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TRANSMISSION LINE DRIVER

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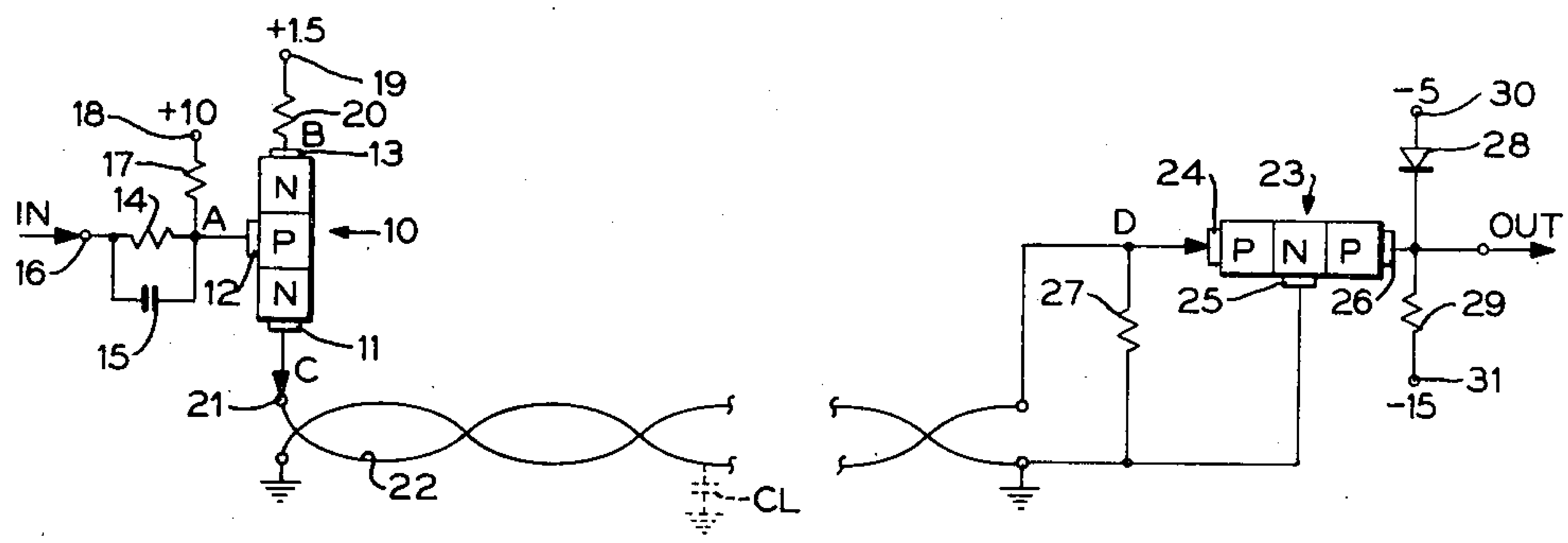

FIG_1

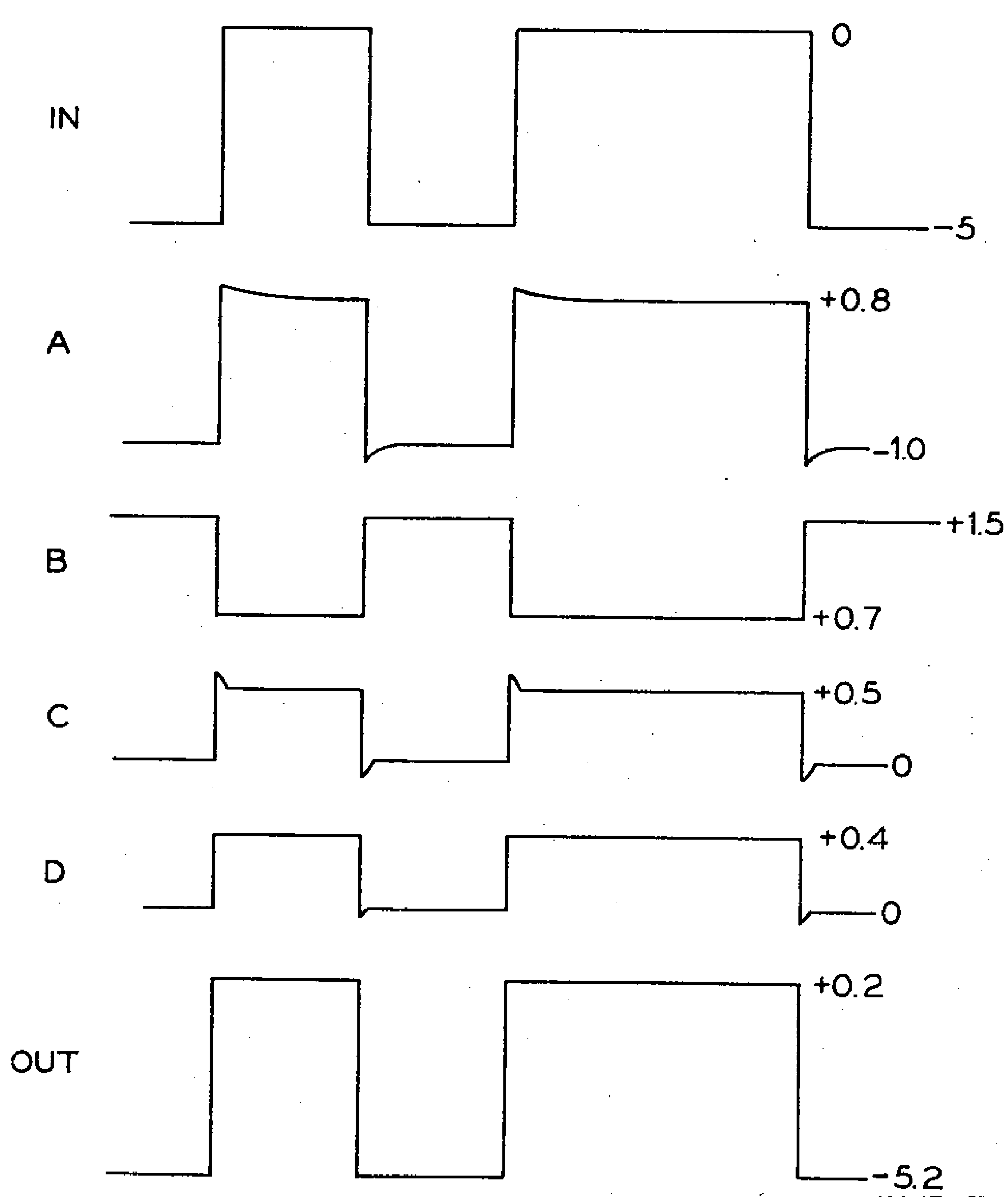

FIG_2

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TRANSMISSION LINE DRIVER

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1 Claim. (Cl. 307—88.5)

This invention relates to the transmission of information over lines and more particularly to the use of transistors to drive a transmission line.

In accordance with the embodiment of the invention, two transistors, a source of signal voltage, and other component elements are arranged to form a transmission network. The transistors are of the type having a base, a collector and an emitter. At the input to the transmission line, there is a transistor switch which is normally cut off but which, upon the application of an input signal of sufficient amplitude, closes and permits the current to flow along the transmission line. At the output end of the transmission line, there is provided a transistor amplifier for amplifying the transmitted signal. Such a circuit has the advantage of requiring negligible power to drive the line. In addition, there is freedom from extraneous noise, no ringing due to poor line terminations, low power dissipation in the driver, and minimum phase shifting.

A principal object of the present invention is to provide an improved transmission circuit having a current switch at the input and a current operated voltage amplifier at the output of a transmission line.

A further object of the present invention is to provide a novel circuit having the ability to drive long lines at low signal levels with minimum capacitative loading effects.

Other objects of the invention will be pointed out in the following description and claim and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

FIG. 1 is a schematic circuit diagram of a transmission circuit employing a current switch at the input and a current operated voltage amplifier at the output in accordance with the present invention.

FIG. 2 is a diagram of the waveforms illustrating the operating characteristics of the circuit of FIG. 1.

In semiconductive materials such as germanium or silicon, the electrical currents, according to presently accepted theory, are carried by electrons designated as "excess" electrons or by "holes" which are defect or missing electrons. According to the theory, a "hole" may be viewed as a carrier of a positive electric charge and an electron as a carrier of a negative electric charge. Electron or "hole" carriers are designated generically by the term "mobile charges."

A semiconductive material is called excess or N type when the mobile charges normally present in excess in the material under equilibrium conditions are electrons. N type semiconductive material passes current easily when the semiconductive material is negative with respect to a conductive connected thereto.

A semiconductive material is called defect or P type when the mobile charges normally present in excess in the mateiral under equilibrium conditions are holes. P type semiconductive material passes current easily when the semiconductive material is positive with respect to a conductive connection thereto.

Two principal classes of semiconductor devices have been developed which have been referred to in the art

as the "point contact transistor" and the "junction transistor." The present invention employs, purely as a matter of choice, the junction transistor which, as the name implies, includes a semiconductive body having alternate zones of N and P type material forming between them junctions or barriers. Electrodes are placed in low-resistance contact with the discrete zones of the material and have been given the names of "collector" electrode, "base" electrode and "emitter" electrode. The collector electrode and the emitter electrode are in contact with the end zones of the semiconductive body, and the base electrode is in contact with the intervening zone of the semiconductive body.

The alternate zones of the body of the junction transistor may be in the series N-P-N or in the series P-N-P. In a base-input, grounded emitter circuit, a positive input pulse applied to the base electrode to a P-N-P junction transistor will cause the current flowing from the collector to decrease; whereas, a positive input pulse applied to the base electrode of an N-P-N junction transistor will cause the current flowing into the collector to increase. Thus P-N-P and N-P-N transistors have complementary operating characteristics.

In accordance with the preferred embodiment of the present invention, a current switch is provided at the input to the transmission line and a current operated voltage amplifier is connected at the output of the line. Referring to FIG. 1, the current switch comprises a junction transistor **10** which is of the N-P-N type. Transistor **10** has an emitter electrode **11** in contact with one N type zone, a base electrode **12** in contact with the P type zone and a collector electrode **13** in contact with the other N type zone. The base electrode **12** functions as the control electrode and is connected, through an input resistor **14** and capacitor **15**, to an input voltage signal terminal **16**. A resistor **17** connected to a positive 10 volt terminal **18** serves to set the voltage at the base electrode **12**. A source of operating voltage, such as positive 1.5 volt terminal **19**, is connected to the collector electrode **13** through a resistor **20** and the emitter electrode **11**, which functions as the output electrode, is connected to the input terminal **21** of a transmission line **22**.

The current operated voltage amplifier comprises a junction transistor **23** which is of the P-N-P type. Transistor **23** has an emitter electrode **24** in contact with one P type zone, a base electrode **25** in contact with the N zone and a collector electrode **26** in contact with the other P type zone. The base or control electrode **25** is shown connected to ground and the emitter electrode **24** is connected to the output of the transmission line. A line terminating resistor **27** is provided between point D and ground. A diode **28** and resistor **29**, connected between a negative 5 volt terminal **30** and a negative 15 volt terminal **31**, set the voltage at the output or collector electrode **26**.

Referring to the waveforms shown in FIG. 2, the circuit operates in the following manner:

When the input signal is at negative 5 volts, transistor **10** is cut off and no current flows from points C to D. When the input rises to ground potential, transistor **10** conducts and the resistor **20** in the collector circuit limits the current flow to around 8 milliamperes. As shown in FIG. 2, resistor **20** drops the voltage at point B to a positive 0.7 volt biasing the collector **13** more negative with respect to base **12** and driving transistor **10** to saturation. Coupled with the drop across the transistor, the voltage swing at point C is only 0.5 volt which is sufficient to drive the line **22** and receiver transistor **23** with minimum loading effects on the line.

Transistor **23** is a current operated voltage amplifier and when no current is flowing in the emitter circuit the output is at negative 5 volts. The 8 milliampere current pulse from the line driver transistor **10** is divided about equally between the resistor **27** connection from point D to ground and the emitter electrode **24** of transistor **23**. The voltage change at point D will then be about 0.4 volt and the voltage swing at the output will be about 5 volts due to the limiting diode **28**. The use of a diode clamp at the output or collector electrode **26** eliminates any spurious signals which may occur in the line and produces a faster response. Hence, the output signal goes from approximately a negative 5 volts to 0 volt and remains at 0 during conduction of transistor **10** and the transmission of current over the line **22**. When the input signal drops sufficiently below 0 volt, transistor **10** will cut off and current will cease to flow in the transmission line **22**. As a result, the transistor **23** output will drop to approximately negative 5 volts.

A major advantage of the present circuit is the negligible power required to drive the line. The energy stored in the line capacitance to ground (C_L) is $\frac{1}{2}C_LE^2$. Since the transient power required to charge the line through a given source impedance is proportional to this; reduction of the signal from 5 volts to 0.5 volt results in a transient power reduction of

$$\frac{1}{10^2}$$

or $\frac{1}{100}$. Conversely, 400 times the power would be required if a 10 volt signal were used instead of 0.5 volt. The same reduction is also obtained in the standby power losses in the terminating resistance **27** of the line, since

$$P=\frac{E^2}{R}$$

Also, as was previously mentioned, the circuit presents freedom from extranoeus noise, no ringing because of poor line terminations, low power dissipation in the driver even under shorted conditions, minimum phase shift, no adverse effects due to transistor variations, and simplicity of circuit design.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and its operation may be made by those skilled in the art,

without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claim.

What is claimed is:

A system for transmitting information comprising, a source of relatively large signal voltage, a transmission line having an input terminal and an output terminal, a first junction type transistor having a base, emitter and collector electrode, said base electrode being connected to said signal source and said emitter electrode being connected solely to said input terminal, a source of bias voltage for said collector electrode, an impedance element connecting said bias voltage to said collector electrode, and a second junction type transistor having a base, emitter and collector electrode, said second emitter electrode being connected to said output terminal and said second base electrode being connected to ground, said first transistor effecting a flow of current in response to said signal voltage with said impedance element allowing said first transistor to go to saturation whereby a measured current flow of known value will be presented to the transmission line, said impedance element dissipating part of the available power output of said first transistor whereby the voltage swing at said input terminal is reduced to a minimum value to drive said transmission line and said second transistor, and said second transistor being responsive to said flow of current to produce an output voltage of the order of magnitude of said input signal voltage.

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