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(54) TELEPHONE LINE COUPLER 5,555,293 A \* 9/1996 Krause ..... 379/399

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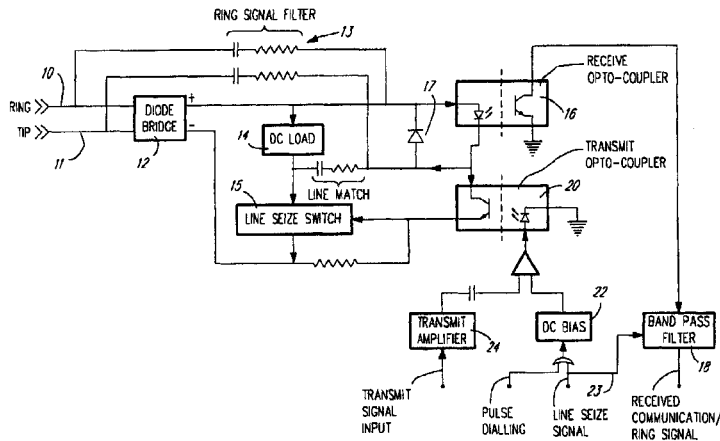
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(57) ABSTRACT

The telephone line coupler circuit has a single transmit opto-coupler whose output includes a DC bias component connected to a gate of a line seize switch for connecting a DC line seize load across the ring and tip contacts of the telephone line. The line seize switch is saturated by the transmit opto-coupler bias output and the AC component of the transmit opto-coupler output is sent over the telephone lines. The receive opto-coupler is used both for receiving communications signal and for detecting the ring signal. The band pass filter connected to the output of the receive opto-coupler may be switched to pass a ring signal frequency band or a communications frequency band. The circuit operates using two opto-coupler devices while conventional circuits require four opto-coupler devices.

12 Claims, 1 Drawing Sheet



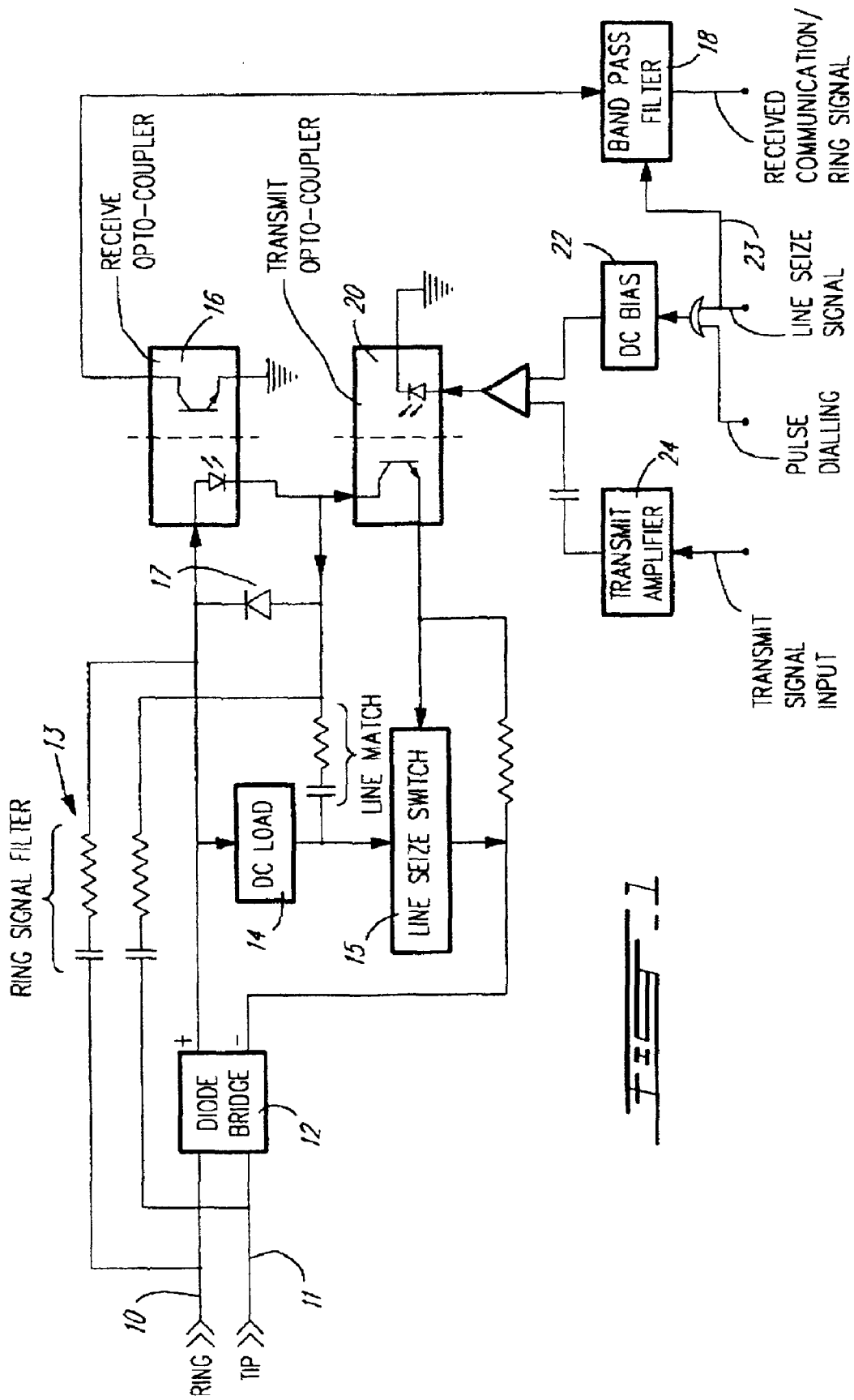


FIG. 1

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## TELEPHONE LINE COUPLER

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

## FIELD OF THE INVENTION

The present invention relates to a telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line.

## BACKGROUND OF THE INVENTION

A telephone line coupler circuit is found in most every type of electronic equipment connected to a telephone line such as modems and fax machines. In order to protect the electronic equipment from surges on the telephone line and side to prevent different ground voltages from causing erroneous operation in the subscriber equipment, transformers or opto-couplers are used in the coupler circuit to connect the subscriber electronic equipment for the telephone line.

Coupler circuits which use opto-couplers are known in the art. In U.S. Pat. No. 4,727,535 to Brandt, a coupler circuit is described in which a single opto-coupler is used for relaying the analog AC transmit signal and another opto-coupler device is used for relaying the received AC signal. The telephone line connect and disconnect circuit (e.g. a line relay) is not disclosed. In U.S. Pat. No. 4,203,006 to Mascia, one opto-coupler is used for relaying a ringing signal to a modem, a second opto-coupler is used in relaying a line seize signal from the modem to the telephone line access coupler and a transformer is used in place of a pair of opto-couplers for relaying the received and transmitted AC signals from the coupler to the modem.

In the known prior art coupler circuits using opto-couplers, the basic functions of relaying the ring signal, relaying the communications receive signal, relaying the line seize signal and relaying the AC transmit signal all require separate opto-coupler devices. In the case that a transformer used, the bi-directional nature of the transformer allows for single device to be used for relaying the received and the transmitted communication signal. In a standard telephone line coupler circuit, the cost of the opto-coupler devices is a substantial portion of the component cost for the circuit.

## SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a telephone line coupler circuit for coupling a telephone line to a subscriber electronic device with isolation between the telephone line and the subscriber device in which the number of opto-couplers is reduced.

In accordance with the first aspect of the present invention, there is provided a telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising: ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs; a high impedance DC load and a gated line switch connected in series between the ring and tip signal outputs for controllably conducting an "off-hook" current between the ring and tip signal outputs; a transmit opto-coupler means having a transmit signal input and output; means connecting the output terminal to the tip output and to a gate input of the gated line switch; means for controllably providing a low level DC bias signal to the

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transmit signal input and generating sufficient current on the output to substantially saturate the gated line switch and seize the line; means for providing an outgoing AC signal to the transmit signal input; and AC signal receive means connected to the ring and tip outputs for detecting an incoming AC signal and producing an incoming AC signal output.

The invention also provides a telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising: ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs; a high impedance DC load and a line switch connected in series between the ring and tip signal outputs for controllably conducting an "off-hook" current between the ring and tip signal outputs; signal transmit means having a transmit signal input and being connected to the ring and tip outputs for transmitting AC signal; AC communications signal receive means connected to the ring and tip outputs for detecting an incoming AC communications signal and producing an incoming AC communications signal output; and AC ring signal detect means connected to the ring and tip outputs for detecting a telephone ring signal on the telephone line and generating a ringing output signal; wherein: the AC communications signal receive means and the AC ring signal detect means share a common receive opto-coupler device.

Preferably, the AC communication signal receive means and the AC ring signal detect means comprise a single band pass amplifier circuit which is switchable between two frequency bands, that is a first frequency band for the telephone ring signal and a second frequency band for received communication signals. Also preferably, the band pass filter amplifier is switched between the ring frequency band to the communications frequency band by the line seize signal connected to the means for controllably providing a load level DC bias signal to the transmit signal input of the transmit opto-coupler means.

Accordingly, the invention also provides a telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising: ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs; a high impedance DC load and a gated line switch connected in series between the ring and tip signal outputs for controllably conducting an "off-hook" current between the ring and tip signal outputs; a transmit opto-coupler means having a transmit signal input and output; means connecting the output terminal to the tip output and to a gate input of the gated line switch; means for controllably providing a low level DC bias signal to the transmit signal input and generating sufficient current on the output to substantially saturate the gated line switch and seize the line; means for providing an outgoing AC signal to the transmit signal input; AC communications signal receive means connected to the ring and tip outputs for detecting an incoming AC communications signal and producing an incoming AC communications signal output; and AC ring signal detect means connected to the ring and tip outputs for detecting a telephone ring signal on the telephone line and generating a ringing output signal; wherein: the AC communications signal receive means and the AC ring signal detect means share a common receive opto-coupler device.

*The invention also provides a method of isolating and connecting a transmit signal generated by subscriber electronic equipment to a telephone line.*

## BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood by way of the following detailed description of a preferred embodiment with reference to the appended drawing in which:

FIG. 1 is a block diagram of the telephone line coupler circuit according to the preferred embodiment.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment as illustrated in FIG. 1, the telephone line coupler circuit according to the invention comprises a telephone line ring/tip connector providing ring and tip outputs **10** and **11** respectively. In the case that the polarity may be reversed by the telephone company, a diode bridge **12** is provided for providing the correct polarity to the rest of the circuit. A receive opto-coupler **16** is connected to the positive ring output of the diode bridge **12** through a capacitor and line seize switch **15** to the negative tip output of bridge **12**. A DC line seize load **14** and a line seize switch **15** are connected in series between the ring and tip outputs of bridge **12**. In order to seize the telephone line, a small DC current must pass through the coupler circuit in order for the telephone company central office equipment to consider the line to be in use.

A transmit opto-coupler **20** has an input consisting of a DC bias signal from a DC bias source **22** and an AC signal component coming from transmit amplifier **24**. A comparator circuit is used to block the AC signal in the absence of the DC bias signal and to allow the DC bias signal to pass through in the absence of the AC signal. When the line seize signal **23** is energized, the DC bias voltage from **22** causes the transmit opto-coupler to output a base DC level which saturates the line seize switch **15** to provide the minimum required DC current through load **14** to seize the line. The DC bias level is chosen to provide a sufficient output to saturate line seize switch even when the AC component from transmit amplifier **24** is superimposed. The AC output from opto-coupler **20** is also fed through a resistance directly to the tip output of bridge **12**. For pulse dialing, a separate pulse dialing input is provided which is ORed with line seize signal **23**.

When the circuit is in the "on-hook" state, line seize signal **23** is low and the band pass filter amplifier **18** is set to amplify AC signals in a frequency range of the telephone ring signal. Current from outputs **10** and **11** corresponding to a ring signal pass through ring signal filter **13** across the receive opto-coupler **16**. Return current passes through diode **17**. The received communication/ring signal output from amplifier **18** produces an AC output corresponding to the ring signal appearing on outputs **10** and **11**. The subscriber device connected to the output of amplifier **18** detects the presence of the ring signal and upon deciding to answer, places an output on line seize signal line **23** resulting in amplifier **18** switching to filtering and amplifying frequencies in the communication band and resulting in DC bias source **22** providing a DC bias signal to transmit opto-coupler **20** which causes the line seize switch **15** to be saturated and the line to be seized by passing the required DC current through load **14**. Since the receive opto-coupler **16** is connected to the transmit opto-coupler **20**, a minimum draw of current to place the light-emitting diode of receive opto-coupler **16** in an operational range is achieved. As an AC signal comes into receive opto-coupler **16**, a faithful isolated AC output is generated.

As can be appreciated, the line coupler circuit according to the invention requires only two opto-coupler devices for

the purposes of relaying ring signal, communication signal, transmission and seizing the telephone line. While in the preferred embodiment, the band pass filter amplifier **18** is shown as a single block circuit having a single output, it is of course possible to provide two separate filter/amplifier circuits connected to the output of opto-coupler **16** without requiring a connection to line seize signal line **23** to switch between the two filters.

I claim:

1. A telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising:

ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs;

a high impedance DC load and a gated line switch connected in series between said ring and tip signal outputs for controllably conducting an "off-hook" current between said ring and tip signal outputs;

a transmit opto-coupler means having a transmit signal input and output;

means for connecting said transmit signal output to said tip output and to a gate input of said gated line switch;

means for controllably providing a low level DC bias signal to said transmit signal input and generating sufficient current on said transmit signal output to substantially saturate said gated line switch and seize said telephone line;

means for providing an outgoing AC signal to said transmit signal input; and

AC signal receive means connected to said ring and tip outputs for detecting an incoming AC signal and producing an incoming AC signal output.

2. A telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising:

ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs;

a high impedance DC load and a gated line switch connected in series between said ring and tip signal outputs for controllably conducting an "off-hook" current between said ring and tip signal outputs;

a transmit opto-coupler means having a transmit signal input and output;

means for connecting said transmit signal output to said tip output and to a gate input of said gated line switch;

means for controllably providing a low level DC bias signal to said transmit signal input and generating sufficient current on said transmit signal output to substantially saturate said gated line switch and seize said telephone line;

means for providing an outgoing AC signal to said transmit signal input;

AC communications signal receive means connected to said ring and tip outputs for detecting an incoming AC communications signal and producing an incoming AC communications signal output; and

AC ring signal detect means connected to said ring and tip outputs for detecting a telephone ring signal on said telephone line and generating a ringing output signal; wherein:

said AC communications signal receive means and said AC ring signal detect means share a common receive opto-coupler device.

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3. A telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising:

ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and tip signal outputs;

a high impedance DC load and a line switch connected in series between said ring and tip signal outputs for controllably conducting an "off-hook" current between said ring and tip signal outputs;

signal transmit means having a transmit signal input and being connected to said ring and tip outputs for transmitting AC signal;

AC communications signal receive means connected to said ring and tip outputs for detecting an incoming AC communications signal and producing an incoming AC communications signal output; and

AC ring signal detect means connected to said ring and tip outputs for detecting a telephone ring signal on said telephone line and generating a ringing output signal; wherein said AC communication signal receive means and said AC ring signal detect means share a common receive opto-coupler device and a common band pass filter circuit switchable between a frequency band of said ring signal and a frequency band of communications signal received over said telephone line, a switching of said filter circuit being in response to a control signal for said line switch.

4. A telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising:

ring and tip connector means for connecting to telephone line ring and tip contacts and providing ring and [t-i-p] tip signal outputs;

a high impedance DC load and a gated line switch connected in series between said ring and tip signal outputs for controllably conducting an "off-hook" current between said ring and tip signal outputs;

a transmit opto-coupler means having a transmit signal input and output;

means connecting said transmit signal output to said tip output and to a gate input of said gated line switch;

means for controllably providing a low level DC bias signal to said transmit signal input and generating sufficient current on said transmit signal output to substantially saturate said gated line switch and seize said line;

means for providing an outgoing AC signal to said transmit signal input;

AC communications signal receive means connected to said ring and tip outputs for detecting an incoming AC communications signal and producing an incoming AC communications signal output; and

AC ring signal detect means connected to said ring and tip outputs for detecting a telephone ring signal on said telephone line and generating a ringing output signal; wherein said AC communications signal receive means and said AC ring signal detect means share a common receive opto-coupler device and include a shared band pass filter circuit switchable between a ring signal frequency band and a communication signal frequency band, said filter circuit being switched by a line seize signal fed to said low level DC bias signal providing means.

5. A telephone line coupler circuit for connecting telephone subscriber equipment to a telephone line, the circuit comprising:

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a ring and tip connector circuitry connecting to telephone line ring and tip contacts and providing ring and tip signal outputs;

a high impedance DC load and a gated line switch connected in series between said ring and tip signal outputs for controllably conducting an "off-hook" current between said ring and tip signal outputs;

a receive opto-coupler having a receive signal input on a line side and a receive signal output on an equipment side;

a transmit opto-coupler having a transmit signal input on said equipment side and a transmit signal output on said line side, said receive opto-coupler and said transmit opto-coupler being connected in series on said line side;

said transmit signal output being connected to said tip output and to a gate input of said gated line switch;

a line side transmit signal and DC bias signal combining circuitry receiving a transmit communications signal and a DC bias signal and outputting a combined signal to said transmit signal input; and

a DC bias voltage generator responsive to a control signal to provide a low level DC signal as said DC bias signal, wherein sufficient current is generated on said transmit signal output to substantially saturate said gated line switch and seize said telephone line.

6. The circuit as claimed in claim 5, further comprising:

AC ring signal detection circuitry connected to said telephone line ring and tip contacts and outputting a ring signal to said receive signal input.

7. The circuit as claimed in claim 5, wherein said ring and tip connector circuitry comprises a diode bridge.

8. The circuit as claimed in claim 6, further comprising a common band pass filter circuit connected to said receive signal output and switchable between a frequency band of said ring signal and a frequency band of a communications signal received over said telephone line, a switching of said filter circuit being in response to said control signal.

9. The circuit as claimed in claim 6, wherein said ring and tip connector circuitry comprises a diode bridge, said AC ring signal detection circuitry being connected to said ring and tip signal contacts before said diode bridge.

10. The circuit as claimed in claim 8, wherein said ring and tip connector circuitry comprises a diode bridge, said AC ring signal detection circuitry being connected to said ring and tip signal contacts before said diode bridge.

11. A method of isolating and connecting a transmit signal generated by subscriber electronic equipment to a telephone line, the method comprising:

providing a transmit opto-coupler;

adding a DC bias to the electronic equipment transmit signal coming from the electronic equipment to obtain a combined signal and feeding the combined signal to the transmit opto-coupler, said DC bias being sufficient to generate a low level DC output on a line side of said transmit opto-coupler;

using said low level DC output to trigger a line seize circuit connected to said telephone line to draw a minimum current required by a central office to seize the telephone line;

transmitting an isolated copy of said transmit signal output from said transmit opto-coupler on said telephone line, using circuitry separate from the line seize circuitry;

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providing a receive opto-coupler; and  
 connecting said transmit opto-coupler and said receive  
 opto-coupler together in series on a telephone line side.  
 12. A method of isolating and connecting a ring signal  
 and a communications receive signal on a telephone line to  
 subscriber electronic equipment, the method comprising: 5  
 providing a receive opto-coupler;  
 connecting said receive opto-coupler using first circuit  
 elements to the telephone line to detect and isolate an  
 incoming AC communications signal; 10  
 connecting said receive opto-coupler using second circuit  
 elements to the telephone line to detect and isolate a  
 ring signal;  
 providing a transmit opto-coupler;

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connecting said transmit opto-coupler and said receive  
 opto-coupler together in series on a telephone line  
 side;  
 detecting the ring signal at an output of the receive  
 opto-coupler in the subscriber electronic equipment  
 when the subscriber electronic equipment is in an  
 on-hook state; and  
 detecting the incoming AC communications signal at the  
 output of the receive opto-coupler in the subscriber  
 electronic equipment when the subscriber electronic  
 equipment is in an off-hook state;  
 wherein said steps of detecting comprise using different  
 filtering characteristics on said output of the receive  
 opto-coupler depending on the on-hook/off-hook state.

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