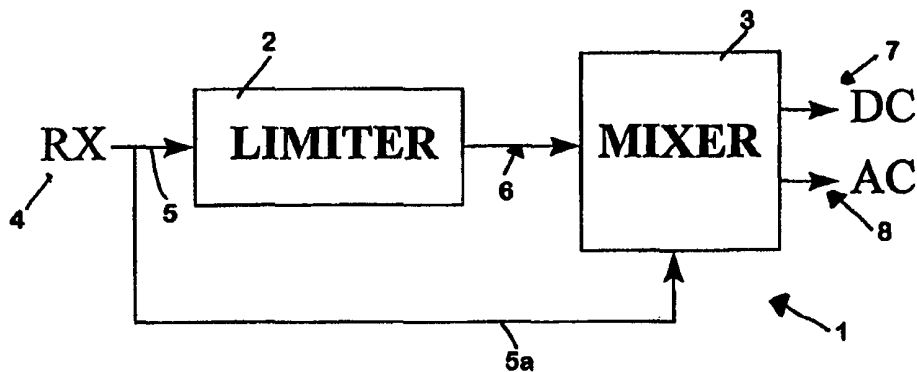




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<p>(21) International Application Number: PCT/DK99/00076 (22) International Filing Date: 23 February 1999 (23.02.99) (30) Priority Data: 0247/98 23 February 1998 (23.02.98) DK (71) Applicant (for all designated States except US): TSS TRAFFIC SUPERVISION SYSTEMS A/S [DK/DK]; Lundtoftegårdsvej 97, DK-2800 Lyngby (DK). (72) Inventors; and (75) Inventors/Applicants (for US only): PETERSEN, Freddy [DK/DK]; Dragevej 6, DK-4040 Jyllinge (DK). MIDT-GAARD, Arne [DK/DK]; Gundestedvej 32, DK-4330 Hvalsø (DK). PEDERSEN, Heine, Ewi [DK/DK]; Sydskråningen 1, DK-2800 Lyngby (DK). (74) Agent: HOFMAN-BANG & BOUTARD, LEHMANN & REE A/S; Hans Bekkevolds Allé 7, DK-2900 Hellerup (DK).</p>		<p>(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>In English translation (filed in Danish). Without international search report and to be republished upon receipt of that report.</i></p>

(54) Title: A METHOD AND A CIRCUIT FOR AM DEMODULATION



(57) Abstract

The invention relates to a method for simultaneous AM demodulation of data which are transferred between a transponder and an interrogator in connection with metal detection. The carrier wave signal is amplitude modulated by the information signal and is fed to an input of a receiver where it is branched into two parts, so that the first part is fed to a severe limiter, while the second part is fed to a first input of a mixer whose second input receives the output signal from the severe limiter. The two signal parts are multiplied in the mixer. A DC signal used for metal detection and an AC signal used for determining a possible information signal occur on the output of the mixer. The AM signal is fed to the receiver from an antenna which contains an adjusted circuit, which receives a signal galvanically separated from a generator. Signals from objects which partly contain a tag with identification data and partly do not contain a tag, may be used for detection and identification of objects.

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A METHOD AND A CIRCUIT FOR AM DEMODULATION-----
5

The invention relates to a method for simultaneous AM demodulation of partly data signals and partly signals formed by interaction with metal.

10 More specifically, the invention is related to monitoring systems of the type which is described e.g. in WO 98/07052. Systems for identification purposes are frequently called RF-ID systems.

15 For monitoring purposes, the object to be monitored may be provided with a TAG which, if the TAG gets near an electromagnetic field, responds with an identification code that can be picked up by the antenna which emitted the electromagnetic field. There are many such systems
20 e.g. for monitoring vehicles.

For a vehicle to be identified, the vehicle must thus be provided with the TAG. On the other hand, no information is achieved on vehicles which are not provided with this
25 TAG.

The object of the invention is to provide a method allowing identification of e.g. vehicles which are provided with a TAG as well as information on e.g. vehicles which
30 are not provided with a TAG.

This object is achieved by performing the method as stated in claim 1. The invention is based on the circumstance that the modulation degree of signals used for
35 identification purposes is very small in accordance with a prescribed standard. The invention is also based on the

finding that passage of a metal part past the antenna which emits the electromagnetic signal causes the antenna to register a received signal with a relatively great modulation degree. The modulation degree of signals for
5 identification purposes is of the order of 10^{-4} , while the modulation degree for detection of metal is typically 10^{-1} according to the invention.

If a crowded road is to be monitored, it will not only be
10 possible to obtain identification of the vehicles which are provided with a TAG, but it will also be possible to obtain information on all other vehicles, as it may e.g. be measured what the average speed is, assuming a standard length of the vehicles. The other part of the re-
15 ceived signal, which contains information on the presence of metal, thus varies relatively slowly, and in a preferred embodiment the information is found on the basis of the DC content of a rectified version of the signal received.

20 Claim 3 defines preferred details of the demodulation according to the invention, and claim 4 defines expedient details, as the influence of the surroundings on the adjusted circuits forming part of the detection is reduced
25 because of the galvanic separation.

Preferably, the rectifier is adapted to perform a severe limitation, which results in phase-correct demodulation.

30 The invention also comprises a circuit for simultaneous AM demodulation of a signal comprising a first part with a relatively small modulation index and a second part with a relatively great modulation index.

35 The object of the circuit according to the invention is to improve the sensitivity of the signal processing which

is defined in claims 1-5. As mentioned, the modulation degree for the identification part of the signal is very small. This means that the TAG - in the prior art - must be relatively close to the antenna which emits and receives the electromagnetic signal. Otherwise, the signal/noise ratio will be very bad.

When the circuit according to the invention comprises a mixer, the very advantageous signal/noise ratio of modern mixer circuits is utilized, not only for identification purposes, but also for the detection of the presence of metal.

The invention will now be explained more fully with reference to an embodiment shown in the drawing, in which

fig. 1 shows the basic structure of a receiver according to the invention,

fig. 2 shows an example of a signal which is received by the receiver according to fig. 1,

fig. 3 shows the signal from fig. 2 after a first processing in the receiver according to fig. 1,

fig. 4 shows an output signal from the receiver according to fig. 1, while

fig. 5 shows a basic set-up in the use of the method according to the invention.

In fig. 1, the numeral 1 designates a receiver which is incorporated as part of a transponder or interrogator according to the invention. This receiver has an input receiving a signal which is branched into two parts 5 and 5a. The signal 5 is fed to a limiter 2 which limits the

signal strongly, while the signal 5a is fed to a first input of a mixer 3.

5 This mixer 3 additionally receives the limited signal 6, and the signals 7 and 8 occur on the output of the mixer 3, as will be explained more fully in connection with the following figures.

10 The signal 4 in fig. 1 may e.g. look as shown in fig. 2. The signal 9 may be the signal which is received when neither a TAG nor metal is in the vicinity of the transponder or the interrogator (see also fig. 5 with associated explanation). In the event that a metal part gets close to the interrogator, the received signal amplitude will drop to the curve shape shown at 11, because
15 energy is absorbed in the metal part. In practice, the amplitude will drop by the order of 10%, which is exaggerated in fig. 2 for clarity. A typical frequency may be 125 kHz, which is common for radio frequency identification purposes (RF-ID).
20

When a TAG gets into the sensitivity range of the interrogator, the TAG will emit an identification signal whereby the signal 9 in fig. 2 is amplitude modulated
25 with a modulation index of the order of 10^{-4} . The demodulation of the identification signal will not be explained in detail, as the principle is well-known. On the other hand, an explanation of the signal processing for the detection of metal will be given below.

30 In fig. 3, the numerals 13 and 14 show the signal 6 on the output of the limiter 2. As will be seen in fig. 3, the signal 9 has been severely limited and now occurs almost as a square on the output 6. The severe limitation
35 is expedient, because it gives the least possible phase error between the signals 6 and 5a which are subsequently

multiplied in the mixer 3. This provides the signal shape 16 shown in fig. 4. The mean value (DC) of the signal 16 is indicated at 17.

5 If a metal object gets near the interrogator, the signal 9 from fig. 2 will typically drop to the signal level 11 in fig. 2, and quite the same will apply to the DC value which is derived in accordance with the explanation of figs. 3 and 4. In the event that metal is present, the
10 signal level typically drops 10%, and by adjusting a threshold value e.g. to 5% DC reduction, the metal can be detected entirely independently of whether the metal object carries a TAG or not, as the identification signals of the TAG only involve a modulation degree of the order
15 of 10^{-4} .

Fig. 5 shows a basic use of the system according to the invention. An object of metal is designated 31. The object is provided with a TAG 32 which is capable of communicating with an interrogator 20.
20

As will be seen, the antenna consists of a transmitter/receiver coil 21 and a capacitor 28 which constitute the oscillation circuit. A signal from a generator 22 is
25 additionally applied to the antenna via a transformer 24, 25.

The numeral 1 designates the receiver according to fig. 1 which receives signals from a transformer 26, 27.
30

The power supply to the antenna via the oscillation circuit is obtained via a control unit 35 via a connection 29.

35 The mode of operation of the system will now be explained with reference to the example in fig. 5.

When an object 31 is in the vicinity of the antenna 21, part of the signal induced in the oscillation circuit from the generator 22 will be absorbed by the object 31, which means that the receiver will receive a weaker signal. This signal varies by interaction with the impact of metal, cf. the previous explanation of fig. 4.

If the object additionally has a TAG 32 capable of emitting a signal to the antenna 20, this will be received in the antenna 21 as an amplitude modulated signal, cf. the previous explanation of fig. 4. The information of this signal contains an identification of the vehicle which may be passed on to the control unit 35 and optionally further on via the central unit 36.

With the system disclosed it is thus possible to provide an extremely efficient system which is not necessarily dependent on the objects as such being adapted to communicate with the system, since any object present in the vicinity of the antenna 20 will be detected.

P a t e n t C l a i m s :

1. A method for AM demodulation of a received signal to
5 provide data signals which are represented by the AC part
of a demodulated version of a part of the received signal
having a relatively small modulation index, c h a r a c -
t e r i z e d in that a signal representing the presence
of metal is simultaneously generated, said signal being
10 dependent on a demodulated version of a second part of
the received signal which has a relatively high modula-
tion index.

2. A method according to claim 1, c h a r a c t e r -
15 i z e d in that the second part of the received signal
is demodulated by finding the DC content of a rectified
version of the signal.

3. A method according to claim 1 or 2, c h a r a c -
20 t e r i z e d in

that an amplitude modulated signal is received on an in-
put of a receiver,

25 that the amplitude modulated signals are branched in a
first part and a second part,

that the first part is fed to a limiter, and

30 that the second part is fed to a first input of a mixer
whose second input receives an output of the limiter.

4. A method according to claim 2 or 3, c h a r a c -
t e r i z e d in that the input of the receiver receives
35 the reception signals galvanically separated from an ad-
justed antenna.

5. A method according to claims 1-4, c h a r a c t e r -
i z e d in that the limiter performs a severe limita-
tion.

5

6. A circuit for simultaneous AM demodulation of a sig-
nal comprising a first part with a relatively small modu-
lation index and comprising a second part with a rela-
tively high modulation index, c h a r a c t e r i z e d
10 in that the circuit comprises a mixer which has a first
output representing a first signal part, and has a second
output representing the second signal part.

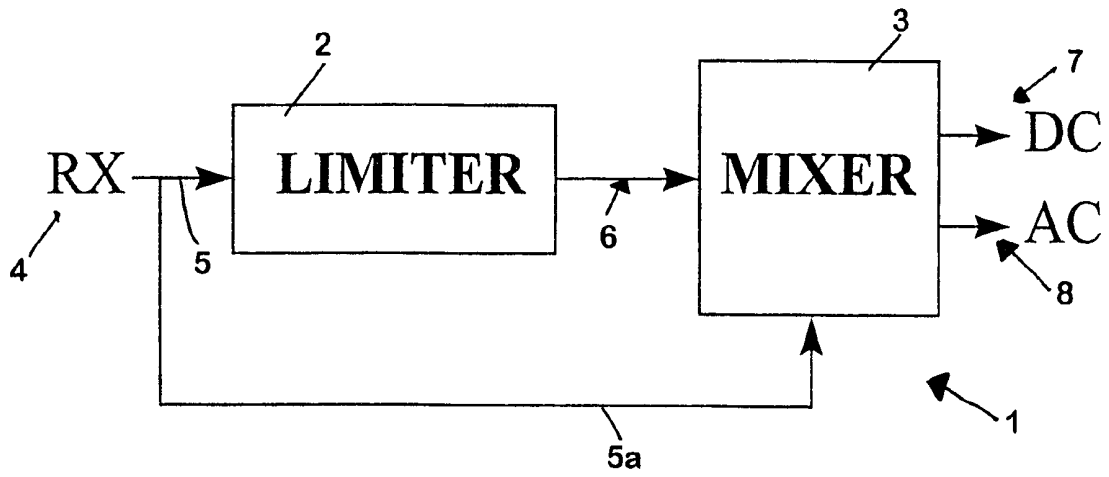


FIG. 1

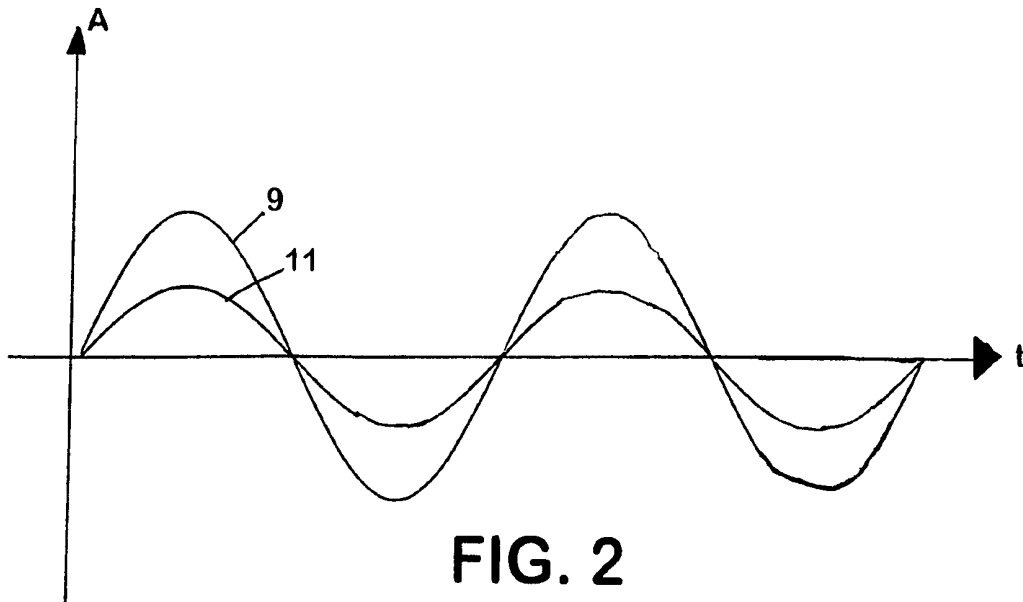


FIG. 2

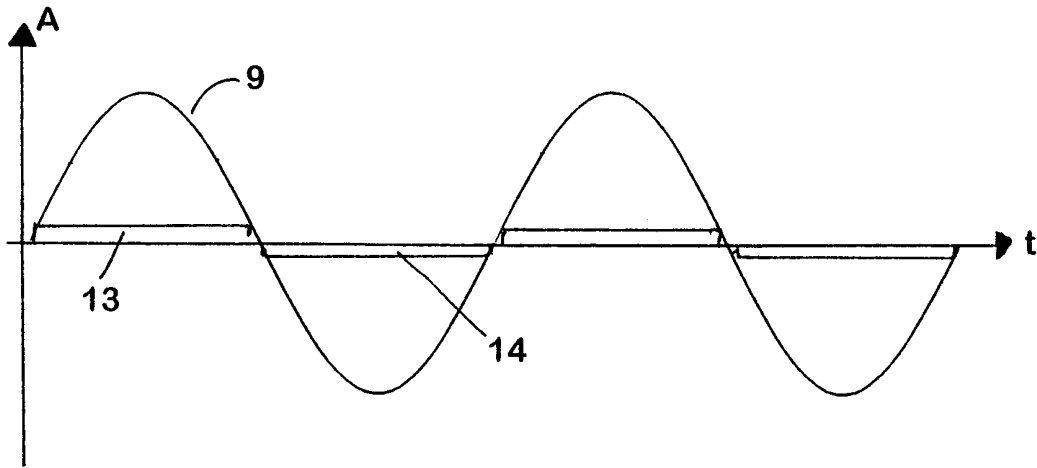


FIG. 3

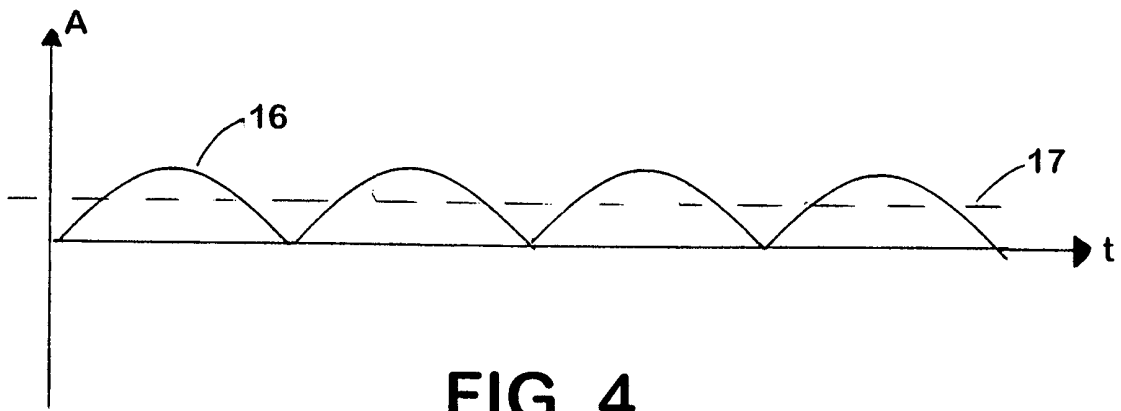


FIG. 4

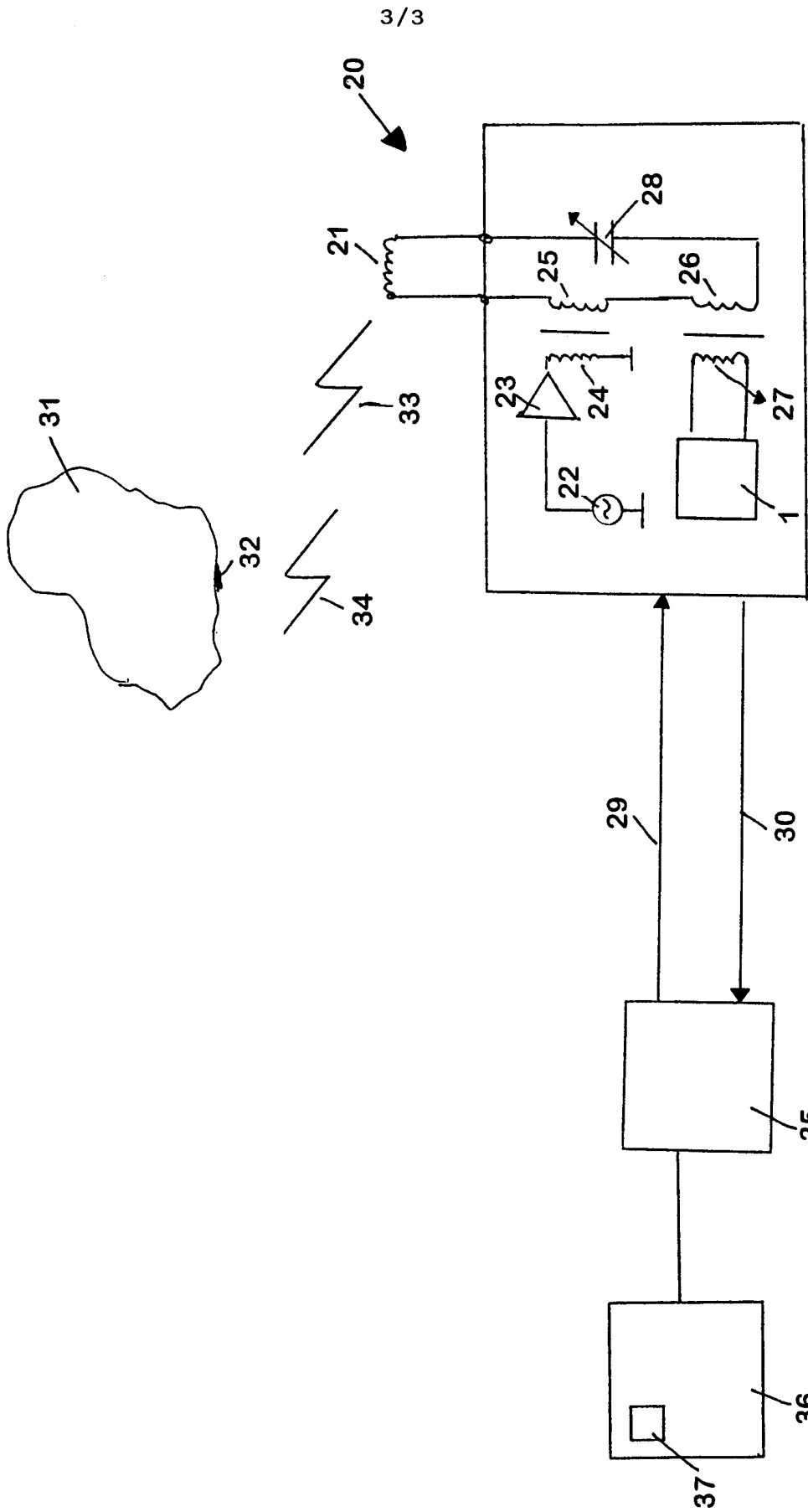


FIG. 5