A seismic gathering system including a plurality of field units (25) for detecting seismic energy and for transmitting information by way of radio transmission to a recording station (51). The recording station (51) preferably includes a command transmitter (71) for transmitting a radio frequency command signal to the field units (25) and a plurality of receivers (57) for receiving information transmitted from the field units (25). The recording station (51) can be located in an aircraft; however, it may be land based, vehicular mounted or ship mounted. Each field unit (25) includes a receiver for receiving the command signal and a radio transmitter for transmitting to the recording station data representative of detected seismic energy. In addition, power-preserving circuits are provided in each field unit which respond to the command signal received for enabling the field transmitter for transmission for only a preset period of time.
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SEISMIC GATHERING RADIO SYSTEM

Technical Field

This invention pertains to seismic surveying systems and more particularly to seismic surveying systems including radio communications between the field data acquisition units and the base recording station.

Background Art

In the gathering of data in seismic surveying operations, the transmission of seismic signals from an array of detectors to a recorder is accomplished conventionally by means of cables. Environmental conditions often are encountered, however, in many terrains, such as for example in ice covered areas, mountainous areas, arid areas, and swampy areas, not to mention across open bodies of waters, where it is either impossible, impractical, inconvenient or inefficient to lay out cables for the transmission of seismic data from a large number of detectors to the recorder.

The use of a radio transmission and receiving system in seismic gathering operations has been proposed for transmitting field data from a large number of detectors along a traverse to a recording station. Of importance in such a system is the lifetime, and hence reliability, of the power supply of the field unit transmitters if an effective data gathering system is to be achieved. This is particularly true when a large number of detector positions, and hence field unit transmitters, for example 24 or 48, are to be employed along a traverse several miles long.

Therefore, it is a feature of the present invention to provide an improved radio transmission and receiving system for use in a seismic gathering system which includes an arrangement for conserving the lifetime of the power supply of each field unit transmitter.

It is another feature of the present invention to provide an improved radio transmission and receiving system operating with respect to a selectable command signal both with respect to frequency and time.
Disclosure of Invention

The seismic gathering system includes a plurality of field units for detecting seismic energy and for transmitting information to a recording station. The recording station may conveniently be located in a mobile vehicle, preferably in a centrally positioned aircraft flying over the arrayed field units. The recording station includes a radio command transmitter for transmitting a command signal to the field units, and a plurality of receivers for receiving information transmitted from the field units.

Each field unit includes a receiver for receiving the command signal from the command transmitter, a field unit transmitter for transmitting to the recording station, data representative of seismic energy detected, and means responsive to the command signal received for enabling the field unit transmitter for transmission for only a preset period of time.

In one embodiment disclosed, each field unit comprises an antenna normally coupled to the receiver of the field unit, a power supply normally coupled to the receiver, circuitry coupled to the output of the receiver for producing a time dependent function in response to a command signal received, and means responsive to the time dependent function for connecting the transmitter with the power supply and with the antenna and for disconnecting the receiver from the antenna during the time period of the time dependent function.

Brief Description of Drawings

So that the manner in which the above-recited features, advantages and objects of the invention, as well as others which will become apparent, are attained and can be understood in detail, more particular description of the invention briefly summarized above may be had by reference to the embodiments thereof which are illustrated in the drawings, which drawings form a part of this specification. It is to be noted, however, that the appended drawings illustrate only typical embodiments of the invention and are therefore...
not to be considered limiting of its scope, for the inven-
tion may admit to other equally effective embodiments.

In the Drawings:

Fig. 1 pictorially illustrates the seismic gathering
system employed in one mode of operation.

Fig. 2 is a block diagram of a first embodiment of a
field unit employed in the seismic gathering system of Fig.

Fig. 3 is a block diagram of a second embodiment of a
field unit employed in the seismic gathering system of Fig.

Fig. 4 is a simplified schematic diagram of a phase
locked loop circuit employed in the circuit shown in Fig. 2.

Best Mode for Carrying Out the Invention

A first embodiment of a field unit in accordance with
the present invention is illustrated in Fig. 2. As illus-
trated, each field unit includes a battery 161 for a power
supply, a seismic amplifier 91, a radio frequency trans-
mitter 93, an antenna 43, and an fm radio receiver illus-
trated in dotted block 159. Each field unit also has a
transformer 99 for effectively coupling either a hydrophone
or a geophone (or a geophone array) to the amplifier, where-
by either type of detector may be used with the field unit.
The coil of a geophone is illustrated at 107, while the
crystal of a hydrophone is illustrated at 105. Inputs 101A
and 101B are provided for hydrophone connections while
inputs 103A and 103B are provided for geophone connections.
Preamplifier 105A provides amplification of the seismic
signal and impedance transformation. Preamplifier termina-
tion 301A provides power for preamplifier 105A. The equip-
ment of each field unit is located in a waterproof container
and may be floated if necessary by a floatable jacket illus-
trated at 45 in Fig. 1, which jacket may be formed of styro-
foam, for example.

A transmitter 93 of the field unit is preferably a
frequency modulated transmitter, each such transmitter oper-
ating on its own specific band or channel. Each transmitter preferably comprises a voltage controlled oscillator, the output frequency of which is modulated by the output of its seismic amplifier. The transmitters are employed to transmit to a remote recording station illustrated at 51 in Fig. 1, data representative of seismic energy detected by their included detector or detectors. The recording station may be located near the seismic source or a point remote therefrom, and may conveniently be located in an aircraft, a truck, a ship or in a building. Such a recording station has a number of radio receivers, corresponding with the number of field units, for receiving the seismic information transmitted from the field units. Each is tuned to one of the channels for receiving information from a specific field transmitter. Thus transmission of information from the field units is by way of fm radio transmission, which allows for conduction of seismic surveys, not only over various types of terrain, but allows surveying operations to be carried out in remote and difficult terrain and areas where such operations have heretofore either been extremely difficult or virtually impossible to conduct.

In Fig. 1, the receivers at the recording station are illustrated at 53. They are fm receivers and are coupled to an antenna 55 by way of a preamplifier 57 and respective channels of a radio frequency power divider system 59. The output of receivers 53 is coupled or interfaced with a field recorder 61 for making traces 81, 83, 85 and 87 on a suitable readout 89.

Also included in the recording station is a command fm transmitter 71 having its own antenna 73. It operates on its own specific band and is employed to send command signals to fm receiver 77 connected to control source 27 and receiver 159 of each of the field units to actuate or enable the field unit transmitters for transmission in a manner hereinafter explained. A suitable command signal is transmitted just before the seismic source is actuated.

Assuming that the recording station is remotely located from the energy source, as illustrated, an energy source
antenna 75 and receiver 77 are employed to receive the
command signal for actuating the energy source, for example,
including a charge of dynamite, to generate seismic energy.
Reflected energy is detected by the detectors and the data
from the respective field units is transmitted by the field
unit transmitters to their respectively tuned receivers at
the recording station. As will be explained in more detail
subsequently, the field units allow transmission for a
preset period of time and then the transmitters therein are
shut down. The length of time of the preset period for each
field unit can be separately set so that for the more remote
units, the periods can be longer. The outputs of the
receivers at the recording station are recorded by recorder
61. Recording of the field data transmitted preferably
is in binary form; however, for the sake of simplicity, the
data transmitted from the four field units is illustrated as
being recorded as analog traces 81, 83, 85, and 87 on a
record 89. Although not illustrated, it is to be understood
that the shot time also will be recorded on an illustrated
readout record 89.

Referring specifically to Fig. 2, there is shown in
block form, components of a field unit for allowing recep-
tion of a command signal from the command transmitter 71 and
then transmission of the detected data to the recording
station. The command signal may comprise a 72.980 MHz car-
rrier, frequency modulated by a 1.2 KHz signal, the latter of
which may be applied for about 0.3 second. In the receive
mode, ganged switches 151 and 153 are in contact with ter-
minals 155 and 157, respectively, so that antenna 43 is
connected to receiver 159 and power is applied to the re-
ceiver from battery 161. In this mode, transmitter 93 is
disconnected from antenna 43 and from the power supply,
again via switches 151 and 153, respectively.

In the receive mode, the command signal is detected by
antenna 43 and its output is applied to a radio frequency
amplifier 163, the output of which is coupled to a mixer
165. Also coupled to mixer 165 is the output of a frequency
tripling circuit 169, in turn, connected to an oscillator
Oscillator 167 in one embodiment produces a 10.76 MHz frequency signal which is tripled by network 169 for the production of a 32.28 MHz frequency output. The mixer 165 produces a difference frequency of 10.7 MHz, which is then applied to a crystal filter 71. Mixer 165 and oscillator 167 reduce the center frequency and take advantage of the narrow band width of the crystal filter 171, which operates at a center frequency of 10.7 MHz and has a band width of 30 KHz.

The output of crystal filter 171 in one path is amplified by amplifiers 173 and 175 and is applied to a series regulator 177. As soon as the radio frequency command signal is received and reaches a preset threshold amplitude, series regulator 177 is activated to apply power to an intermediate frequency amplifier 179, connected to a discriminator 181, connected to an audio amplifier 183 and finally connected to a narrow band pass filter 185. Power also is applied to series regulator 197, and hence to timer 187. Filter 185 is employed to filter out sporadic noise. The purpose of the discriminator is to demodulate the 10.7 MHz frequency signal and to recover the command modulating signal.

The command modulating signal is amplified by audio amplifier 183 and is applied by way of filter 185 to trigger adjustable timer 187, which produces an output level or rectangular wave for a preset period of time to actuate relay coil 189. When coil 189 is energized, ganged switches 151 and 153 are moved to contact terminals 191 and 193, respectively. When this occurs, antenna 43 is disconnected from receiver 159 and connected to transmitter 93. Power also is disconnected from receiver 159 and connected to 15-volt regulator 195 to supply power to transmitter 93 and to seismic amplifier 91. Thus, during the time period of the rectangular wave output from timer 187, the output of the particular detector employed is amplified and transmitted to the recording station.

In one embodiment, timer 187 comprises a one-shot or monostable multivibrator whose output waveform may be ad-
justed to various time periods by adjustment of switch 187A, which forms part of the time constant network connected to the monostable multivibrator. Timer components 187 and 187a may be an integrated circuit of type SN74121 manufactured and sold by Texas Instruments of Dallas, Texas. The purpose of timer 187 is to allow transmission for only a preset time period to conserve the life of battery 161 and to avoid the use of a separate receiver antenna, which would otherwise be required for the reception of a turn-off signal. In one embodiment, monostable multivibrator 187 is adjusted to produce output waveforms having time durations of 20, 40, 80, or 160 seconds. After the termination of the waveform from multivibrator 187, coil 198 is deenergized, thereby allowing contacts 151 and 153 to return to their normal or standby position in contact with terminals 155 and 157, respectively. Thus, the use of timer 187 allows transmission to take place only for a preset period of time following reception of a command signal from the recording station command transmitter. The time periods above mentioned are sufficient in most cases to allow detection of seismic energy by the seismic detectors and transmission of the data to the recording station following actuation of the seismic energy source. It is to be understood that different or longer time periods may be employed, if desired.

In the embodiment disclosed in Fig. 2, power is applied to timer 187 by way of a series regulator 197. This regulator is powered by regulator 177 initially when it is activated by the command signal and then directly from battery 161 when switch 153 is moved to contact terminal 193. A storage capacitor is employed in regulator 177 which maintains power during the switching time of the relay comprising coil 189 and switches 151 and 153. Thus, there is no interruption of power to timer 187 during switching when switch 153 moves from terminal 157 to contact terminal 193. The power normally applied to receiver 159 during the quiescent period is of such low amplitude that very little drain on the battery is experienced.
In one system embodiment, the seismic gathering system includes 40 individually selected crystal controlled channels, for the field unit transmitters and recording station receivers, with 40 KHz channel spacing from 72.020 MHz to 72.980 MHz as the carrier frequencies. Forty-eight field units, and hence forty-eight field transmitters, may be employed for detecting and transmitting seismic information. A corresponding number of receivers are employed at the recording station, each being tuned to receive information transmitted by way of a specific channel from a given transmitter. The receivers each are preferably of the single-conversion fm superheterodyne type, although other types of receivers may be used. Each channel is manually tunable within ±20 KHz of its assigned channel center frequency.

The carrier frequency of the recording station command transmitter operates in one system embodiment at 72.980 MHz, as indicated previously. The energy source receiver, if employed, and the receiver of each field unit are tuned to this same frequency.

In one physical arrangement, each field unit is contained in a two-part case. The electronics are located in one module and a battery in the second. Both compartments are waterproof and designed with a quick disconnect. Although not shown, an anchor may be employed if desired for anchoring a field unit in water. The output voltage of the battery is 18 volts dc. The discharge time of the battery is 20 hours at 20°C and 4 hours at -40°C. The antennas for the field units and for the recording station may be vertical dipoles, 56 inches high. They are used, as explained above, both as a transmitter or receiver antenna and the transmitter has a range up to 30 miles. The command antenna may also be a vertical dipole antenna.

Transformer 99 may have a turns ratio of 10:3 between inputs 101A and 101B and coil 99B and a turns ratio of 1:3 between inputs 103A and 103B and coil 99B. This arrangement provides a high impedance load for crystal 105 of the hydrophone and allows one to obtain a low damping resistance for coil 107 of the geophone. A resistor 109 may be coupled
across the leads of coil 107 to obtain the desired damping resistance. Transformer 99 also provides common mode rejection of ac power line noise on the detector leads, which may be present in certain areas, particularly in land areas where the geophones are employed. This coupling arrangement for allowing either geophones or hydrophones to be coupled to each field unit is well known.

Now referring to the embodiment shown in Fig. 3, components are illustrated in block diagram form of another model of a field unit suitable for operating with respect to a radio transmitted command signal from command transmitter 71 located in recording station 51. In a manner similar to that described above, the field unit is activated by the command signal, detects seismic data in the vicinity of the field unit and radio transmits the detected data to the recording station. The command signal preferably comprises a 72.980 MHz carrier, frequency modulated by a 1.2 KHz signal, the latter of which may be applied for about 0.3 second.

The field unit shown in Fig. 3 is activated when switch 252 is manually positioned to be in contact with terminal 251. This is done at the time that the field unit is made operable in the field. As is evident, 18 volts of power is supplied through the switch from battery 253 to constant current source 254. The output of source 254 is a 5 milliampere constant current and protects the battery against excessive battery drain, since long battery life is a principal feature of the unit.

The output from source 254 is connected to two voltage regulators, 11.2-volt regulator 255 and 5.6-volt regulator 256. The components in the receiver section of the field unit, as is explained more fully hereinafter, are biased by either the 11.2-volt output from regulator 255 or the 5.6-volt output from regulator 256. In addition, the 11.2-volt output from regulator 255 is connected to timer 257 to enable operation thereof in a manner hereafter explained.

When manual switch 252 is connected to switch terminal 251, battery 253 is also connected to 15-volt regulator
control 258 and to diode control 259, which may conveniently be housed in the same package. 15-volt regulator control 258 is connected to 15-volt regulator 260, for enabling the field unit transmitter components at the appropriate time, and diode control 259 is connected to diode switch 261.

Antenna 43, which may be conveniently of the same type as for the other field unit embodiment previously described, is normally connected through switch 261 to the receiver section of the field unit when the unit is awaiting an activating command signal from the central recording station. An activating command signal has the time delayed effect of producing an activating input 263 to timer 257. The output of the timer is typically either the normal low level output of zero or the high level output of 11.2 volts, as supplied thereto from regulator 255. This type of output is sometimes referred to as a rectangular wave, the duration of which is determined by timer control 265. Timer 257 may conveniently be an integrated circuit MCL4541 and timer control 265 may conveniently be selectable time constant network operable therewith.

Transmit delay 257B retards activation of 15-volt regulator control 258, which consequentially delays transmitter activation. The delay provides other field units in the vicinity an opportunity to detect the command without interference from the transmitter of a unit which has detected the command more quickly. The preferred time delay is one second.

In any event, the high voltage output from the timer activates 15-volt regulator control 258 and diode control 259. Control 258 causes 15-volt regulator 260 to supply bias voltage for the transmitter components of the field unit until the low voltage output again occurs from timer 257. Diode control 259 produces a 20 milliamperes output that switches diode switch 261 so as to disconnect antenna 43 from the receiver section of the field unit and to connect antenna 43 to the transmitter section of the field unit. After the timing period for the high voltage production from timer 257 has expired, the output from timer
257 again reduces to the low voltage level. Application of this lever to control units 258 and 259 causes removal of 15-volt bias voltage from the transmitter section of the field unit via regulator 260 and causes switching of diode switch 261 so as to disconnect the antenna from the transmitter section and connect it to the receiver section. Switch 261 may conveniently be a PIN diode switch.

Now returning to the operation of the receiver section of the field unit, the received signal at 72.98 MHz on antenna 43 by way of rf switching network 261 is amplified by rf amplifier 270, which is coupled to first autodyne converter 271, which comprises in a single network a suitable oscillator, mixer, and amplifier. Separate oscillators, mixers and amplifiers could be employed, if desired.

The oscillator of the autodyne converter, in one preferred embodiment, operates in the third overtone mode at 62.28 MHz. The output from the mixer and amplifier, and, hence, from the autodyne converter, is at 10.7 MHz.

Autodyne converter 271 is connected to filter 273 for removal of undesirable harmonics and spurious signals. Filter 273 is coupled to rf amplifier 275, where the 10.7 MHz signal is amplified prior to being coupled to a second autodyne converter 277. Like converter 271, converter 277 is a unitary network comprising suitable oscillator, mixer and amplifier components, although separate components may be used, if desired. In one preferred embodiment, the oscillator is crystal controlled to operate on the fundamental mode of 11.155 MHz. Mixing of the incoming 10.7 MHz therewith produces an output of 455 KHz, which is amplified and furnished to filter 279. 455 KHz filter removes unwanted harmonics and spurious signals.

The output from filter 279 is connected to both limiter 281 and AGC amplifier 283. Limiter 281 amplifies the 455 KHz signal and then removes all amplitude components over a predetermined amount so as to create a fairly clean frequency modulated output to phase-locked-loop (PLL) demodulator 285. AGC amplifier 283 samples the 455 KHz signal and provides a dc voltage level which is dependent on amplitude
as feedback automatic gain control to the receiver section of the field unit via its input rf amplifier 270. This feedback signal controls the amount of amplification of the rf signal applied to amplifier 270. Hence, any distortion in the receiver caused by an overly strong rf signal will be avoided by a reduction in the signal before distortion can occur.

The output of limiter 281 is applied to PLL demodulator 285, the main components of which are shown in Fig. 4. The PLL demodulator detects the presence of the modulation signal carried by the 455 KHz if signal. In a preferred operating embodiment this modulation signal is 1100 Hz. A PLL network comprises three basic components, as shown in Fig. 4, viz., a phase comparator, a first order filter and a voltage controlled oscillator (VCO). The three components are connected in a loop, the input being applied to the phase comparator together with the output of the VCO. The phase difference of this internal oscillator and the applied input produces an output to the filter, viz., the modulation product carried on the 455 KHz if input. The filter filters out noise and other products of the combined signal and supplies the 1100 Hz output. The 1100 Hz voltage to the VCO is integrated to a voltage level that phase locks the VCO to the incoming 455 KHz signal.

AFC 287 is connected to demodulator 285 to further provide setting of the internal frequency of the oscillator so that the band pass of the demodulator is centered about the 455 KHz if signal.

Filter 289, receiving the output from demodulator 285, removes unwanted signals from the demodulated signal. This signal is a voltage varying between zero volts and about 5.6 volts at the 1100 Hz rate.

The 1100 Hz voltage signal is applied to another phase-locked-loop network, viz., PLL tone decoder 291. Since there are no modulation products on the 1100 Hz signal other than noise, the output from decoder 179 is either noise (when there is no 1100 Hz signal present) or 5 volts (the dc level produced when there is an 1100 Hz signal present).
AFC 293 is connected to decoder 291 to further provide setting of the internal frequency of the oscillator so that the band pass of the decoder is centered about 1100 Hz.

Integrator 295 connected to receive the output of decoder 291 removes any noise from the output of the decoder. Hence, when the 1100 Hz signal is not present, there is a zero-volt output from the integrator. On the other hand, when there is a 5-volt output from the decoder, the integrator produces an appropriate trigger to timer 257 to cause the timer to transfer the field unit into the transmit mode. Timer trigger input 257A inhibits a trigger pulse from integrator 295 to timer 257 for a period of approximately 11 seconds. The timer control is suitable for setting the timer for operation once a trigger is received from about 20 seconds of transmitter operation to more than four hours. A four position, push button control may be used for selecting the time delay operations from 16 possible times.

The transmitter section of the field unit comprises, consecutively, seismic amplifier 201, modulator 303, oscillator 305, driver 307, and rf power amplifier 309, all of which are conventional components. Seismic amplifier gain control 311, conveniently packaged with timer control 265, controls the gain of amplifier 301. Typically, control 311 is a three-position gain select for the seismic amplifier in 6 db increments. The detector portion of the unit comprises substantially the same components of the unit shown in the embodiment of Fig. 2 and are similarly numbered. Typically, the detected seismic signals are in the 0-240 Hz range and the signal transmitted is narrow band fm modulated with 5 KHz deviation.

It is evident that such narrow band operation for transmissions to and from the field units are FCC acceptable and are suitable to a recording station that may be land, sea or air based.

It has been discovered that when a transmitter of a field unit is on constantly, the battery rapidly runs down, the unit being dependably operable for only about 24 hours. With operation of the unit in a typical use wherein the
field unit is being switched from the transmit mode to the receive mode as described above, the unit is operable for about a week. With the unit in standby, that is, with the receiver operational, but the transmitter not switched on, the unit stays ready for operation for several weeks. Hence, the advantage of the unit as described above is apparent.

**Industrial Applicability**

Referring to the drawings and specifically to Fig. 1, there are illustrated various types of areas which may exist along a traverse desired to be surveyed. For example, a water covered area 11 is located between two land areas 13 and 15. A plurality of field units in accordance with the present invention are located along the traverse at spaced positions, each of these units being suitably equipped for detecting seismic energy. Each field unit includes either one or an array of geophones or a hydrophone coupled thereto depending upon the type of surface area where the unit is located. The geophones are located, of course, on land and are identified at 21; the hydrophones are located in the water and are identified at 23; and the field units, both on land and connected to the hydrophones on suitable platforms floating on the water are identified at 25. Usually a single hydrophone is employed at a given water seismic detector location while an array of geophones, illustrated at 21A, 21B and 21C is employed at a given seismic detector location on land. Incident seismic energy from a seismic sound or energy source 27 is depicted by arrow 29, while reflected seismic energy from interface 31 is depicted by arrows 33, 35, 37 and 39. The energy source may be conventional dynamite or the newer nonexplosive sources. Although only four seismic detector or receiver locations are shown, it is to be understood that more are normally actually employed, for example 24, 48, 96, etc., depending upon the number of traces and amount of coverage desired per record.

While particular embodiments of the invention have been shown and described, it will be understood that the inven-
ation is not limited thereto, since modifications may be made and will become apparent to those skilled in the art. For example, the command transmitter does not have to be located at the recording station. Also, the packaging of the field unit may conveniently be in one package rather than two, as described above with respect to the Fig. 2 embodiment.
Claims

1. A seismic gathering system for use in carrying out seismic exploration, comprising
   a plurality of field units for detecting seismic energy and for radio transmitting information to a
   recording station, said recording station including
   a radio command transmitter for transmitting a command signal to said field units, and
   a plurality of radio receivers for receiving information transmitted from said field units,
   each of said field units including
   an antenna,
   a receiver for receiving the radio command signal from said command transmitter by way of said
   antenna,
   a field radio transmitter for transmitting to said recording station by way of said antenna data
   representative of seismic energy detected, seismic detector means for detecting seismic energy,
   input means for applying the output of said seismic detector means to said field transmitter, and
   means responsive to the command signal received for disenabling said receiver and enabling
   said field transmitter for transmission for only a preset period of time.

2. A field unit for use in a seismic gathering system wherein a radio command signal is transmitted from a recording station to said field unit and said field unit transmits seismic information to said recording station, comprising
   a radio receiver for receiving the command signal transmitted from said recording station,
a radio field transmitter for transmitting seismic information to said recording station, seismic detector means for detecting seismic energy, input means for applying the output of said seismic detector means to said transmitter, and control means responsive to the command signal received for disenabling said receiver and for enabling said field transmitter for transmission for only a preset period of time.

3. A field unit in accordance with claim 2, and including an antenna normally coupled to said receiver, power supply means normally disconnected from said transmitter, circuitry coupled to the output of said receiver for producing a time dependent function in response to the command signal received, and means responsive to said time dependent function for connecting said transmitter with said power supply means and with said antenna and for disconnecting said receiver from said antenna during the time period of said time dependent function.

4. A field unit in accordance with claim 2, and including a seismic amplifier, an antenna normally coupled to said receiver, power supply means normally coupled to said receiver, circuitry coupled to the output of said receiver for producing a time dependent function in response to the command signal received, and means responsive to said time dependent function for connecting said transmitter and said seismic amplifier with said power supply means, and said transmitter with said antenna and for disconnecting said receiver from said antenna and from said power supply means during the time period of said time dependent function.
5. A field unit in accordance with claim 2, wherein said control means comprises circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received for enabling said transmitter for transmission only for the time period of said electrical signal.

6. A field unit in accordance with claim 2, and including a seismic amplifier coupled to said transmitter, an antenna normally coupled to said receiver, power supply means normally coupled to said receiver, circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received, and an electrical relay coupled to the output of said circuitry and having two switches normally coupling said antenna to said receiver and said power supply to said receiver, said relay being responsive to said time dependent electrical signal for disconnecting said receiver from said antenna and from said power supply means, and for connecting said transmitter with said power supply means and with said antenna for the time period of said time dependent electrical signal.

7. A field unit in accordance with claim 2, and including a seismic amplifier coupled to said transmitter, an antenna normally coupled to said receiver, power supply means normally disconnected from said transmitter, circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received, and an electrical relay coupled to the output of said circuitry and having switch means normally coupling said antenna to said receiver,
said relay being responsive to said time-dependent electrical signal for disconnecting said receiver from said antenna and for connecting said transmitter with said power supply means and with said antenna for the time period of said time-dependent electrical signal.

8. A field unit in accordance with claim 2 wherein said control means is responsive to the command signal for dis-enabling said receiver and for enabling said transmitter for transmission only for said preset period of time.

9. In a seismic gathering system for use in carrying out seismic exploration, said system including a transmitter for transmitting an fm modulated command signal burst to initiate field unit operation, a field unit comprising an antenna,

switching means connected to said antenna,
receiver means connected through said switching means to said antenna for detecting the presence of a command signal burst modulation,
timer means connected to said receiver means, said timer producing first and second enabling signals, and

seismic detection and transmitter means for producing fm modulation transmissions indicative of seismic reflections detected at the field unit, said first enabling signal switching said switching means to disconnect said antenna from said receiver means and to connect said antenna to said seismic detection and transmitter means,
said second enabling signal switching said switching means to activate said seismic detection and transmitter means,

the termination of said first enabling signal switching said switching means to disconnect said antenna from said seismic detection and transmitter means,
the termination of said second enabling signal
disenabling said seismic detection and transmitter
means.

10. A field unit in accordance with claim 9, wherein said
timer means includes
   a two-lever output timer actuated by a voltage level,
a settable control connected to said timer for deter-
mining the length of production from said timer of
the higher of the two level outputs, after which
the output from said timer returns to the lower of
the two level outputs.

11. A field unit in accordance with claim 9, wherein said
receiver means includes two successive autodyne converters
and two successive phase locked loop networks for detecting
the command signal burst modulation.

12. A field unit in accordance with claim 9, wherein said
timer means includes
   a switch control for producing said first enabling
   signal, and
   a regulator control for activating a regulator for
   supplying power to said seismic detection and
transmitter means.
AMENDED CLAIMS

(AMENDED) A seismic gathering system for use in carrying out seismic exploration, comprising

A plurality of field units for detecting seismic energy and for radio transmitting information to a recording station,

said recording station including

a radio command transmitter for transmitting a command signal to said field units, and

a plurality of radio receivers for respectively receiving information transmitted from said field units,

each of said field units including

an antenna,

a receiver for receiving the radio command signal from said command transmitter by way of said antenna,

a field radio transmitter for transmitting to said recording station by way of said antenna data representative of seismic energy detected,

seismic detector means for detecting seismic energy,

input means for applying the output of said seismic detector means to said field transmitter, and

means responsive to the command signal received for disenabling said receiver and enabling said field transmitter for transmission for only a preset period of time.

2. A field unit for use in a seismic gathering system wherein a radio command signal is transmitted from a recording station to said field unit and said field unit transmits seismic information to said recording station, comprising

a radio receiver for receiving the command signal transmitted from said recording station,
a radio field transmitter for transmitting seismic information to said recording station, seismic detector means for detecting seismic energy, input means for applying the output of said seismic detector means to said transmitter, and control means responsive to the command signal received for disengaging said receiver and for enabling said field transmitter for transmission for only a preset period of time.

3. A field unit in accordance with claim 2, and including an antenna normally coupled to said receiver, power supply means normally disconnected from said transmitter, circuitry coupled to the output of said receiver for producing a time dependent function in response to the command signal received, and means responsive to said time dependent function for connecting said transmitter with said power supply means and with said antenna and for disconnecting said receiver from said antenna during the time period of said time dependent function.

4. A field unit in accordance with claim 2, and including a seismic amplifier, an antenna normally coupled to said receiver, power supply means normally coupled to said receiver, circuitry coupled to the output of said receiver for producing a time dependent function in response to the command signal received, and means responsive to said time dependent function for connecting said transmitter and said seismic amplifier with said power supply means, and said transmitter with said antenna and for disconnecting said receiver from said antenna and from said power supply means during the time period of said time dependent function.
5. A field unit in accordance with claim 2, wherein said control means comprises circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received for enabling said transmitter for transmission only for the time period of said electrical signal.

6. A field unit in accordance with claim 2, and including a seismic amplifier coupled to said transmitter, an antenna normally coupled to said receiver, power supply means normally coupled to said receiver, circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received, and an electrical relay coupled to the output of said circuitry and having two switches normally coupling said antenna to said receiver and said power supply to said receiver, said relay being responsive to said time dependent electrical signal for disconnecting said receiver from said antenna and from said power supply means, and for connecting said transmitter with said power supply means and with said antenna for the time period of said time dependent electrical signal.

7. A field unit in accordance with claim 2, and including a seismic amplifier coupled to said transmitter, an antenna normally coupled to said receiver, power supply means normally disconnected from said transmitter, circuitry coupled to the output of said receiver for producing a time-dependent electrical signal in response to a command signal received, and an electrical relay coupled to the output of said circuitry and having switch means normally coupling said antenna to said receiver,
said relay being responsive to said time-dependent electrical signal for disconnecting said receiver from said antenna and for connecting said transmitter with said power supply means and with said antenna for the time period of said time-dependent electrical signal.

8. A field unit in accordance with claim 2 wherein said control means is responsive to the command signal for disabling said receiver and for enabling said transmitter for transmission only for said preset period of time.

9. In a seismic gathering system for use in carrying out seismic exploration, said system including a transmitter for transmitting an fm modulated command signal burst to initiate field unit operation, a field unit comprising an antenna, switching means connected to said antenna, receiver means connected through said switching means to said antenna for detecting the presence of a command signal burst modulation, timer means connected to said receiver means, said timer producing first and second enabling signals, and seismic detection and transmitter means for producing fm modulation transmissions indicative of seismic reflections detected at the field unit, said first enabling signal switching said switching means to disconnect said antenna from said receiver means and to connect said antenna to said seismic detection and transmitter means, said second enabling signal switching said switching means to activate said seismic detection and transmitter means, the termination of said first enabling signal switching said switching means to disconnect said antenna from said seismic detection and transmitter means to said receiver means,
the termination of said second enabling signal
disabling said seismic detection and transmitter
means.

10. A field unit in accordance with claim 9, wherein said
timer means includes
    a two-lever output timer actuated by a voltage level,
    a settable control connected to said timer for deter-
mining the length of production from said timer of
the higher of the two level outputs, after which
the output from said timer returns to the lower of
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11. A field unit in accordance with claim 9, wherein said
receiver means includes two successive autodyne converters
and two successive phase locked loop networks for detecting
the command signal burst modulation.

12. A field unit in accordance with claim 9, wherein said
timer means includes
    a switch control for producing said first enabling
signal, and
    a regulator control for activating a regulator for
supplying power to said seismic detection and
transmitter means.
INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER

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

| 8 INT. CL. | G01V 1/22 |
| U. S. Cl. | 367/77; 343/6.5R |

II. FIELDS SEARCHED

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III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
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  "A" document defining the general state of the art
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  "L" document cited for special reason other than those referred to in the other categories
  "O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed
"T" later document published on or 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

IV. CERTIFICATION

Date of the Actual Completion of the International Search: 21 August 1980
Date of Mailing of this International Search Report: 22 Sep 1980

International Searching Authority: ISA/US
Signature of Authorized Officer: Nelson Moskowitz