

(22) Date de dépôt/Filing Date: 2000/01/20

(41) Mise à la disp. pub./Open to Public Insp.: 2000/07/29

(45) Date de délivrance/Issue Date: 2005/07/12

(30) **Priorité/Priority:** 1999/01/29 (199 03 645.4) DE

(51) Cl.Int.⁷/Int.Cl.⁷ G01S 1/76, B66B 3/02, G01S 11/14

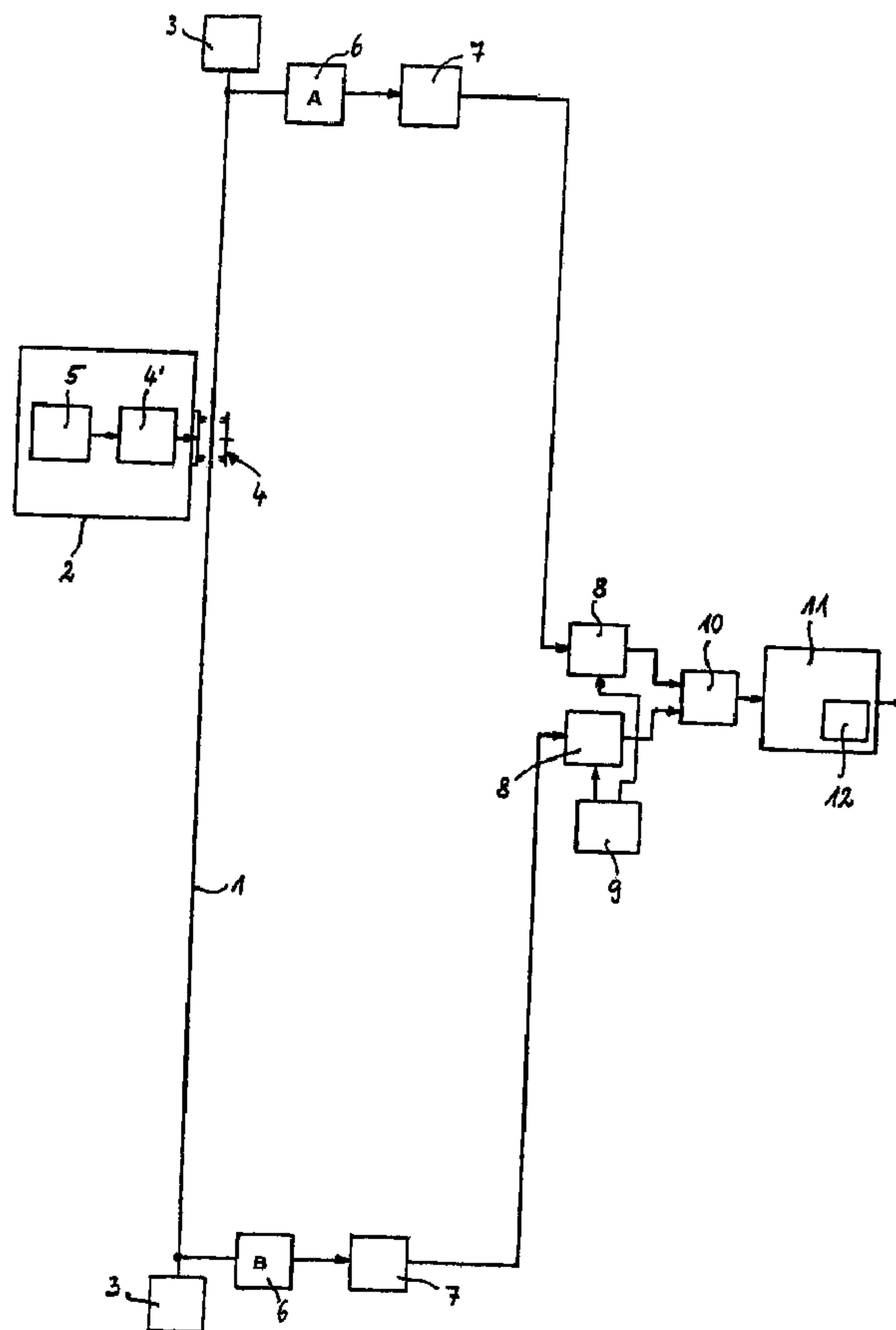
(72) Inventeur/Inventor:
HOEPKEN, HERMANN, DE

(73) Propriétaire/Owner:
K.A. SCHMERSAL GMBH & CO., DE

(74) Agent: SIM & MCBURNEY

(54) Titre : DETECTEUR DE POSITION

(54) Title: DEVICE FOR DETECTING POSITION



(57) Abrégé/Abstract:

The invention relates to an apparatus for detecting the position of an object moveable along a predetermined travel path, comprising: an acoustic signal waveguide extending along the travel path and having a predetermined, uniform speed of propagation of sound; a signal input coupler located on the moveable object, to couple a clocked acoustic signal into the acoustic

(57) **Abrégé(suite)/Abstract(continued):**

signal waveguide, at least one signal output coupler being arranged at one end of the acoustic signal waveguide and being connected to an evaluation unit for determining the propagation-time of the sound signal from a position at which it is coupled in to the at least one signal output coupler and for generating a signal representative of the instantaneous position of the moveable object on the travel path, wherein the signal input coupler couples in, as acoustic signal, adjacent pulses having a varying time interval.

ABSTRACT OF THE DISCLOSURE

The invention relates to an apparatus for detecting the position of an object moveable along a predetermined travel path, comprising:

an acoustic signal waveguide extending along the travel path and having a predetermined, uniform speed of propagation of sound;

a signal input coupler located on the moveable object, to couple a clocked acoustic signal into the acoustic signal waveguide,

at least one signal output coupler being arranged at one end of the acoustic signal waveguide and being connected to an evaluation unit for determining the propagation-time of the sound signal from a position at which it is coupled in to the at least one signal output coupler and for generating a signal representative of the instantaneous position of the moveable object on the travel path,

wherein the signal input coupler couples in, as acoustic signal, adjacent pulses having a varying time interval.

DEVICE FOR DETECTING POSITION

FIELD OF THE INVENTION

The invention relates to an apparatus for detecting the
10 position of an object which can move along a predefined path. Such
apparatus may be used for controlling the position of a lift cage or the like
and thus ensuring its positioning at predetermined stops according to floor
levels.

15 BACKGROUND OF THE INVENTION

European patent 694 792 discloses an apparatus of this type for
detecting the position of a movable object, which has an acoustic signal
waveguide which extends along a travel path and has a predetermined,
uniform speed of propagation of sound, and has a signal input coupler, which
20 is connected to a signal generator and is located on the movable object, to
couple an acoustic signal into the acoustic signal waveguide. In this case,
signal output couplers are arranged at both ends of the acoustic signal
waveguide and are each connected to a counter, the two counters being
clocked by a clock generator and connected to a subtracter for the output
25 signals from the two counters. The output signal from the subtracter, as a
measure of the propagation-time difference of the acoustic signal coupled in
from the point at which it is coupled in to the signal output couplers, can be
processed by an evaluation unit to form a signal which is representative of
the instantaneous position of the movable object on the travel path, the signal
30 input coupler operating with a signal spacing which is greater than the
propagation time of sound from one end of the travel path to the other. If the
movable object is at a standstill, standing waves can form, depending on the
position of the object, as the result of reflections of the acoustic signal at the

- 2 -

ends of the acoustic signal waveguide, and can lead to measurement problems as a result of fluctuations in amplitude.

SUMMARY OF THE INVENTION

5

It is an object of an aspect of the invention to provide an apparatus for detecting the position of an object which can be moved along a prescribed path, with which it is possible to pick up measured values even when the object is at a standstill.

10

An apparatus for detecting the position of an object moveable along a predetermined travel path in accordance with the present invention comprises

an acoustic signal waveguide extending along the travel path and having a predetermined, uniform speed of propagation of sound;

15

a signal input coupler located on the moveable object, to couple a clocked acoustic signal into the acoustic signal waveguide,

at least one signal output coupler being arranged at one end of the acoustic signal waveguide and being connected to an evaluation unit for determining the propagation-time of the sound signal from a position at which it is coupled in to the at least one signal output coupler and for generating a signal representative of the instantaneous position of the moveable object on the travel path,

20

wherein the signal input coupler couples in, as acoustic signal, adjacent pulses having a varying time interval.

25

By varying the time intervals between successive pulses fed into the acoustic signal waveguide, it is possible to pick up valid measured values even in unfavourable stopping positions of the movable object, since in this case the standing wave is shifted as the result of variation of the repetition time, and thus evaluation outside the oscillation nodes of the said wave is made possible.

30

- 3 -

Further objects, embodiments and advantages of the invention will become apparent from the following description and the claims.

5

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained in more detail below with reference to a preferred embodiment illustrated schematically in the appended drawings.

10 Fig. 1 shows, schematically, an embodiment of an apparatus for detecting position according to the invention.

Fig. 2 shows a timing diagram relating to the signals of the apparatus from Fig. 1.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus shown for detecting position, which can be used in particular for detecting the position of a lift cage, comprises an acoustic signal waveguide 1, for example a steel rail or in particular a wire, which extends along a predefined travel path, along which a moveable object 2, for example
20 a lift cage, can be moved to and fro. The acoustic signal waveguide 1 having a predetermined, uniform speed of propagation of sound, is clamped or held in a damped manner at both ends in a damping clamp or mounting 3.

The moveable object 2 carries a signal input coupler 4 which is connected to a signal generator 5, for example an oscillator, via a signal
25 matching circuit 4'. The signal input coupler 4, which in particular operates inductively, couples an acoustic signal, which periodically includes a synchronization pulses S received from the signal generator 5, into the acoustic signal waveguide 1. The synchronization pulses S have a clock period greater than the duration of the propagation of the acoustic signal from
30 one end of the acoustic signal waveguide 1 to the other.

- 4 -

In addition, the signal input coupler 4 couples in additional pulses M, specifically a large number of additional pulses M, during each clock period of the synchronization pulses S. The clock period of the additional pulses M is such that a distance resolution, needed for example for braking
5 and for moving to an exact position of the object 2, is achieved in the direction of the travel path.

The synchronization pulses S are marked, that is to say can be distinguished from the additional pulses M during the evaluation. The marking can be made, for example, by their clock period being an appropriate multiple
10 of the clock period of the additional pulses M, and additionally by their temporal offset in relation to the additional pulses M, for example by one half clock period, cf. the pulse train generated by the signal generator 5 in the first line of Fig. 2. Then, a predetermined number of m additional pulses M follows a synchronization pulse S in each case.

15 However, marking can also be made in an other way, thus the synchronization pulses S can be distinguished from the additional pulses M by modulation, pulse width, pulse height or the like.

The synchronization and additional pulses S, M to be coupled in may be short electromagnetic pulses, for example simple pulses or pulse
20 trains, or periodic frequency shift keying. The synchronization pulses S are used when the travel path is very long, for example in lifts in multi-storey buildings, in which case the necessary distance resolution leads to new pulses being coupled into the acoustic signal waveguide 1 before a preceding pulse has reached the end of the signal waveguide 1.

25 A signal output coupler 6 is arranged in each case at the ends of the acoustic signal waveguide 1. This is preferably a piezoelectric signal output coupler 6, however those operating inductively or capacitively can also be used.

In order that the signal output coupler 6 can pick up an evaluable
30 signal even when the object 2 is at a standstill, and therefore the signal generator 5 is in an unfavourable stopping position thereof, and does not

- 5 -

operate in an oscillation node of a standing wave produced by reflection at the end of the acoustic signal waveguide 1, the additional pulses M are coupled in with a varying time interval, as emerges from the signal illustrated in Fig. 2 and fed into the acoustic signal waveguide 1. The time interval of the
5 additional pulses M is expediently jittered by 0.1 ms, for example, around a mean value of, for example, 1.0 ms. This variation can be carried out in a predetermined sequence or else randomly, and preferably with a predetermined variability around the mean value.

Each signal output coupler 6 is connected to a signal matching
10 circuit 7 whose output lines in each case lead to a counter 8. Both the counters 8 are clocked by a clock generator 9, an oscillator. The clock time of the clock generator 9 is considerably lower than the propagation time of the sound from one end of the acoustic signal waveguide 1 to the other and is selected in accordance with the desired measurement path resolution. The
15 outputs from the counters 8 are fed to a subtracter 10, which forms the difference of the output signals of the counters 8 and feeds it to an evaluation unit 11, for example a microprocessor, where the output signal from the subtracter 10 is evaluated.

The synchronization pulses S are used to indicate to the
20 evaluation unit 11 which following pairs of additional pulses belong to each other, namely the respective nth, that is to say the first, second, third and so on, additional pulses M arriving at the two signal output couplers 6 (designated by A and B in Fig. 2) at different times T_a and T_b following the respective synchronization pulse S, in order that the evaluation unit 11 can
25 detect or determine the associated absolute time difference $T_a - T_b = \Delta T$ between associated additional pulses M, and hence the position of the object 2. The jittering of the additional pulses M has no influence on this, since the time difference is absolute.

The evaluation in order to detect the position is primarily carried
30 out in relation to the additional signals M, however the synchronization pulses S can also be evaluated in this regard, specifically above all but not

- 6 -

exclusively when the respective m th additional pulse is specially marked, in order in this way to serve as a synchronization pulse S .

If the movable object 2 is located in the centre between the signal output couplers 6, the outputs from the counters 8 are equal and their
5 difference is zero. If the object 2 (in the case of a vertical path) is located above the centre, the output from the counter 8 which is connected to the upper signal output coupler 6 is smaller than that of the other. From the propagation time difference of the additional pulses M belonging together in the acoustic signal waveguide 1, determined by the subtracter 10, and the
10 known sound speed in the latter, there results the distance of the movable object 2 from the centre. Since the difference would have a different sign if the movable object 2 were to be located below the centre, it is also known whether the movable object 2 is located above or below the centre, that is to say the exact position of the movable object 2 can thus be calculated. A
15 digital or analog position signal which can be generated by the evaluation unit 11 can be used for tracking control.

A monitoring circuit 12 (watchdog) of the evaluation unit 11 can be used for the simple monitoring of the measurement path in the case of an input coupling which is constant over time of the input coupling signal. In the
20 case of a contamination which is capable of damping the signal on the acoustic signal waveguide 1, the difference determined by the subtracter 10 exceeds a predetermined value, to which the monitoring circuit 12 responds in order to trigger a corresponding alarm signal or the like.

The speed of sound in a acoustic signal waveguide 1 made of
25 steel is approximately 5300 m/s. In the case of a time resolution of 188 ns, for which a clock generator frequency of 5.3 MHz is necessary, the location resolution of the measurement path is about 1 mm.

Instead of being coupled to the signal generator 5, the signal input coupler 4 may be triggered by evaluation unit 11 to couple the acoustic
30 signals into the signal waveguide 1. Instead it is also possible that the signal input coupler 4 triggers the evaluation unit 11 via an electric signal to

- 7 -

define the temporal start of each coupling of an acoustic signal into the signal waveguide 1 for the evaluation to be done by the evaluation unit 11.

Instead of the preferred provision of a signal output coupler 6 at each of the two ends of the signal waveguide 1, only one signal output
5 coupler 6 provided at one of the ends of the signal waveguide 1 may be used.

While the invention has been shown and described with reference to a preferred embodiment, it should be apparent to one of ordinary skill in the art that many changes and modifications may be made
10 without departing from the spirit and scope of the invention as defined in the claims.

WHAT IS CLAIMED IS:

1. An apparatus for detecting the position of an object moveable along a predetermined travel path, comprising:
 - 5 an acoustic signal waveguide extending along the travel path and having a predetermined, uniform speed of propagation of sound;
a signal input coupler located on the moveable object, to couple a clocked acoustic signal into the acoustic signal waveguide,
at least one signal output coupler being arranged at one end of the
 - 10 acoustic signal waveguide and being connected to an evaluation unit for determining the propagation-time of the sound signal from a position at which it is coupled in to the at least one signal output coupler and for generating a signal representative of the instantaneous position of the moveable object on the travel path,
 - 15 wherein the signal input coupler couples in, as acoustic signal, adjacent pulses having a varying time interval.
2. The apparatus of Claim 1, wherein the time interval fluctuates above and below by a constant amount from a mean value.
3. The apparatus of Claim 1, wherein the acoustic signal couples in
- 20 synchronization pulses with a clock period which is greater than the propagation time of sound from one end of the travel path to the other, and a plurality of additional pulses located in between, whose time interval from one another varies.
4. The apparatus of Claim 3, wherein the synchronization pulses are
- 25 marked with respect to the additional pulses.
5. The apparatus of Claim 4, wherein the clock of the synchronization pulses is offset in time with respect to that of the additional pulses.
6. The apparatus of Claim 3, wherein the synchronization pulses
- 30 and the additional pulses are fed to the evaluation unit to determine the propagation-time difference.

- 9 -

7. The apparatus of Claim 1, wherein a counter connected with the signal output coupler is clocked by a clock generator.

8. The apparatus of claim 7, wherein at each end of the signal waveguide a signal output coupler is provided, each of which being
5 connected to a counter, said counters being connected to a subtracter for the output signals from the two counters.

9. The apparatus of Claim 8, wherein the two counters are connected to a subtracter for the output signals from the two counters.

10. The apparatus of Claim 7, wherein the clock generator for the
10 counter operates at a minimum frequency which is needed for an envisaged measurement path resolution.

11. The apparatus of Claim 1, wherein the signal output coupler is a piezoelectric output coupler.

12. The apparatus of Claim 1, wherein the signal output coupler is a
15 capacitive output coupler.

13. The apparatus of Claim 1, wherein the signal output coupler is an inductive output coupler.

14. The apparatus of Claim 1, wherein the acoustic signal waveguide is a metallic body extending along the travel path.

20 15. The apparatus of Claim 14, wherein the acoustic signal waveguide is a metal rail.

16. The apparatus of Claim 14, wherein the acoustic signal waveguide is a wire.

17. The apparatus of Claim 1, wherein the signal input coupler is an
25 inductive input coupler.

18. The apparatus of Claim 1, wherein the movable object is a lift cage.

19. An apparatus for detecting the position of an object which can be moved along a predetermined travel path, having an acoustic signal
30 waveguide extending along the travel path and having a predetermined, uniform speed of propagation of sound, and having a signal input coupler,

- 10 -

which is connected to a signal generator and is located on the movable object, for coupling a clocked acoustic signal into the acoustic signal waveguide, signal output couplers being arranged at both ends of the acoustic signal waveguide and being connected in each case to a counter, 5 the two counters being connected to an evaluation unit for determining the propagation-time difference of the acoustic signal coupled in from the point at which it is coupled in to the signal output couplers and for generating a signal that is representative of the instantaneous position of the movable object on the travel path, wherein the signal input coupler couples in, as acoustic 10 signal, adjacent pulses having a varying time interval.

20. The apparatus of Claim 19, wherein the evaluation unit includes a monitoring circuit which triggers an alarm signal if the difference determined by the subtracter exceeds a predetermined value.

15

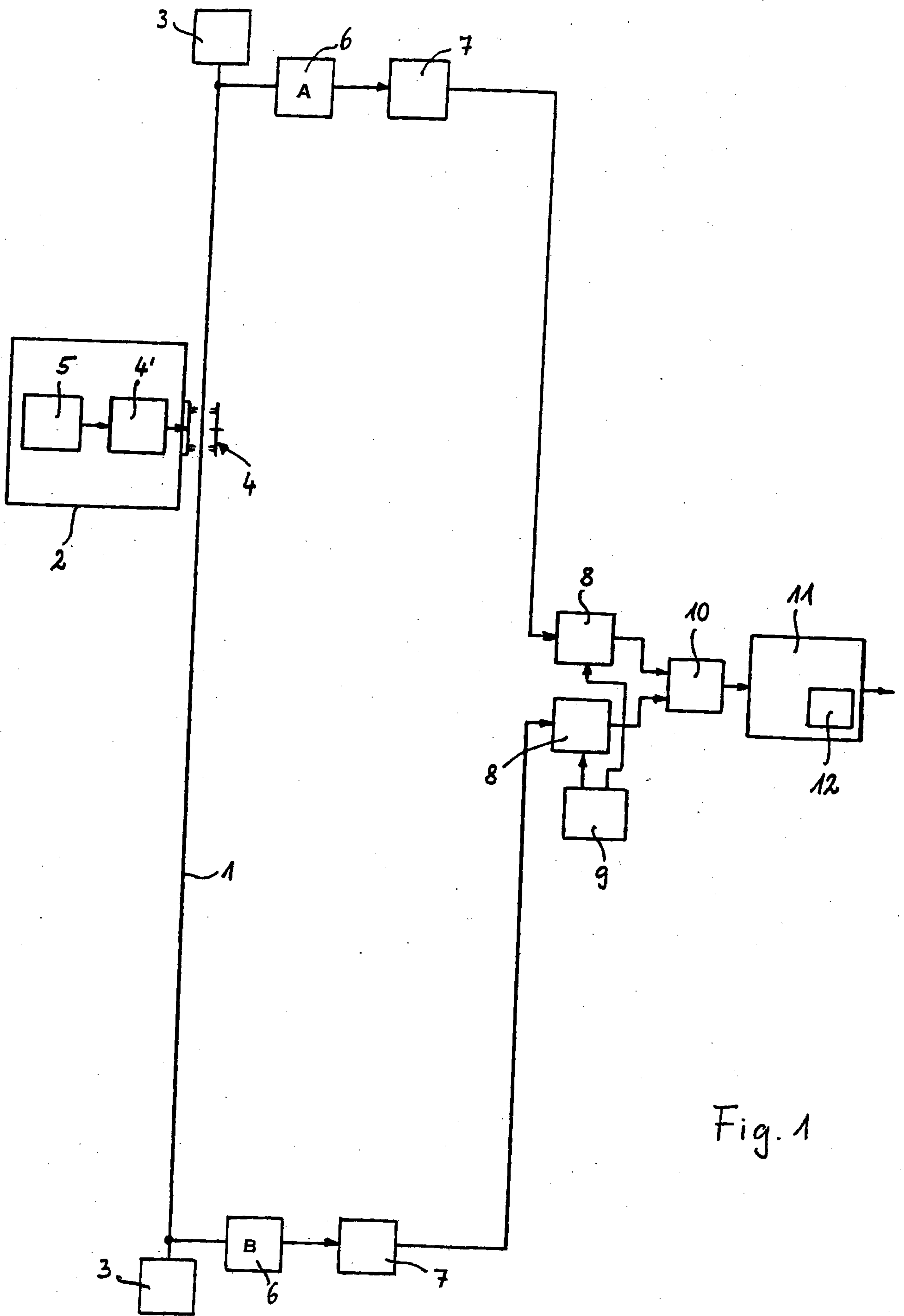


Fig. 1

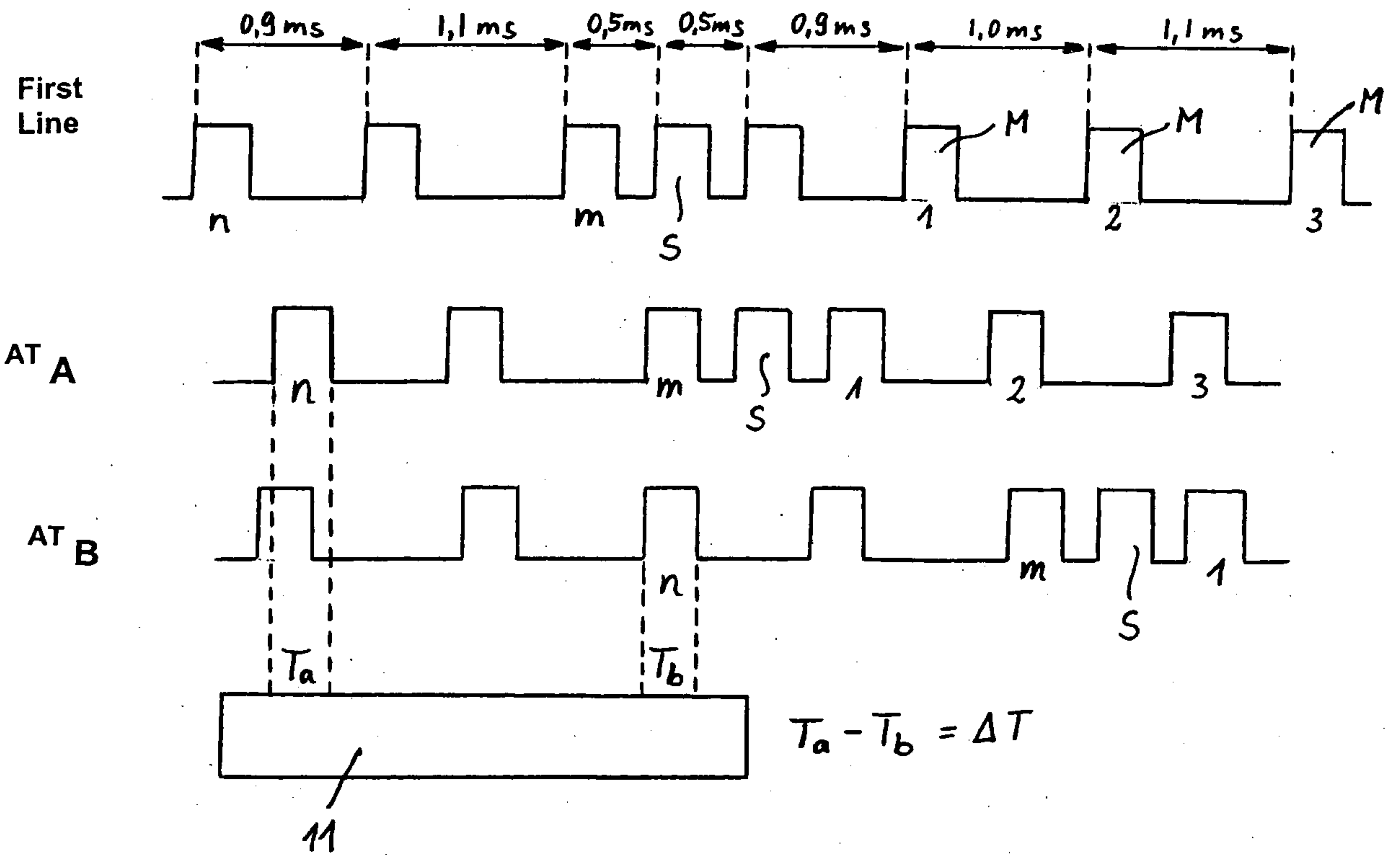


Fig. 2

