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(54) **Intruder Detection**

(57) The invention relates to signalling apparatus with pressure sensors, in particular for sensing intrusion into a closed surface area, with a yielding pipe embedded underground along the periphery of the surface area and filled with fluid. According to the invention the pipe is divided into two separate sections 10, 11 by a deformable baffle plate to which are connected sensor means for supplying a signal depending on the deformation of said baffle plate, for initiating signalling means 29 when said baffle plate is deformed.

Fig.1

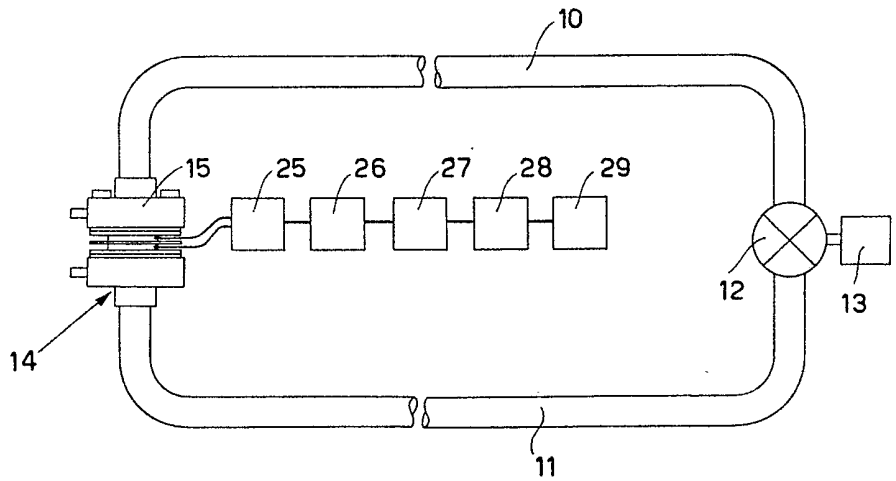

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Fig.1

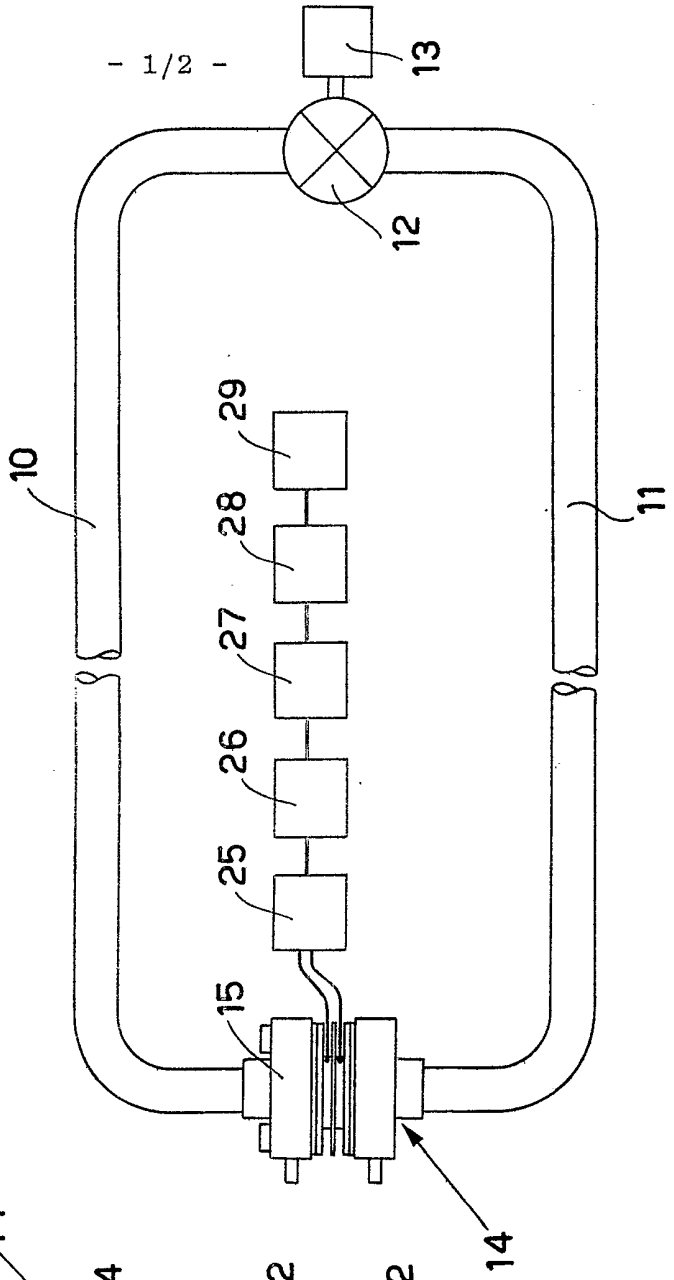

Fig.2

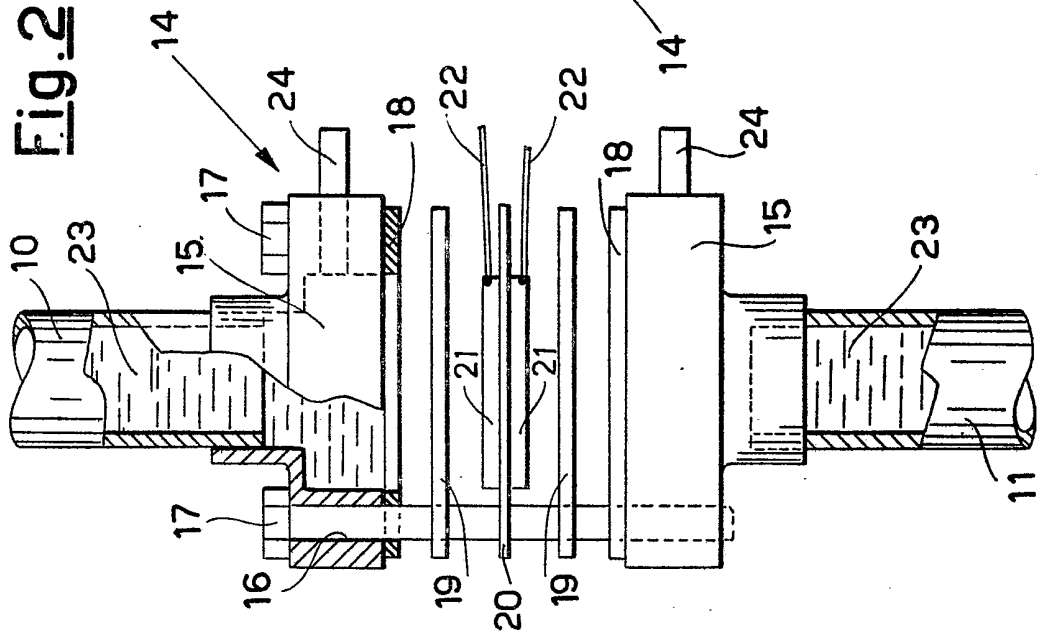

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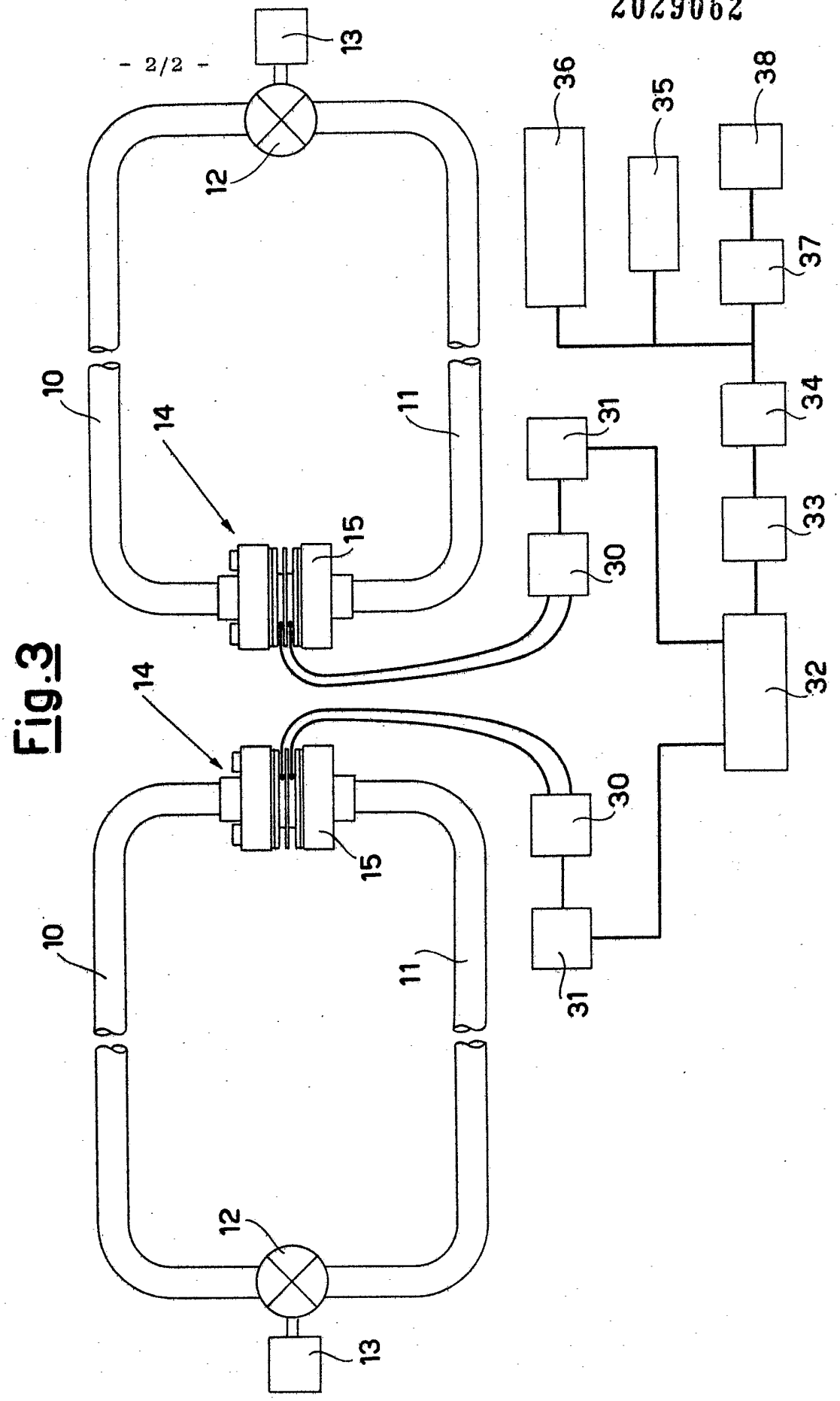
Fig.3



SPECIFICATION

Apparatus for Signalling Intrusion into a Closed Area

The present invention relates to elements of an apparatus which signals intrusion into a confined or closed area.

Apparatus of this type is known which consists substantially of a pair of yielding tubes filled with fluid, positioned side-by-side and embedded underground, extending around the entire perimeter of the area to be confined. Such pipes are also provided at one of their extremities with an equal number of receiver transducers. In this way, when the fluid contained in one of the two pipes receives an impulse from the outside, due for example to the passing of a person over the terrain, differentiated signals are sent to the transducers of a kind such as to activate an alarm.

This principle is of great validity, inasmuch as it means that even very weak signals can be captured, such as for example those caused by persons crawling on the terrain. Additionally, in this manner there is actuated a wholly hidden signaller which it is impossible to disactivate except from the inside of the protected area.

Nevertheless, an apparatus of this type has a considerable defect; for, as will be appreciated, the alarm signal has to be activated by very small impulse variations inasmuch as the pressure brought to bear by a person on the terrain generates in the fluid of one of the two pipes a very slight impulse as compared with the rest condition.

The alarm, therefore, must function when the signals coming from the two transducers are hardly at all differentiated—a differentiation of the order of a few millivolts. The result of this is that environmental factors such as wind, rain or very busy roads and nearby railways can frequently cause small variations in the impulses to the fluids of the two pipes, of a kind that can activate the alarm at any time.

The dependability of this device thus falls down precisely because the two transducers in this case would be supplying signals of the order of a few volts, so that it would be very easy for the signal of one pipe to deviate from the signal of its adjacent pipe by the few millivolts necessary to activate the alarm, which, as has been seen, must commence to function when a minimum difference exists between the two signals.

This occurs inasmuch as the impulse from the fluid contained in the pipes to the alarm arrives through two sensors each connected to a membrane positioned at the end of each tube, in direct contact with the fluid.

The behaviour of the membranes is not always definite, and in any case not linear, thus making it impossible to perceive useful signal levels beyond a certain limit by appropriately countering any external disturbances due, as has been seen, to atmospheric and environmental factors.

The present invention proposes the elimination of these defects by embodying an apparatus in which the membrane is single and the ends of both the pipes are in contact therewith.

In this way the membrane will deform on one side and the other only when one of the two tubes is more greatly affected by a deformation due to a pressure on the terrain.

On the other hand, when the impulse reaches the two pipes in identical manner, the membrane will remain immobile, supplying a nil signal to the two sensors. In this way there is embodied a mechanical system and not an electronic system as is the case with the known apparatus. From this it follows that it is not necessary to employ two identical membranes—it is moreover practically impossible for them to be identical, especially when the signals are of great intensity—but only two identical tubes, so that their differentiated deformations will be as precise as possible.

For this and additional purposes, which will be more clearly set out hereinafter, the present invention proposes the embodiment of an element of a signalling apparatus featuring pressure sensors, in particular for sensing intrusion onto a closed surface area, characterised by the fact that it comprises a yielding tube placed underground along the periphery of the surface area and filled with fluid, said tube being divided into two separate sections by a deformable baffle to which are connected sensor means for supplying a signal depending on the deformation of the baffle plate, for piloting signalling means when the baffle is deformed.

A preferred embodiment is now described as exemplification, which is not limiting. This preferred embodiment of the invention according to the present application is referred to the attached drawings, in which:

Figure 1 is a general schematic view of an apparatus according to the invention;

Figure 2 is a blown-up view of a particular of the apparatus of Figure 1; and

Figure 3 is a general schematic view of a second form of embodiment of the apparatus according to the invention.

A tube is divided into two sections 10 and 11, which are parallel, of equal length and interspaced, and which are embedded underground at a depth, or possibly at differing depths, depending on the type of signal that they are intended to sense when an intruder walks on the terrain in their vicinity. For convenience of description, hereinafter mention will be made of two tubes 10 and 11 and not tube sections.

The tubes 10 and 11 are advantageously of yielding material, and filled with liquid, with appropriate additives for lowering the freezing point in the case of installation in cold locations or in locations where the temperature varies greatly during the year. The tubes have a perfect seal and the liquid contained therein is pressurized at a pressure such as will determine a load of the tube as to attenuate to the greatest extent possible the signal losses due to the elastic properties of the said tube and to keep in constant equilibrium the

degree of tension of the two tubes. Otherwise, that is to say if the liquid were maintained at atmospheric pressure, the tubes would have a different degree of deformation one with respect to the other, which would adversely effect the precision of the signal which, as the tubes would deform in different degree, would be lost along them before reaching the sensor.

One end of each tube 10, 11 is connected to that of the adjacent tube by means of a valve 12, which is a filler valve which also enacts a capillary communication between the fluid contained in the two tubes 10 and 11, so as to allow a slow balancing out of the pressures in the two tubes. This is required when, for example, a vehicle is parked for a long time on the terrain around one of the two tubes, adversely affecting the usual reaction between the said tubes.

A third inlet of the valve 12 serves to fill the liquid into the tubes 10 and 11 or for the pressurization of said liquid through an external unit 13.

The extremities of the two tubes 10 and 11 opposite the valve 12 carry the sensor unit 14 forming subject matter of the invention, better illustrated in Figure 2. This unit 14 consists substantially of a fitting 15, connected to each end of the two tubes, axially hollow and provided laterally with through holes 16 for their reciprocal assembly by means of bolts 17.

Between the two fittings 15 annular seal gaskets 18 are interposed, and also insulating membranes 19 and a central membrane 20 supporting the sensors 21 provided with related connecting cables 22 to the unit for reception of the signal captured by the sensors and for its conversion into an alarm signal.

The specific purpose of the insulating membranes 19 is to separate the liquid 23 of the pipes from the sensors 21, but without in the slightest degree altering the correct functioning of the apparatus.

Two vent plugs 24 close holes in the fittings 15 and are used to remove any air bubbles from the pipes possibly forming during installation, filling or functioning of the apparatus, which would considerably reduce the sensitivity of the system.

The sensors 21 are advantageously of the piezo-electric type, and the signals received by them are transmitted to a pre-amplifier-adder 25, then to an amplifier 26 and to a filter 27, followed by a threshold indicator 28 for generation of an alarm signal 29 of whatsoever type.

The functioning of the apparatus described is as follows. The passage of a person over the terrain on which the pipes 10 and 11 are embedded underground causes an impulse to reach the fluid 23 contained in one pipe (the closest to the intruding person) thus causing a load on the membrane 20. This membrane is subject to two types of load, one of flexure and one of decompression. The latter load, as may be surmised, has a maximum value that is considerably inferior to the maximum flexure load to which the membrane can be subjected. The sensors 21 on each side of the membrane 20 are in practice two transducers for the conversion of mechanical loads on the membrane to tension signals and are secured to the membrane in the same direction, so that an identical load affecting the two tubes at the same time will produce an electric tension signal of equal sign. (For other types of sensor not sensitive to compression, a single sensor attached to one side only of the membrane may suffice.)

So that, when a person walks over the terrain in the vicinity of the tubes, these are affected one at a time, causing a flexure of the membrane 20 first on one side and then on the other.

In this way, the two sensors supply two signals of tension of opposite sign, even if not of identical value. The pre-amplifier-adder 25 which makes the difference of the signals will thus be effected by the sum of the two, attaining a tension value which, subsequently amplified at 26, filtered at 27 and compared with a pre-established basal value at 28, will certainly suffice to actuate the alarm 29, whatever this may be—luminous, acoustic, or other.

If, on the other hand, the external disturbance is caused by atmospheric agents (wind, rain) or environmental agents (road or rail traffic), the two pipes will deform simultaneously so that the membranes 20 will not deform, that is flex, either on one side or the other. Thus the sensors 21 will be affected only by components of compression due to the fluid in turbulence in the pipes. The tension produced by the compression on the sensors 21 will however be very low as compared with that produced, as seen, by the flexure and will moreover have the same sign, and thus the pre-amplifier-adder 25 will sum the difference, forming at output a practically nil signal or a signal so small as not to overcome the indicator 28 and actuate the alarm 29.

Figure 3 illustrates the apparatus according to the invention in a further form of embodiment particularly suitable for installations in locations markedly disturbed by the external environment, such as airports or mechanical industries and the like.

According to this embodiment, the installation consists of a plurality of pairs of apparatus of the type illustrated in Figure 1, arranged in series, in which each pair covers a length of 200 to 300 metres, while the pairs follow one another to cover the entire perimeter to be protected.

Figure 3 illustrates one of such pairs of apparatus, all the pairs being identical.

The impulses received by each sensor 21 are, as has been seen, sent to and treated by two pre-amplifiers 30 and filtered at 31 so as to derive two signals of different tension.

The difference between said signals is now made in a single adder 32, and the resultant value is amplified at 33 and appropriately integrated at 34 with adjustable times.

The signal therefrom deriving can, for example be visualized with a central zero pointer 35, so

that there can be read both a plus signal or a minus signal, which fact makes it possible to calibrate the equilibrium of the system by intervening in respect of the gains from pre-amplifiers 30 and from the amplifier 33.

A memorizer device 36, independent for the two channels, gives information as to any out of balance due to systematic but casual and assymetrical sources of noise, making it possible to intervene a posteriori in respect of the balance calibration.

The signal of the integrator 34 reaches a threshold indicator 37 with adjustable threshold, and thence to the alarm 38.

This signal will thus be a signal in logic "0", "1" able to pilot any alarm system 38.

By means of this embodiment, therefore, the sensitivity of the apparatus is increased, which is desirable when the place to be protected is so large as to require very long pipes—which would in any case entail signal dispersion. Furthermore, as has been seen, in the case of locations which are particularly noisy because of external environmental factors, with this application possible false alarms that might occur at any time during the life of the apparatus are eliminated.

The foregoing is a non-limiting example of a preferred form of embodiment of the invention according to the application, but it should be understood that formal and structural modifications can be made thereto without in any way detracting from the scope of the said invention, as protected also by the following claims.

Claims

1. An element of signalling apparatus with pressure sensors, in particular for sensing intrusion into a closed surface area, characterised by the fact that it comprises a yielding pipe embedded underground along the periphery of the surface area and filled with fluid, said pipe being divided into two separate sections by a deformable baffle plate to which are connected sensor means for supplying a signal depending on the deformation of said baffle plate, for initiating signalling means when said baffle plate is deformed.

2. An element of signalling apparatus according to claim 1, characterised by the fact that the pipe is double the length of the perimeter of the surface area and is embedded underground so as to constitute a double course in which two sections of pipe are constantly side-by-side and spaced along the entire periphery.

3. An element according to claim 1, characterised by the fact that the deformable baffle plate consists of a membrane on one or both opposite sides of which facing the sections of pipe, are fitted transducer pressure-sensor means consisting of piezoelectric crystals.

4. An element according to claim 1 and claim 3, characterised by the fact that between the fluid of each section of pipe and the intermediate baffle plate two insulating membranes are placed.

5. An element according to claim 1, characterised by the fact that the sensors are fitted on the baffle plate in such a way that the electric signals by them produced at the time of compression load on the baffle plate have the same sign.

6. An element according to claim 1, characterised by the fact that the signals from the two sensors reach a pre-amplifier-adder which sums their difference and the resultant signal is amplified, filtered and sent to a threshold indicator and from this to the signalling means.

7. An element according to claim 1, characterised by the fact that the apparatus consists of a plurality of pipes which in sequence cover the entire perimeter of the area to be protected, signals of each pipe being added to those of the adjacent pipe to initiate the signalling means.

8. An element according to claim 1, characterised by the fact that the pipe is filled with liquid under pressure.

9. Signalling apparatus substantially as hereinbefore described with reference to any of the accompanying drawings.

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