bits (280 ms)
•long message	144 bits (360 ms)
Bit Rate	400 bps
Operating Temperature Range:	
•Class 1	-40°C to 55°C
•Class 2	-20°C to 55°C
Thermal shock	-30°C temperature difference
Operating Life Time:	At least 24 hours at minimum temperature

The satellite spacecraft 22 includes a 406 MHz receiver 42, a 406 MHz receiver-processor 44, a satellite memory 48, and a 1544.5 MHz transmitter 46. The receiver-processor 44 receives the radio frequency uplink signal from the transmitter 40 and recovers the encoded digital data including the user identifier of the personal satellite link 20. The receiver-processor 44 also measures the Doppler shift in the radio frequency uplink signal from the personal satellite link 20 and generates a time tag.

The recovered digital data, the Doppler shift data, and the time tag are stored in satellite memory 48 for subsequent transmission to a ground station such as the ground station 23. Once the ground station 23 is within appropriate range and view of the satellite spacecraft 22, the transmitter 46 transmits the stored user identifier, Doppler shift, and time tag information from the satellite memory 48 to the signal processing facility 26 through a downlink provided by the ground station 23.

The signal processing facility 26 includes a 1544.5 MHz receiver 50, a processor 52, a communication interface 54, and a database 56. The receiver 50 provides a 1544.5 MHz downlink from the transmitter 46 on the satellite spacecraft 22. The processor 52 uses the time tag and Doppler shift information received from the satellite spacecraft 22 to determine the global position for the personal satellite link 20. The techniques used to determine the global position of the personal satellite link 20 are further described in COSPAS-SARSAT documents including C/S T.001 entitled *"Specification for COSPAS-SARSAT 406 MHz Distress Beacons," September 1994,* and C/S G.003 entitled

"Introduction to the *COSPAS-SARSAT* system," December 1994, which are both incorporated herein by reference.

The processor 52 uses the user identifier of the personal satellite link 20 relayed by the satellite spacecraft 22 to index the database 56 which contains user pre-defined data. The signal processing facility 26 includes the appropriate computer hardware and software for enabling information access to the database 56. The user pre-defined data from the database 56 along with the global location information determined for the personal satellite link 20 are then available for transfer to the search and rescue communication center 28 via the communication interface 54. The communication interface 54 may also enable communication with COSPAS-SARSAT Mission Control Centres as described in C/S A.002 entitled "COSPAS-SARSAT Mission Control Centres Standard Interface Description," September 1994, C/S A.005 entitled "COSPAS-SARSAT Mission Control Centre (MCC) Performance Specification and Design Guidelines," December 1993, and C/S A.006 entitled "COSPAS-SARSAT Mission Control Centre Commissioning Standard," September 1993, which are incorporated herein by reference.

The transmitter 40 generates an approximately 5 watt radio frequency uplink signal burst of approximately 0.5 seconds duration every 50 seconds. The carrier frequency of the uplink signal from the transmitter 40 is stable and the uplink signal pulse is phase-modulated with a digital message that includes the user identifier. The frequency stability of the transmitter 40 enables the Doppler shift measurement by the receiver-processor 44. In addition, the relatively high peak power of 5 watts increases the probability of detection of the uplink signal by the satellite spacecraft 22. The peak power of the transmitter 40 can be increased or decreased in other embodiments.

Fig. 4 illustrates the radio frequency uplink signal generated by the personal satellite link 20 for one embodiment. The uplink signal includes a carrier portion of 160 milliseconds duration. The carrier portion consists of an unmodulated 406.025 ± .005 MHz carrier signal from the transmitter 40. The bit sync portion of the uplink signal consists of 15 consecutive "1" bits. The frame sync portion of the uplink signal is a 9-bit pattern of 000101111. The uplink signal includes a payload length flag that indicates the length of a message payload in the uplink signal. The message payload may be either 87 bits or 119 bits according to the payload length flag.

Fig. 5 is a block diagram that illustrates the personal satellite link 20. The personal satellite link 20 includes a microprocessor 60, a modulator 62, and a power amplifier 64 that drives an antenna 90. The personal satellite link 20 also includes a battery subsystem 68 and a frequency synthesizer 66.

The microprocessor 60 generates the digital message contained in the radio frequency uplink signal including the user identifier. The microprocessor 60 stores the user identifier or transmitter identifier for the personal satellite link 20 in an internal electrically alterable read-only memory within the microprocessor 60. The digital message including user identifier is transferred via a set of modulation signals 80 to the modulator 62.

The microprocessor 60 also generates control signals 86 and 88 that control the power duty cycles of the various elements of the personal satellite link 20.

The microprocessor 60 programs the frequency synthesizer 66 which generates a stable uplink carrier or transmit frequency for the modulator 62 via a signal 84. The modulator 62 uses the modulation signals 80 to modulate the uplink carrier frequency 84.

The modulator 62 generates a radio frequency uplink signal 82 by modulating the uplink carrier frequency 84 with the modulation signals 80. The radio frequency uplink signal 82 is transferred to the power amplifier 64 for transmission via the antenna 90.

Fig. 6 illustrates the microprocessor 60 for one embodiment. The microprocessor 60 provides the modulation signals 80 according to the pre-programmed contents of an internal electrically alterable read-only memory. The preprogrammed contents in the microprocessor 60 include a unique user identifier or transmitter identifier for the personal satellite link 20. Alternatively, the unique user identifier may be stored in a read-only memory separate from the microprocessor 60 or in a separate register.

The microprocessor 60 also provides the control signal 86 that controls the power duty cycles supplied by the battery subsystem 68, and provides the control signal 88 that controls operation of the frequency synthesizer 66.

Fig. 7 illustrates the modulator 62 for one embodiment. The modulator 62 includes a set of transistors Q1 through Q4 that shape and level shift the modulation signals 80 from the microprocessor 60. The level shifted modulation signals are coupled to a radio frequency modulator U1. The radio frequency modulator U1 is a quadrature modulator. The radio frequency modulator U1 modulates the uplink carrier frequency 84. The radio frequency uplink signal 82 is provided to the power amplifier 64 through an amplifier U9.

Fig. 8 illustrates the frequency synthesizer 66 for one embodiment. The frequency synthesizer 66 implements an oscillator including a field-effect transistor (FET) Q5. The transistor Q5 provides a 406.025 MHz signal to a prescaler U5 which divides down the 406.025 MHz signal. The divided-down signal is transferred to a frequency synthesizer U4. An oscillator U3 generates a 12.8 MHz reference signal for the synthesizer U4. The 12.8 MHz reference signal provides a stable reference frequency for the FET oscillator Q5. A phase-locked loop which includes an operational amplifier U6A provides feed-back to control the frequency of the FET oscillator Q5. As a consequence, the FET oscillator Q5 provides the relatively stable uplink carrier signal 84 for the modulator 62.

Fig. 9 illustrates the power amplifier 64 for one embodiment. The power amplifier 64 receives the radio frequency uplink signal 82 from the modulator 62 and amplifies the signal through a set of power transistors Q6 and Q7. The power amplifier 64 also includes a set of appropriate matching networks for driving the antenna 90.

Fig. 10 illustrates the battery subsystem 68 for one embodiment. The battery subsystem 68 is controlled by the microprocessor 60 to provide the appropriate power duty cycles to the modulator 62, the power amplifier 64 and the frequency synthesizer 66. The microprocessor 60 contains a timer that determines the duty cycle for all the elements of the personal satellite link 20, except the microprocessor 60 which remains powered-up all the time.

If the personal satellite link 20 is activated, the microprocessor 60 performs a power-on transmit sequence when the duty cycle timer in the microprocessor 60 expires. The power-on transmit sequence generates the required transmit pulse for detection by the COSPAS-SARSAT system. The microprocessor 60 performs the power-on transmit sequence by initially switching on the frequency synthesizer 66 including U4, U5, U3, and the transistor Q5, and then allowing the frequency synthesizer 66 to settle on a stable frequency. The microprocessor 60 then switches on the power amplifier 64 including the transistors Q6 through Q7 and U1 and U9 of the modulator 62.

Fig. 11 illustrates the data encoding employed by the modulator 62. The modulator 62 employs a bi-phase NRZ encoding scheme.

Figs. 12 and 13 illustrate two possible form factors for the personal satellite link 20 which show relative configurations for the antenna, the electronics, and the battery. The battery is selected to provide the necessary transmission characteristics while minimizing size and weight. The antenna is selected for lightweight properties as well as flexible properties.

The foregoing detailed description is provided for the purposes of illustration and is not intended to be exhaustive or to limit the invention to the precise embodiment disclosed. Accordingly, the scope of the present invention is to be defined by the appended claims.

Claims

What is claimed is:

1. A personal satellite link, comprising: memory that stores a user identifier for the personal satellite link, wherein the user identifier provides an index into a database that contains a set of user information corresponding to the personal satellite link;

transmitter having circuitry that generates a radio frequency uplink signal that carries the user identifier.

2. The personal satellite link of claim 1, wherein the memory is an electrically alterable read only memory.

3. The personal satellite link of claim 1, further comprising a microprocessor that contains the memory that stores the user identifier.

4. The personal satellite link of claim 1, wherein the user information includes a user blood type.

5. The personal satellite link of claim 1, wherein the user information includes a user medical history.

6. The personal satellite link of claim 1, wherein the radio frequency uplink signal is received by a satellite spacecraft that includes circuitry for measuring a Doppler shift of the radio frequency uplink signal.

7. The personal satellite link of claim 6, wherein the satellite spacecraft recovers the user

identifier from the radio frequency uplink signal and relays the user identifier and the Doppler shift and a time tag to a signal processing facility that includes the database.

8. An emergency locating system, comprising:

personal satellite link that stores a user identifier and having a transmitter that generates a radio frequency uplink signal that carries the user identifier;

signal processing facility that receives the user identifier through a satellite downlink and that uses the user identifier to access a database that contains a set of user information corresponding to the personal satellite link.

9. The emergency locating system of claim 8, wherein the memory is an electrically alterable read only memory.

10. The emergency locating system of claim 8, wherein the personal satellite link further comprises a microprocessor that contains the memory that stores the user identifier.

11. The emergency locating system of claim 8, wherein the user information includes a user blood type.

12. The emergency locating system of claim 8, wherein the user information includes a user medical history.

13. The emergency locating system of claim 8, wherein the radio frequency uplink signal is received

by a satellite spacecraft that includes circuitry for measuring a doppler shift of the radio frequency uplink signal.

14. The emergency locating system of claim 13, wherein the satellite spacecraft recovers the user identifier from the radio frequency uplink signal and relays the user identifier and the Doppler shift and a time tag to the signal processing.

15. A system, comprising:

means for storing a user identifier that corresponds to a set of user information;

transmitter that generates a radio frequency uplink signal that carries the user identifier;

database that contains the user information corresponding to the user identifier;

means for receiving the user identifier through a satellite downlink and for accessing the database with the user identifier.

16. The system of claim 15, wherein the transmitter includes a modulator that generates the radio frequency uplink signal by modulating a carrier signal with the user identifier.

17. The system of claim 15, wherein the means for storing is contained in a microprocessor that supplies the user identifier to the transmitter.

18. The system of claim 15, further comprising a satellite spacecraft that measures a Doppler shift of the radio frequency uplink signal and relays the Doppler shift through the satellite downlink.

19. The system of claim 18, wherein the satellite spacecraft orbits the earth in a low polar orbit.

20. The system of claim 15, wherein the database stores a set of medical information for a user corresponding to the user identifier.

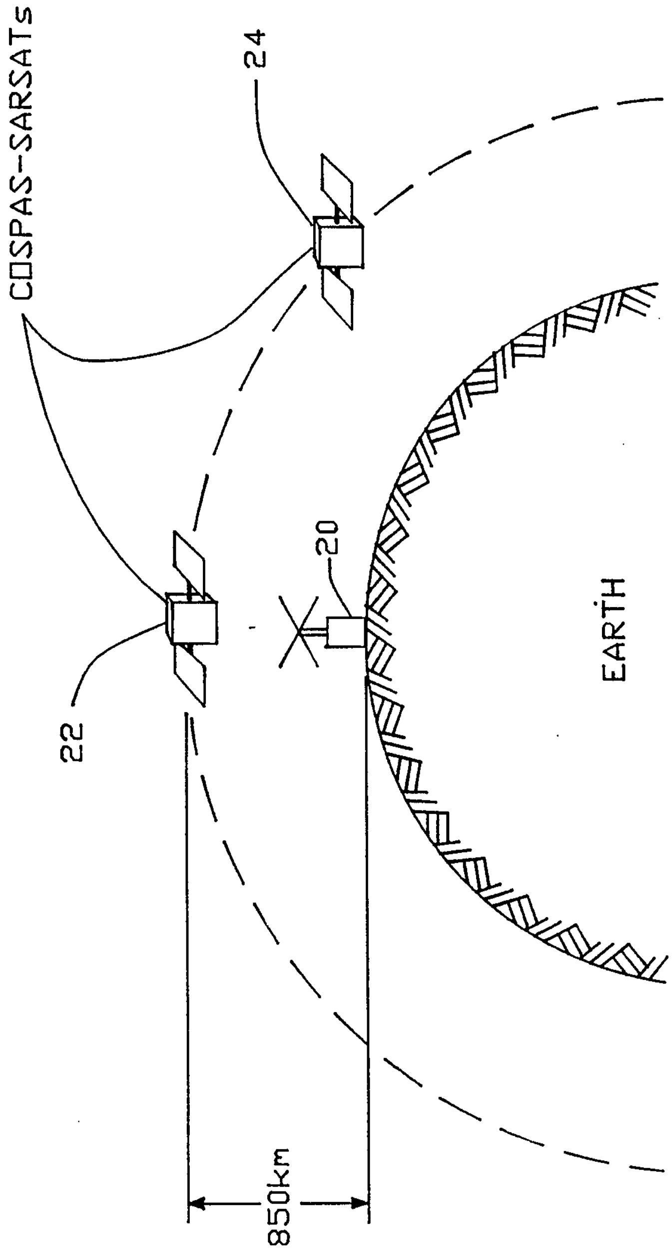
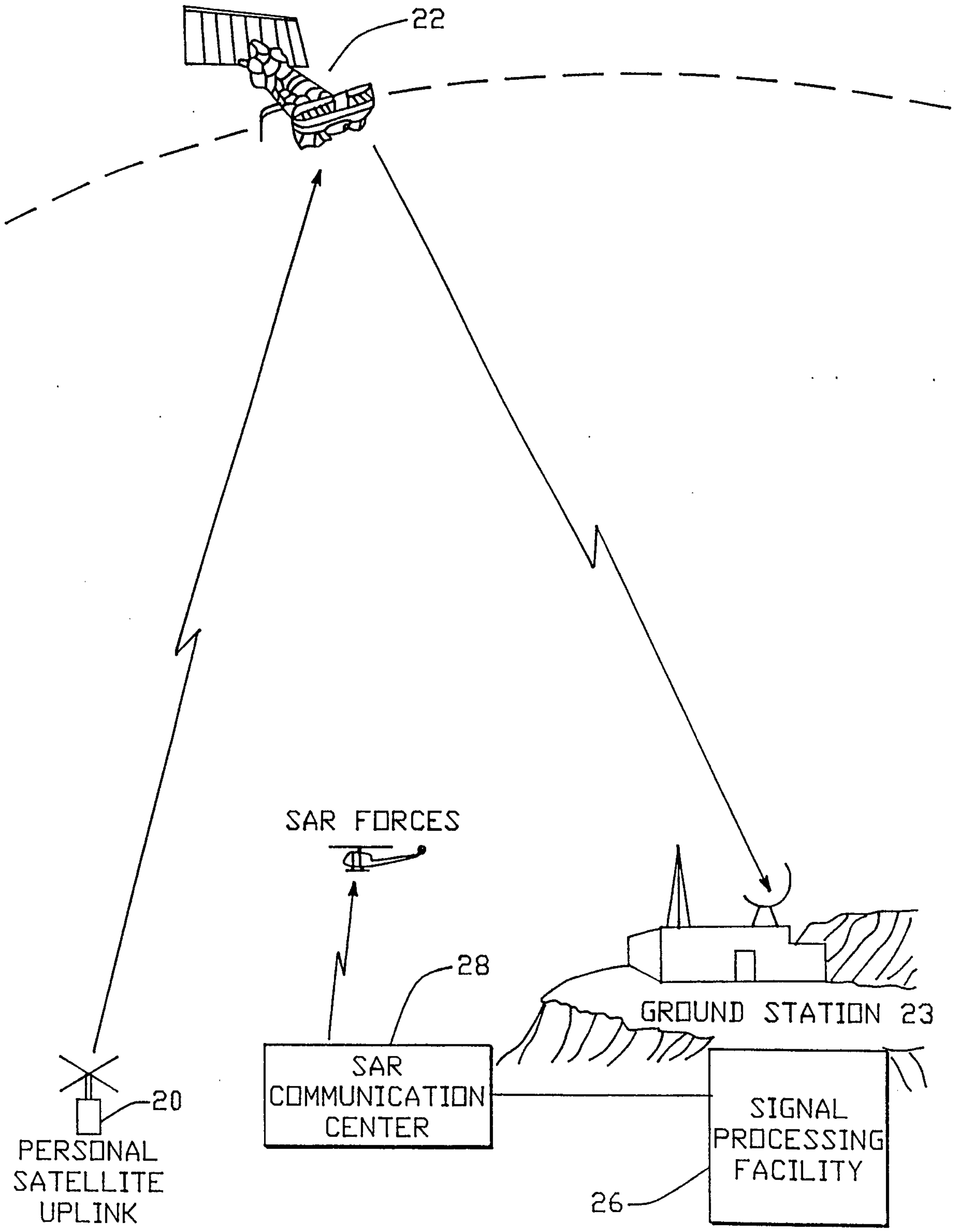


FIG. — 1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SAR FORCES
28
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CENTER
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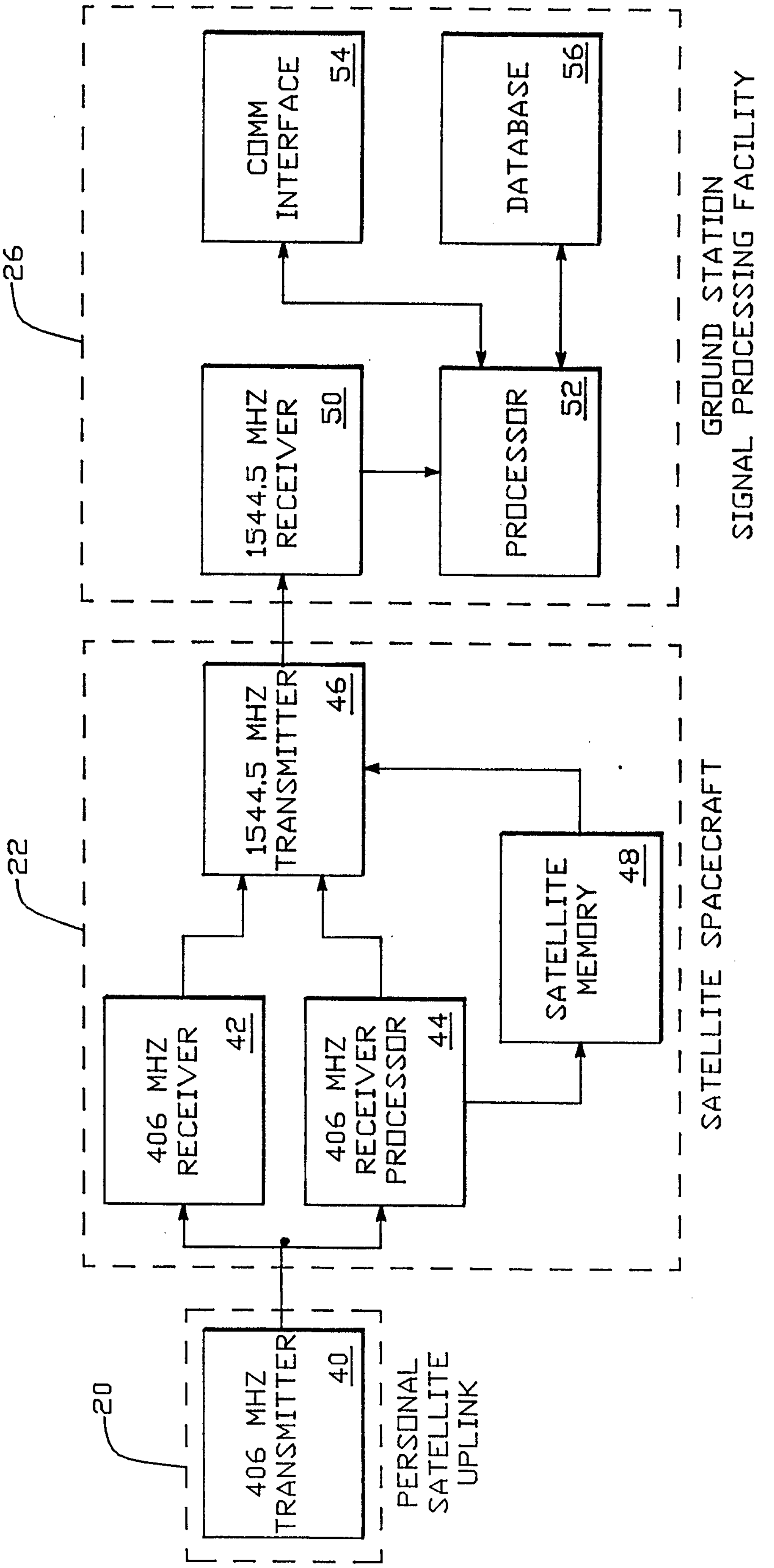
SIGNAL
PROCESSING
FACILITY
26

FIG.—2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1544.5 MHZ RECEIVER 50
PROCESSOR 52
COMM INTERFACE 54
DATABASE 56
GROUND STATION SIGNAL PROCESSING FACILITY
22
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SATELLITE MEMORY 48
406 MHZ RECEIVER 42
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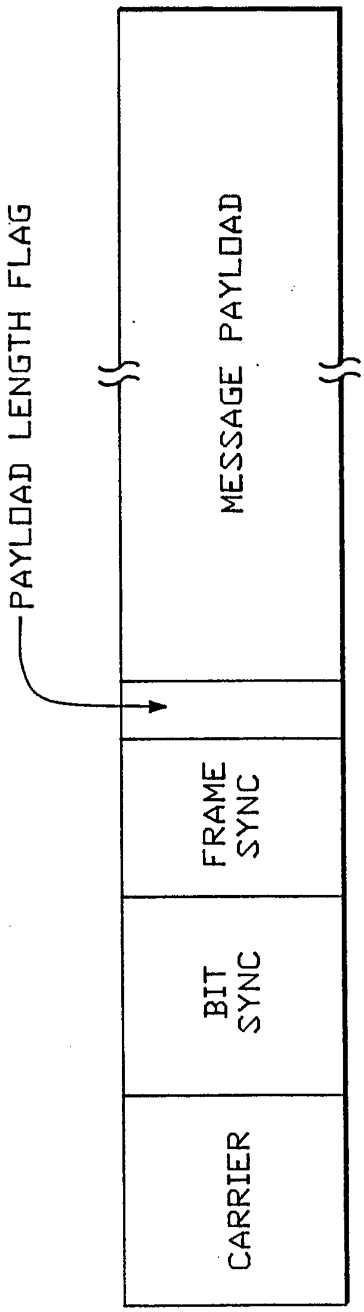
SATELLITE SPACECRAFT
20
406 MHZ TRANSMITTER 40
PERSONAL SATELLITE UPLINK

FIG. - 3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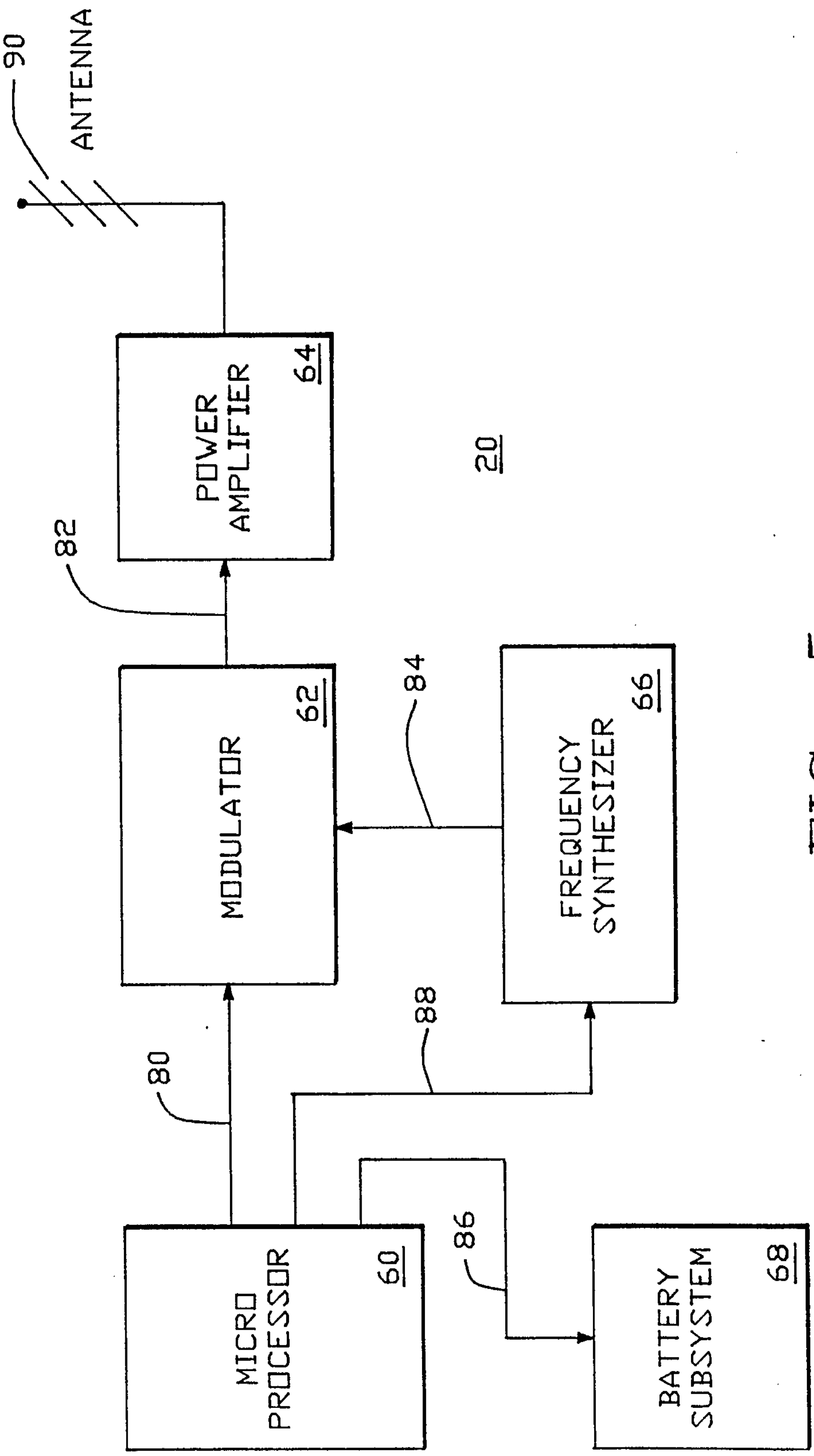
MESSAGE PAYLOAD
FRAME SYNC
BIT SYNC
CARRIER

FIG.—4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68

FIG.—5

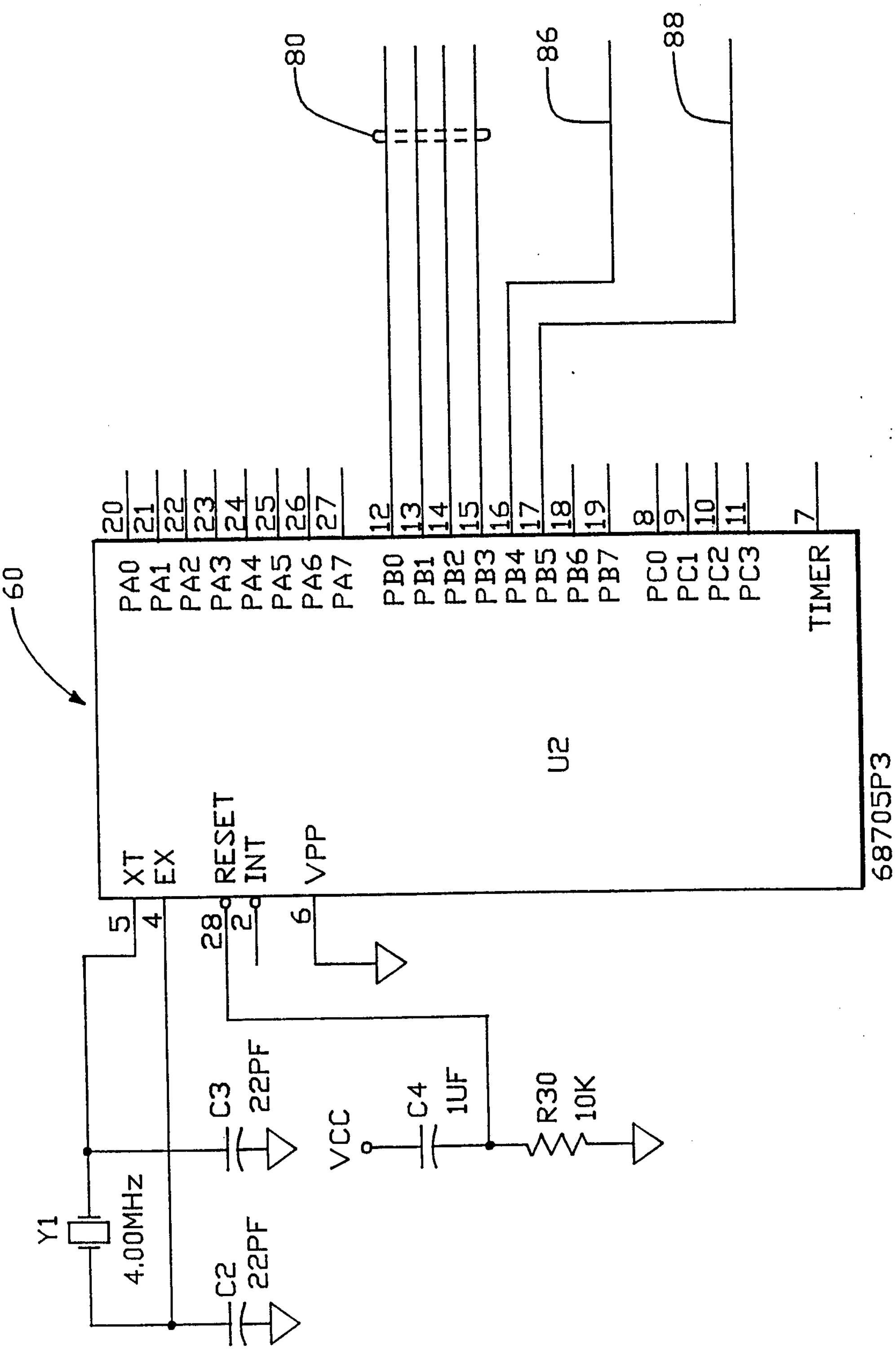
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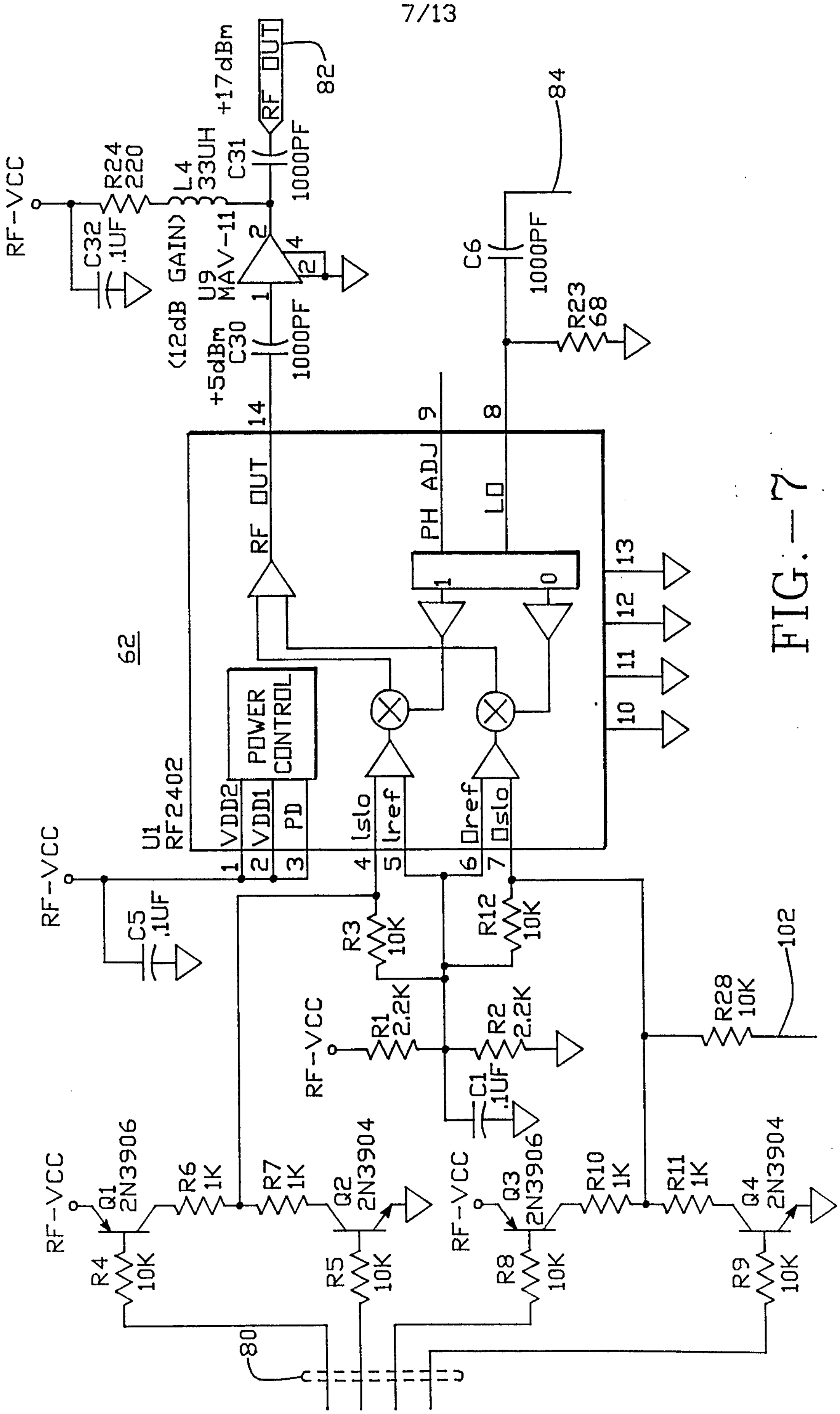
FIG.—6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C32
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U9
MAV-11
C6
1000PF
R23
68
+5dBm
C30
1000PF
14
9
8
RF OUT
PH ADJ
LO
62
POWER
CONTROL
U1
RF2402
VDD2
VDD1
PD
Islo
Iref
Qref
Qslo
13
12
11
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2.2K
C1
.1UF
Q1
2N3906
R6
1K
R7
1K
Q2
2N3904
Q3
2N3906
R10
1K
R11
1K
Q4
2N3904
R4
10K
R5
10K
R8
10K
R9
10K
80

FIG.—7

8/13

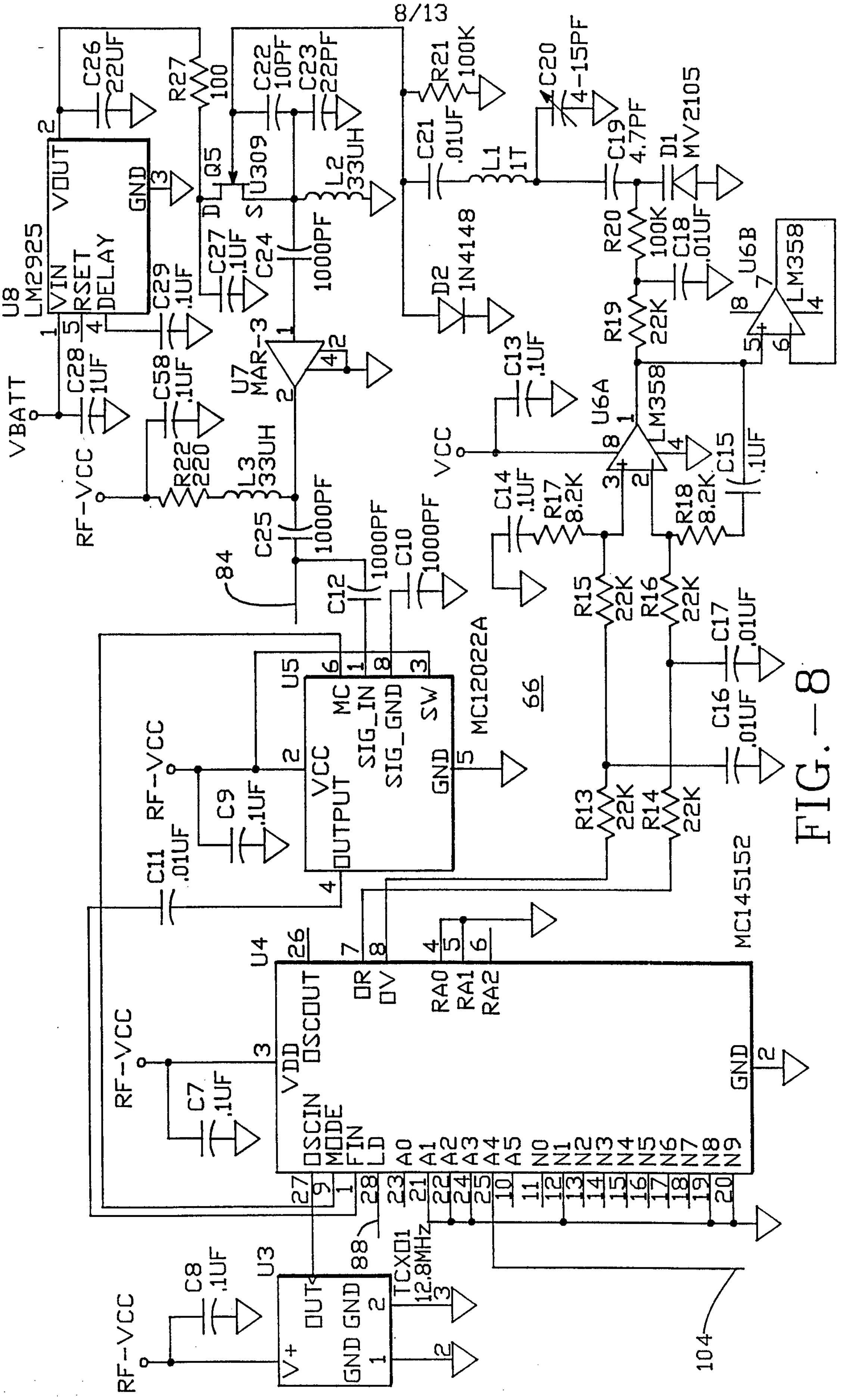
U8
LM2925
VIN
RSET
DELAY
VOUT
GND
VBATT
C26 22UF
R27 100
C22 10PF
C23 22PF
Q5 U309
L2 33UH
C24 1000PF
C27 .1UF
C29 .1UF
C28 .1UF
C58 .1UF
U7 MAR-3
RF-VCC
R22 220
L3 33UH
C25 1000PF
84
C12 1000PF
C10 1000PF
R21 100K
C20 4-15PF
C21 .01UF
L1 1T
C19 4.7PF
D1 MV2105
D2 1N4148
R20 100K
C18 .01UF
U6B LM358
R19 22K
C13 .1UF
VCC
U6A LM358
C14 .1UF
R17 8.2K
R18 8.2K
C15 .1UF
R15 22K
R16 22K
C17 .01UF
U5 MC12022A
MC
SIG_IN
SIG_GND
SW
VCC
OUTPUT
66
C9 .1UF
C11 .01UF
C16 .01UF
R13 22K
R14 22K
U4 MC145152
OSCOUT
OR
OV
RA0
RA1
RA2
VDD
OSCIN
MODE
FIN
LD
C7 .1UF
88
104
U3 TCXO1 12.8MHz
C8 .1UF
V+
OUT
GND

FIG.—8

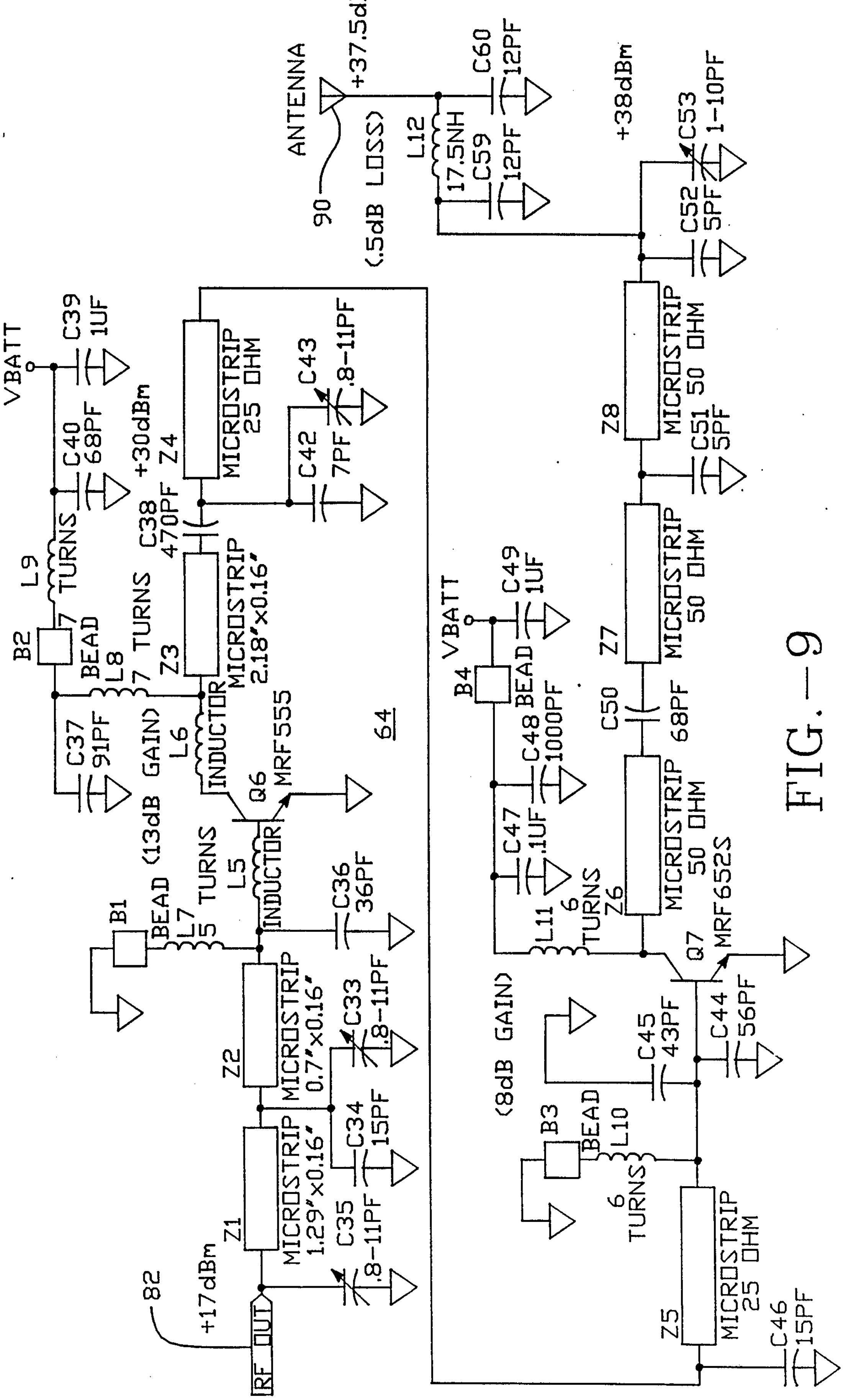
ANTENNA
90
+37.5dB
(.5dB LOSS)
L12
17.5NH
C60
12PF
C59
12PF
+38dBm
C53
1-10PF
C52
5PF
VBATT
C39
1UF
C40
68PF
+30dBm
Z4
MICROSTRIP
25 OHM
C43
.8-11PF
C42
7PF
L9
7 TURNS
B2
BEAD
L8
7 TURNS
Z3
MICROSTRIP
2.18"x0.16"
C38
470PF
C37
91PF
(13dB GAIN)
L6
INDUCTOR
Q6
MRF555
64
B1
BEAD
L7
5 TURNS
L5
INDUCTOR
C36
36PF
Z2
MICROSTRIP
0.7"x0.16"
C33
.8-11PF
C34
15PF
Z1
MICROSTRIP
1.29"x0.16"
C35
.8-11PF
82
+17dBm
RF OUT
Z8
MICROSTRIP 50 OHM
C51
5PF
Z7
MICROSTRIP
50 OHM
C50
68PF
VBATT
C49
1UF
B4
BEAD
C48
1000PF
C47
.1UF
L11
6
TURNS
Z6
MICROSTRIP
50 OHM
Q7
MRF652S
(8dB GAIN)
C45
43PF
C44
56PF
B3
BEAD
L10
6
TURNS
Z5
MICROSTRIP
25 OHM
C46
15PF

FIG.—9

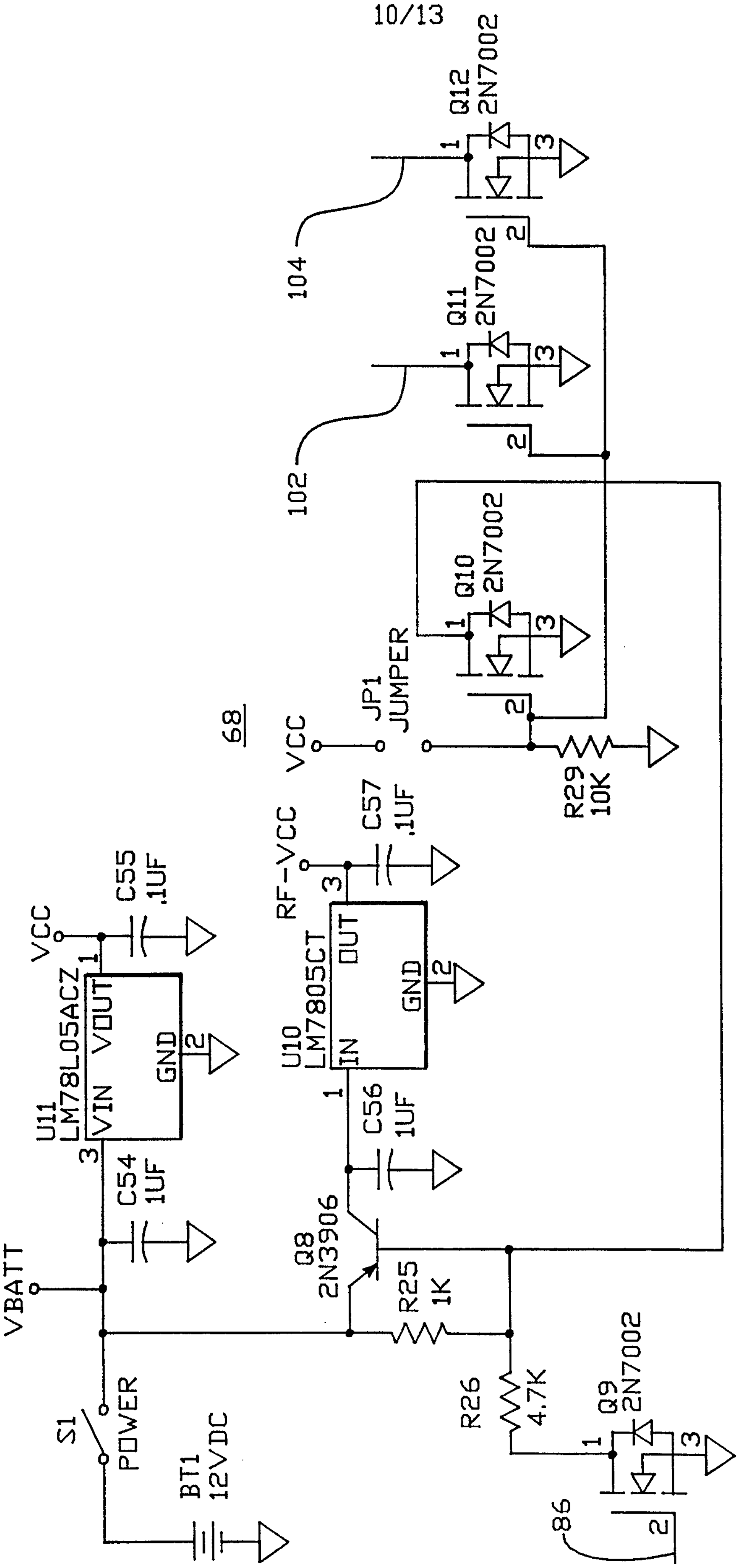
Q12
2N7002
104
Q11
2N7002
102
Q10
2N7002
68
VCC
JP1
JUMPER
R29
10K
RF-VCC
C57
.1UF
U10
LM7805CT
IN
OUT
GND
C56
1UF
VCC
C55
.1UF
U11
LM78L05ACZ
VIN
VOUT
GND
C54
1UF
VBATT
Q8
2N3906
R25
1K
R26
4.7K
Q9
2N7002
86
S1
POWER
BT1
12VDC

FIG. -10

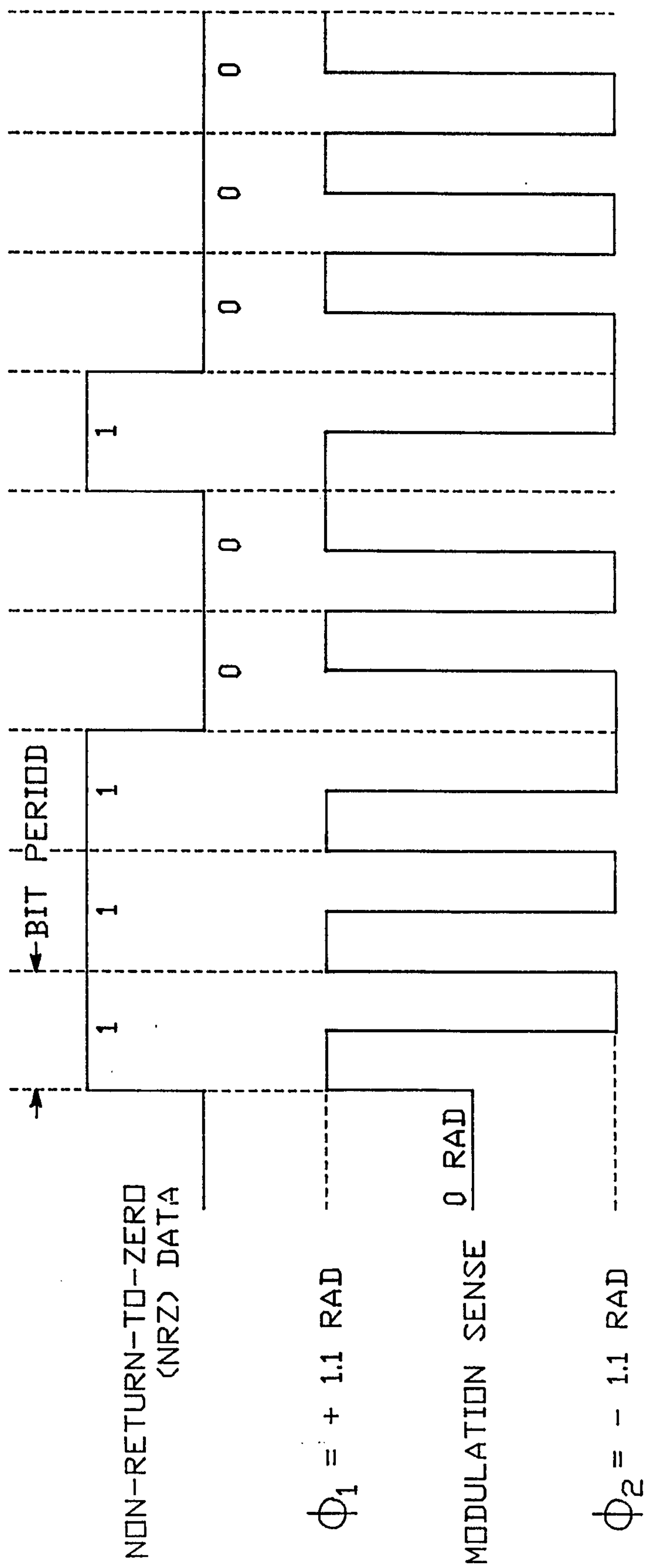
BIT PERIOD
1
1
1
0
0
1
0
0
0
NON-RETURN-TO-ZERO (NRZ) DATA
Φ_1 = + 1.1 RAD
0 RAD
MODULATION SENSE
Φ_2 = − 1.1 RAD

FIG. — 11

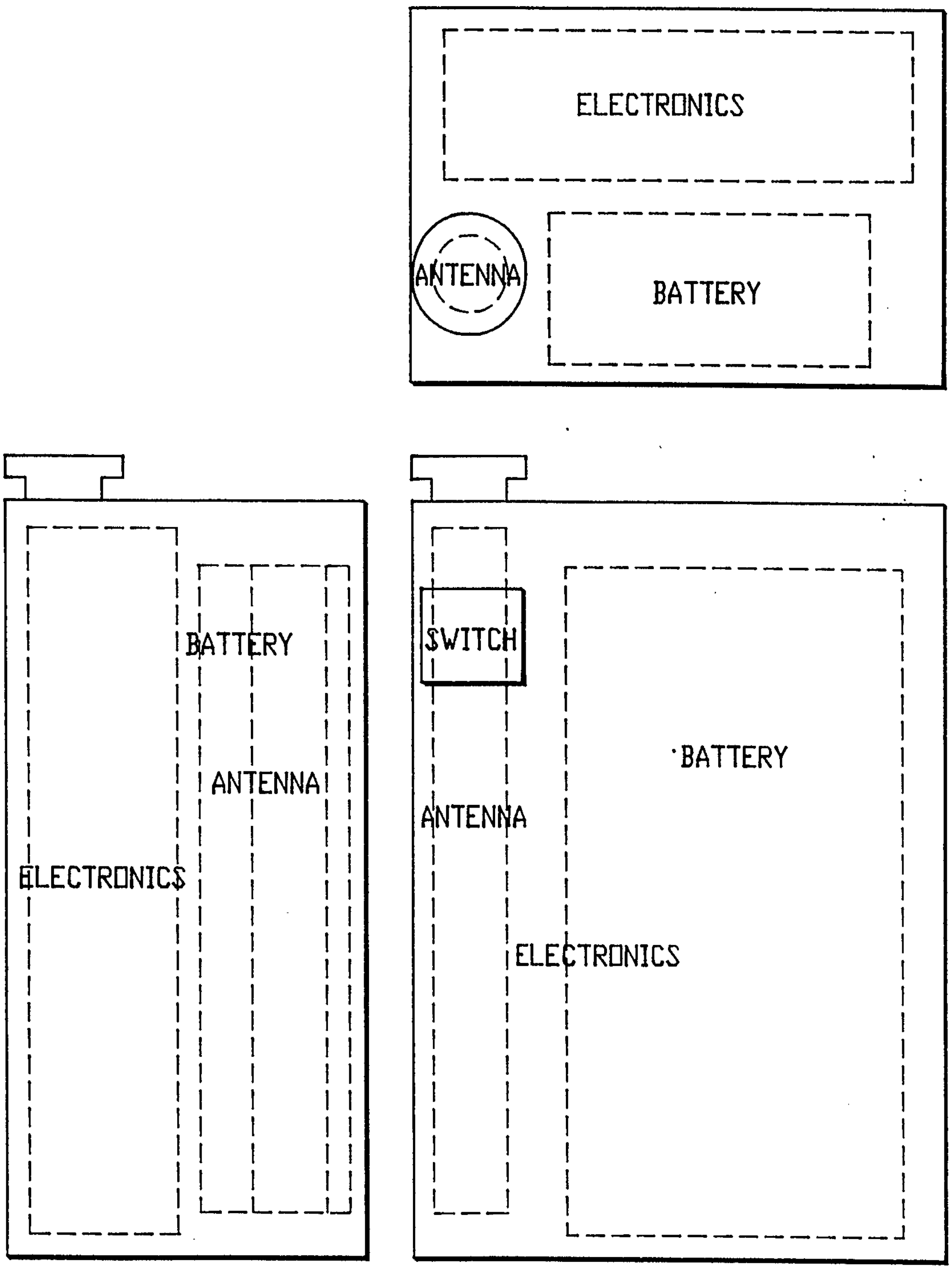
ELECTRONICS
ANTENNA
BATTERY
BATTERY
ANTENNA
ELECTRONICS
SWITCH
BATTERY
ANTENNA
ELECTRONICS

FIG.–12

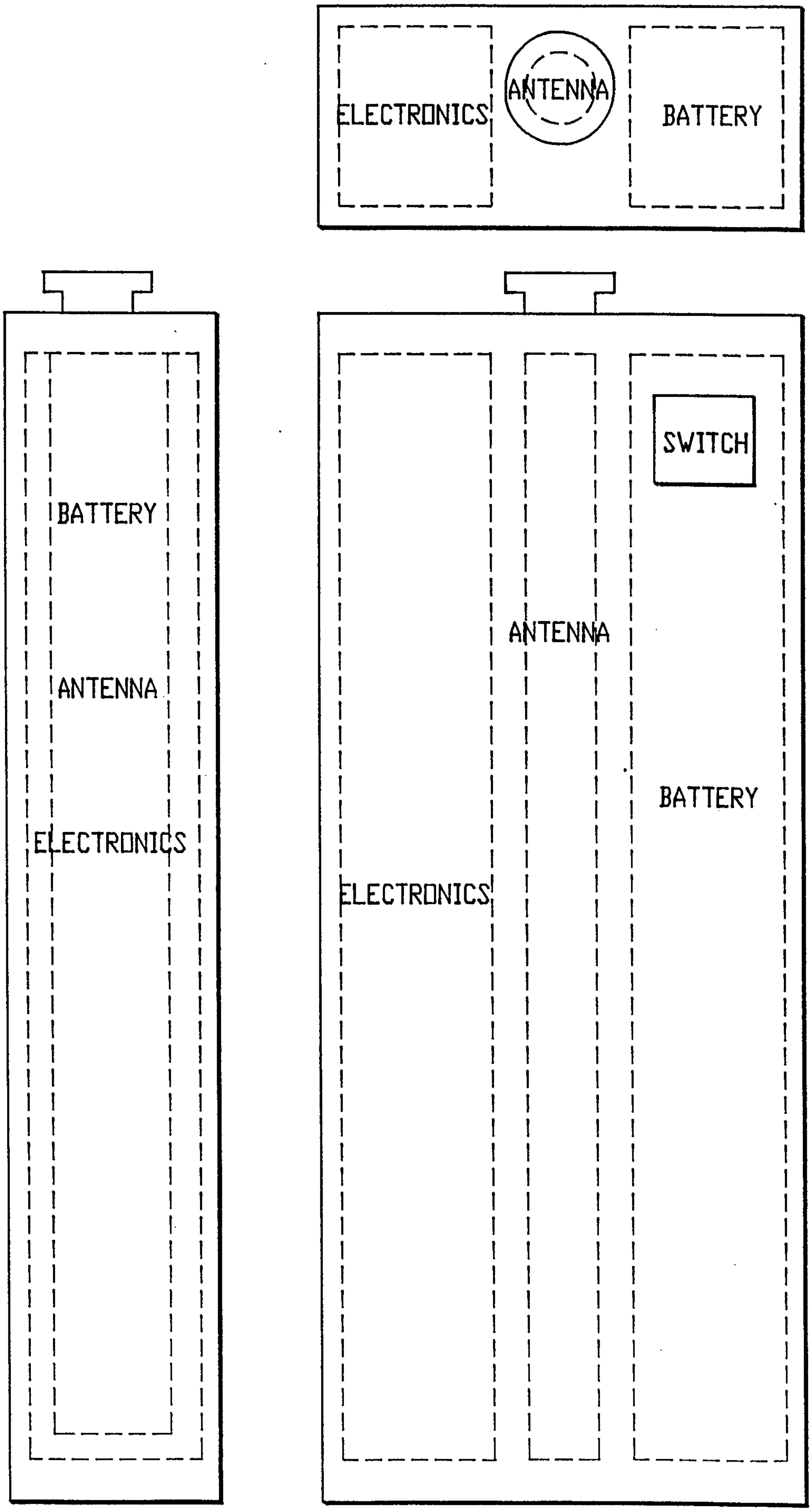
ELECTRONICS
ANTENNA
BATTERY
BATTERY
ANTENNA
ELECTRONICS
SWITCH
ANTENNA
BATTERY
ELECTRONICS

FIG.—13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09186

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G01S 3/02; G08G 1/123; G06F 17/30
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/12.1; 340/539, 988, 989, 990; 342/352, 357, 457; 364/449, 459

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US, A, 5,334,974 (SIMMS et al.) 02 August 1994 (02.08.94), column 3, lines 57-68, column 5, lines 45-55.	1, 3-5, 8, 10-12 ----- 2, 9, 13-14, 20
X ---,P Y	US, A, 5,500,648 (MAINE et al.) 19 March 1996 (19.03.96), column 3, lines 57-65, column 6, lines 18-20, 30-40 and 51-52, and column 7, lines 35-66.	1, 6-7, 15-19 ----- 8, 13-14, 20
Y	US, A, 5,025,253 (DILULLO et al.) 18 June 1991 (18.06.91), column 8, lines 3-11.	2, 9
Y	US, A, 5,497,149 (FAST) 05 March 1996 (05.03.96), column 2, lines 50-55, column 4, lines 55-67, column 6, lines 8-11, column 11, lines 11-16, column 12, lines 17-21.	1-20

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

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

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 AUGUST 1996	17 SEP 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer LESTER KINCAID
Facsimile No. (703) 305-3230	Telephone No. (703) 305-4700

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09186

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,240,079 (ZHILIN) 16 December 1980 (16.12.80), column 7, lines 36-46, and column 11, lines 48-52.	1, 8, 15
A	US, A, 5,223,844 (MANSELL et al.) 29 June 1993 (29.06.93), column 30, lines 13-59.	1-20
A	US, A, 5,327,144 (STILP et al.) 05 July, 1994 (05.07.94), column 14, lines 2-15.	1-20
A,P	US, A, 5,519,621 (WORTHAM) 21 May 1996 (21.05.96).	1, 8, 15
A,P	US, A, 5,515,419 (SHEFFER) 07 May 1996 (07.05.96).	1, 8, 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09186

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

455/12.1; 340/990; 342/357, 457; 364/459