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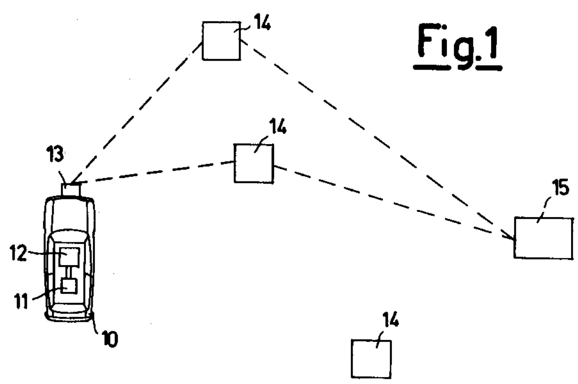
(54) Anti-theft apparatus for mobile means.

(57) An anti-theft apparatus for mobile means comprises an electronic device (11) suitable for being installed on board of the mobile means (10) and operatively connectable with force or movement detecting devices (12) of known type, in which the electronic device (11) comprises a signal generator operatively connected with a transmitter device (13), with the emitted signals being coded in such a way that they contain an identification code univocally associated with the mobile means (10) in question, and in which the transmitter means (13) is suitable for transmitting these coded signals to a coordination station (15) capable of processing these received coded signals, so as to univocally identify the mobile means (10) and determine the position thereof.

Fig.1



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The present invention relates to an anti-theft apparatus for mobile means.

The need for protecting, from possible thefts, mobile means including land mobile means and naval mobile means is being sent more and more often.

For these functions, mechanical devices are already known and used, which are capable of rendering uncontrollable the mobile means even if the thief succeeds in starting the engine up.

For example, as regards vehicles, a large number or devices are very much diffused by now, which lock the steering wheels, the clutch or the brake, while, as regards boats, rudder locking devices are commonly used.

Unfortunately, these mechanical lock means suffer from the serious drawback that they are absolutely uncapable of preventing the mobile means from being stolen, if said mobile means is removed or towed away.

A further drawback of these anti-theft devices consists in that they are often easily forced or overcome by even not particularly skilled thieves.

Less easily overcome are other types of systems for passive defence, which are devices suitable for electrically locking engine startup, devices, or fuel feed locking devices, by means of either hidden or combination-operated circuit breakers.

Unfortunately, also these passive defence systems suffer from the drawback, that they are unable to prevent said mobile means from being removed or towed away.

In order to try to overcome these drawbacks, a very large number of protecting devices were introduced in the past, most of which are of electronic or electromechanical nature, and are suitable for generating sound signals every time that an attempt at forcing and/or removing the mobile means is carried out.

The alarm and signalling devices, possibly associated with the locking and/or passive defence devices cited hereinabove, theoretically should secure a good ant-theft protection or, at least, represent a sufficient deterrent, such as to prevent the thief from continuing its work.

Unfortunately, the extremely large number of false alarms and the relative ease and rapidity with which an expert thief succeeds in going round both these sound alarm devices and any passive defence systems possibly associated with them, cause also the protection actually secured by these devices, to be rather poor.

One should also remind that even if they to not secure an absolute protection of the mobile means, the most recent alarm devices are often very complex and expensive, and easily undergo failures.

The purpose of the present invention is of providing an anti-theft apparatus for mobile means, of the type, and for such applications as mentioned hereinabove, which substantially eliminates the drawbacks displayed by the anti-theft devices mentioned in the foregoing.

In order to achieve said purpose, an anti-theft apparatus for mobile means is proposed, which apparatus is constituted by an electronic device suitable for being installed on board of the mobile means to be protected, which electronic device is operatively connectable with force detecting devices of known type and/or movement detecting devices, also of known type, characterized in that said electronic device comprises a signal generator operatively connected with at least one transmitter device, with said signals being coded in such a way that they contain an identification code univocally associated with the mobile means, and that said transmitter device is suitable for transmitting said coded signals generated by said eletronic device, to at least one coordination station capable of processing these received coded signals, so as to univocally identify said mobile means and determine the position of said mobile means.

According to a form of practical embodiment of the present invention, said transmitter device is suitable for transmitting said coded signals to said coordination station through a communication network comprising a plurality of receiving/transmitting stations, said coordination station being capable of determining the position of said mobile means by means of geometrical detection procedures based on the relative time delay with which said signals reach at least two stations belonging to said plurality of receiving/transmitting stations.

In particular, said coordination station can comprise at least one receiver device suitable for receiving the coded signals re-transmitted by said at least two receiving/transmitting stations, and a data processing unit capable of decoding the coded signals received by said receiver device, so as to univocally identify the mobile means which transmitted said signals, said data processing unit being suitable for performing a program which performs the task of calculating the position of said mobile means by carrying out algebraic calculations, by starting from the positions of said at least two receiving/transmitting stations, and from the relative time delays with which said coded signals transmitted by said transmitter devices installed on board of said mobile means reach said at least two receiving/transmitting stations.

The advantages attained by means of the present invention essentially consist in that, in that way, one can know, at each time point, the current position of the mobile means after an activation of an alarm device, or an unauthorized movement of the mobile means.

Inasmuch as the ground station is capable of getting into connection with the Police Forces, either by radio or by telephone, it will be possible the thieves to be caught in the act, and the stolen mobile means to be recovered.

The structural and functional characteristics and the advantages of an apparatus according to the present invention will be better understood from the following exemplifying, non-limitative disclosure made by referring to the accompanying schematic drawings, in which:

Figure 1 shows a schematic in which the connections between the main components in a first form of practical embodiment using a communication network of "Loran" type are displayed;

Figure 2 shows a structural scheme of a ground coordination station;

Figure 3 shows a schematic in which the main components of a second form of practical embodiment, using a communication network based on geo-stationaty satellites, are displayed;

Figure 4 shows a schematic in which the main components of a third form of practical embodiment, using both a communication network of "Loran" type with a mesh structure, and a communication network based on geo-stationaty satellites, are displayed;

Figure 5 shows a paraboloid aerial suitable for transmission towards satellites;

Figure 6 shows a possible installation of said paraboloid aerial inside the interior of a bumper of a vehicle;

Figure 7 shows a schematic view in which the connections between the main components of a fourth form of practical embodiment, using an optical-fibre gyroscope, are displayed.

Referring to Figure 1, the reference number 10 indicates a mobile means equipped with an electronic device 11 operatively connected with a force detecting device indicated with the reference numeral 12.

This force detecting device can be a whatever electrical, mechanical or electronic device of known type, suitable for signalling the movement of the mobile means, the starting up of its engine, or the occurred forcing of a part thereof.

If an attempt at forcing the mobile means 10 is detected, the force detecting device 12 enables the electronic device 11, which sends an electrical signal, with signal frequencies comprised within the range of from 10 to 15 MHz, to a dipole aerial 13 provided on the same mobile means 10.

The electrical signal emitted by the electronic device 11 is so coded, that with said electrical signal a unique code is associated, which is different for all mobile means, and is suitable for univocally identifying the mobile means 10.

The signals irradiated by the dipole aerial 13 are picked up by at least two ground receiving/transmitting stations 14 belonging to a communication network of "Loran" type.

The at least two receiving/transmitting stations 14 receive the signal emitted by the mobile means 10 with a relative time delay, due to the difference in distance of said stations from the mobile means 10.

The receiving/transmitting stations 14 which received the signal re-transmit it back to a ground coordination station, generally indicated with the reference numeral 15.

The coordination station 15 is capable of processing the signal coming from receiving/transmitting transmitting stations 14 and of calculating, by starting from this time delay and from the (known) positions of the receiving/transmitting stations 14, the position of the mobile means 10.

In order to prevent that thieves may become aware of the signalling device installed on board of the mobile means 10 and may try to interrupt the transmissions thereof in some way, the electronic device 11 and the dipole aerial 13 should suitably be adequately concealed inside the interior of the mobile means 10.

This positioning is facilitated by the extremely small size of both electronic device 11 and dipole aerial 13.

The electronic device 11 can furthermore be equipped with internal accumulator batteries, not shown in the drawings, which allow the signals to be emitted also in case the electrical system of the mobile means 10 is disconnected.

Figure 2 shows in greater detail a functional block diagram in which the connections between the main elements which constitute the coordination station 15, are displayed.

A receiver device 16 is connected with a data processing unit generally indicated with the reference numeral 17.

The data processing unit 17 essentially comprises a programmable microcomputer 18, which is furthermore connected with further peripherals. These peripherals are at least one mass storage unit 19, preferably of magnetic-storage type, an interface device 20, to interface the system with the human operator, preferably a keyboard and/or a pointing device, and at least one display means 21, preferably a graphic CRT (cathodic ray tube) display.

The data processing unit 17 performs a program which can physically reside, indifferently, either in an internal ROM, or in the mass storage unit 19, which program enables the data processing unit 17 to perform the following functions:

(a) decoding the code associated with the electronic device 11 and hence univocally identify the mobile means which is transmitting;

(b) calculating the physical position of the mobile means, by carrying out simple geometrical calculations, based on the data contained in the mass storage unit 19, relevant to the positions of the receiving/transmitting stations 14, and starting from the data coming from the receiver device 16, relevant to the time delay with which the signal emitted by the electronic device 11 reaches the receiving/transmitting stations 14;
(c) displaying, in graphic form, and in real time, on the display device 21, the position of the mobile means relatively to maps of territory, stored in the mass storage unit 19;
(d) interacting with a human operator, by means of the interface device 20, in order to manage the information displayed on the display device 21;
(e) storing in memory, time-by-time, at least the last one of the detected positions of the mobile means in alarm status.

Thanks to these functions performed by the data processing unit 17, inside the coordination station 15 the position of all mobile means in alarm status can be always known, or, at least, the position can be known which the mobile means had before the connection was interrupted.

In fact, it is always possible that a stolen mobile means travels through places, or stop in localities, e.g., tunnels, underground tunnels, and so forth, where transmissions are impossible.

However, if the last position of the vehicle is known, with the transmission absence persisting, it will be anyway possible to supply the Police Forces with sufficient information for recovering the stolen mobile means.

Referring to Figure 3, the common elements shared with the form of practical embodiment shown in Figure 1 are indicated with the same reference numerals.

It can be observed that, in this case, the electronic device 11 is connected with a paraboloid aerial 22.

This paraboloid aerial 22, which is installed orientated upwards, irradiates the coded electrical signal generated by the electronic device 11 with better directionality and higher power than dipole aerial.

These signals are picked up by at least two receiving/transmitting stations 23 installed on board of satellites in a geo-stationary orbit, which transmit the received signal back to the ground coordination station 15.

Owing to the different characteristics displayed by the receiving/transmitting stations installed on board of satellites, relatively to the receiving/transmitting stations belonging to a "Loran" mesh, the transmission frequency of the electrical signal emitted by the electronic device 11 is comprised, in this form of practical embodiment, e.g., within the range of from 10 to 15 GHz.

The receiving/transmitting stations 23 which received the signal re-transmit it back to the ground coordination station 15.

By starting from the time delay with which the signal emitted by the mobile means 10 reaches the various satellites and from the (known) positions of said satellites, the coordination station 15 calculates the position of the mobile means 10.

Still referring to the apparatus shown in Figure 3, the receiver device 16 of the coordination station 15 is preferably equipped with a parabolic receiver aerial, not depicted.

The program performed by the data processing unit 17 performs, in this case, absolutely analogous tasks to those as disclosed with reference to the form of practical embodiment of Figure 1.

The only difference is that, in the present case, the detection of the position of the mobile means 10 is carried out by processing the data of delay with which the signal reaches the receiving/transmitting stations 23 installed on board of the satellites, with the position of the geo-stationary satellites being known.

Referring to Figure 4, the common elements shared by the forms of practical embodiment of Figures 1 and 3 are indicated with the same reference numerals.

In the form of practical embodiment of Figure 4, the simultaneous presence can be observed of both ground receiving/transmitting stations 14 and receiving/transmitting stations 23 installed on board of geo-synchronous satellites.

This time, the electronic device 11 installed aboard the mobile means 10 is capable of sending the coded signal, alternatively to the dipole aerial 13 and to the paraboloid aerial 22.

Said coded electrical signal is however sent to both aerials 13 and 22, with transmission frequencies which are very different from each other.

In the latter case, in fact, the dipole aerial 13 is provided in order to exclusively transmit towards the "Loran" communication network, with transmission frequencies comprised within the range of from 10 to 15 MHz, i.e., typical values for this first communication network.

On the contrary, the paraboloid aerial 22 is provided in order to exclusively transmit towards the communication network based on geo-stationary satellites, with transmission frequencies comprised within the range of from 10 to 15 GHz, typical values for this second communication network.

Therefore, the dipole aerial 13 transmits, alternatively and at regular time intervals, signals directed to the ground receiving/transmitting stations 14 and, during the time intervals during which the electronic device 11 does not send signals to dipole aerial 13, the paraboloid aerial 22 transmits signals directed to the receiving/transmitting stations 23 installed aboard the geo-synchronous satellites.

The electronic device 11 alternates the sending of the signals to aerials 13 and 22 with an extremely rapid switching pattern, so as to obtain a virtually simultaneous transmission to both the "Loran" mesh communication network, and to the geo-synchronous satellite network.

Still referring to the third form of practical embodiment of Figure 4, the receiver device 16 of the coordination station 15 is equipped with means, not depicted in the drawing, suitable for receiving both the signals coming from the stations 14 belonging to the mesh communication network of "Loran" type, and the signals coming from the receiving/transmitting stations 23 belonging to said communication network of the type based on geo-synchronous satellites.

The management program performed by the data processing unit 17 performs such functions as to make it possible the position of the mobile means 10 to be identified, by processing both the data received from the receiving/transmitting stations 14, and the data received from receiving/transmitting stations 23.

One will realize that, in that way, the position of the mobile means can be determined according to two absolutely independent ways.

A higher reliability is thus achieved in case of failures, of bad reception or in case of emission of purposely false signals, together with a useful redundancy, which considerably decreases the possibility that the signal emitted by the electronic device 11 may not reach the coordination station 15.

One will realize that, by using such three forms of practical embodiment as disclosed hereinabove, the position of the mobile means 10 can be determined with a maximal error of approximately 20 metres both in latitude and in longitude.

One will easily realize that, thanks to a so precise information, it will be very easy for the Police Forces to reach and recover the stolen mobile means.

Figure 5 displays a possible form of practical embodiment of the paraboloid aerial 22, in which said aerial is constituted by an emitter 24 installed in the focus of a reflector 25.

The emitter 24 irradiates the radio waves towards the reflector 25 which, in its turn, reflects them and concentrates them in the direction of its own axis.

In that way, the beam emitted by the aerial 22 results to be concentrated in a well precise direction and, although its width decreases, it considerably gains in power.

Figure 6 shows an example of a possible positioning of the paraboloid aerial 22 of Figure 5, inside the interior of a bumper 26 of a motor vehicle.

One will easily realize that, thanks to such a positioning, also the paraboloid aerial 22 results to be absolutely hidden and invisible, without that the signals emitted by the aerial 22 are in anyway attenuated.

In fact, it should be observed that, inasmuch as the aerial 22 transmits at transmission frequencies of 10-15 GHz, the materials the mobile means is normally composed by, are completely transparent for the radio signals, which pass through them as if they did not exist.

In the form of practical embodiment depicted in Figure 3, in which the dipole aerial 13 and the paraboloid aerial 22 are provided simultaneously, these aerials should suitably be installed as spaced apart from each other as possible.

This is necessary in order to minimize any possible interferences which may arise between both aerials during the transmission of alarm signals.

Figure 7 shows a fourth form of practical embodiment of the apparatus according to the present invention, in which the common elements shared by this, and the forms of practical embodiment of Figures 1, 3 and 4 are indicated with the same reference numerals.

Aboard the mobile means 10 an optical-fibre gyroscope 27 of known type is installed and operatively connected with the electronic device 11.

Also in this case, the electronic device 11 is further connected with the dipole aerial 13 and the force detecting device 12.

The optical-fibre gyroscope 27 is a sturdy and reliable device and not particularly expensive, suitable for detecting the latitude and longitude of the site in which it is installed.

This gyroscope 27 is capable of performing very precise measurements, basing on the change in earth magnetic field as a function of latitude and longitude.

By using the gyroscope 27, the current position of the mobile means 10 will immediately be known on board of the same mobile means.

In order to transmit the position information to the coordination station 15, in this case the electronic device 11 is capable of coding the electrical signal in such a way that with said signal, besides the identification code, also the information of current position of
the mobile means 10, as received from the optical-fibre gyroscope 27, will be associated.

This electrical signal is sent, by the dipole aerial 13, to at least one receiving/transmitting station 14, belonging to the "Loran" type communication network.

The coordination station 15 decodes the code received and re-transmitted by the receiving/transmitting station 14 and directly obtains, without performing any geometrical processing, the position of the vehicle which emitted the signal.

One will realize that with this fourth form of practical embodiment the advantage is achieved, as compared to the three forms of practical embodiment disclosed hereinabove, that it is no longer needed that at least two receiving/transmitting stations are reached, in order that the system can determine the position of the mobile means 10.

In this case, the stations 14 of the "Loran" communication network are not used in order to perform the geometrical detection of the position of the mobile means 10, but are simply used as repeater stations.

In fact, even if the coded signal contains, per se, all the necessary data in order to perform the detection of the position of the mobile means, it is necessary that this signal, in order that it can be suitably used, reaches the coordination station 15.

Should the signal transmitted by the dipole aerial 13 be directly sent to the coordination station 15, the certainty that the signal was actually received would not be obtained.

In this connection, it will suffice to remind that, owing to earth bending, radio waves cannot be directly transmitted over long distances.

The precision of the measurement of position performed by the optical-fibre gyroscope 27 is very high, with errors of just a few metres both in latitude and longitude.

One will realize that, by using an apparatus according to the present invention, a very good protection which affect the mobile means is achieved, with the limits of the traditional anti-theft devices being overcome.

In fact, the present invention starts to act exactly where the devices known from the prior art --which are incapable of preventing at all costs the theft of the mobile means, or of obliging the criminals to get away -- fail, whilst, even under such circumstances, the present invention makes it possible the position of the mobile means to be monitored, and said mobile means to be rapidly recovered, without that the thief may suspect anything.

One will easily realize the advantageous effect which the wide diffusion of such a type of systems will have as a psychological deterrent on evil-minded persons.

The fact may be furthermore appreciated that, inasmuch as the thefts are often organized by big specialized gangs of thieves, which store a plurality of stolen mobile means inside a same hiding-place, the theft of even just one mobile means equipped with an anti-theft device according to the present invention can allow all the booty concealed inside said hidding-place, to be recovered.

Claims

1. Anti-theft apparatus for mobile means, constituted by an electronic device suitable for being installed on board of a mobile means, which electronic device is operatively connectable with force detecting devices of known type and/or movement detecting devices of known type, characterized in that said electronic device comprises a signal generator operatively connected with at least one transmitter device, with said signals being coded in such a way that they contain an identification code univocally associated with the mobile means, and that said transmitter device is suitable for transmitting said coded signals generated by said electronic device, to at least one coordination station, which is capable of processing these received coded signals, so as to univocally identify said mobile means and determine the position of said mobile means.

2. Apparatus according to claim 1, characterized in that said transmitter device is suitable for transmitting said coded signals to said coordination station through a communication network comprising a plurality of receiving/transmitting stations, said coordination station being capable of determining the position of said mobile means by means of geometrical detection procedures based on the relative time delay with which said signals reach at least two stations belonging to said plurality of receiving/transmitting stations.

3. Apparatus according to claim 2, characterized in that said coordination station comprises at least one receiver device suitable for receiving the coded signals re-transmitted by said at least two receiving/transmitting stations, and a data processing unit capable of decoding the coded signals received by said receiver device, so as to univocally identify the mobile means which transmitted said signals, said data processing unit being suitable for performing a program which performs the task of calculating the position of said mobile means by carrying out algebraic calculations, by starting from the positions of said at least two receiving/transmitting stations, and from the relative time delays with which said coded signals transmitted by said transmitter devices

installed on board of said mobile means reach said at least two receiving/transmitting stations.

4. Apparatus according to claim 2 or 3, characterized in that said plurality of receiving/transmitting stations belong to a communication network of "Loran" type.

5. Apparatus according to claim 1, characterized in that said signal generator provided in said electronic device is capable of generating signals with signal frequencies comprised within the range of from 10 to 15 MHz, and that said transmitter device comprises a dipole aerial.

6. Apparatus according to claim 3, characterized in that said plurality of receiving/transmitting stations belong to a communication network of the type based on geo-synchronous satellites, with each station belonging to said plurality of receiving/transmitting stations being installed on board of a respective geo-synchronous satellite belonging to said communication network.

7. Apparatus according to claim 6, characterized in that said signal generator comprised in said electronic device is suitable for generating signals with transmission frequencies comprised within the range of from 10 to 15 GHz, and said transmitter device comprises a paraboloid aerial.

8. Apparatus according to claim 2, characterized in that said a portion of said plurality of receiving/transmitting stations belong to a communication network of "Loran" type, and a portion thereof belong to a communication network of the type based on geo-synchronous satellites.

9. Apparatus according to claims 1 and 8, characterized in that said signal generator comprised in said electronic device is suitable for generating both signals with signal frequencies comprised within the range of from 10 to 15 M Hz and signals with transmission frequencies comprised within the range of from 10 to 15 GHz, that said transmitter device comprises a paraboloid aerial as well as a dipole aerial, and that said electronic device is capable of alternatively sending at regular time intervals the signals with signal frequency comprised within the range of from 10 to 15 MHz to said dipole aerial, and the signals with signal frequency comprised within the range of from 10 to 15 GHz to said paraboloid aerial, with said dipole aerial being suitable for transmitting said coded signals to said plurality of receiving/transmitting stations belonging to said communication network of "Loran" type, and said paraboloid aerial being suitable for transmitting said coded signals to said plurality of receiving/transmitting stations belonging to said communication network of the type based on geo-synchronous satellites, so that said coded signal may reach said coordination station virtually simultaneously both through the communication network of "Loran" type, and through the communication network of the type based on geo-synchronous satellites.

10. Apparatus according to claim 1, characterized in that with said electronic device an optical-fibre gyroscope is connected, which is capable of supplying the current position of said mobile means, that said electronic device is capable of coding said signal in such a way that the signals also contains the current position of said mobile means, and that said transmitter device is suitable for transmitting, through a communication network of "Loran" type, said coded signals to said coordination station, with said coordination station being capable of directly receiving the position of said mobile means supplied by said optical-fibre gyroscope.

11. Apparatus according to claim 10, characterised in that said coordination station comprises at least one receiver device suitable for receiving the coded signals transmitted by said mobile systems and a data processing unit capable of decoding the coded signals received by said receiver device, so as to univocally identify the mobile means which transmitted said signals, said data processing unit being capable of performing a program which performs the task of associating with each of said mobile means the relevant position supplied, for each of said mobile means, by the optical-fibre gyroscopes

12. Apparatus according to one or more of the preceding claims, characterised in that the program performed by said data processing unit contained in said coordination station, comprises keeping stored in memory the last position of all of the mobile means which transmit said coded signals.

13. Apparatus according to one or more of the preceding claims, characterised in that the program performed by said data processing unit contained in said coordination station, comprises the interactive management of the information received by said mobile means.

14. Apparatus according to one or more of the preceding claims, characterised in that said data processing unit is constituted by a programmable microcomputer, with said programmable micro-computer being connected with at least one mass storage unit, with at least one display device and with at least one interface device with the human operator.

15. Apparatus according to one or more of the preceding claims, characterised in that said electronic device is provided with internal accumulator batteries suitable for feeding said electronic device with electric power in buffer operating mode, or in a completely independent operating mode.

Fig.1

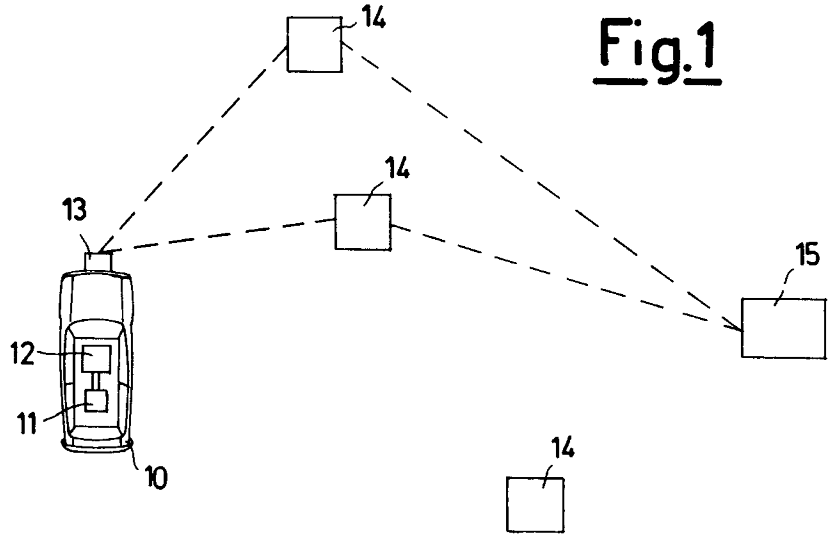


Fig.2

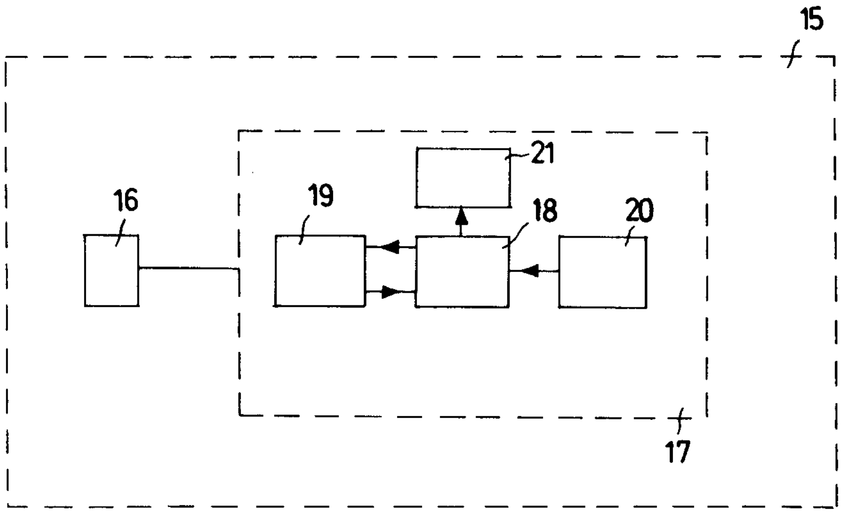


Fig.3

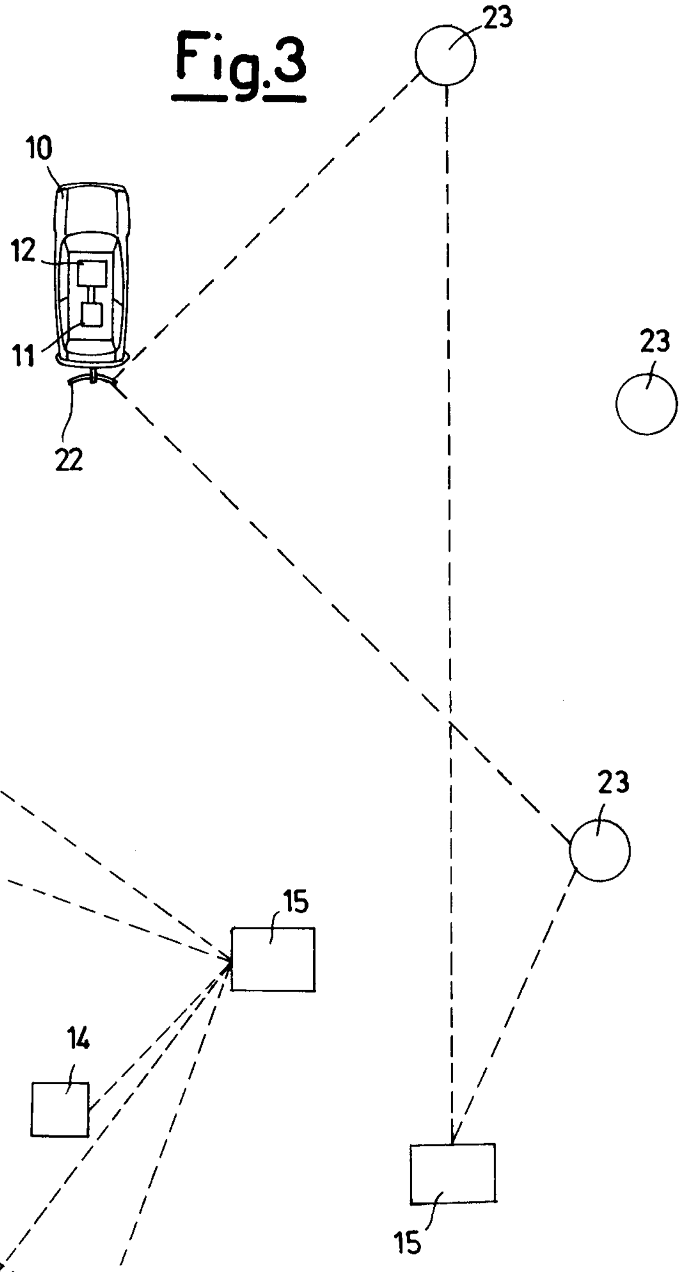


Fig.4

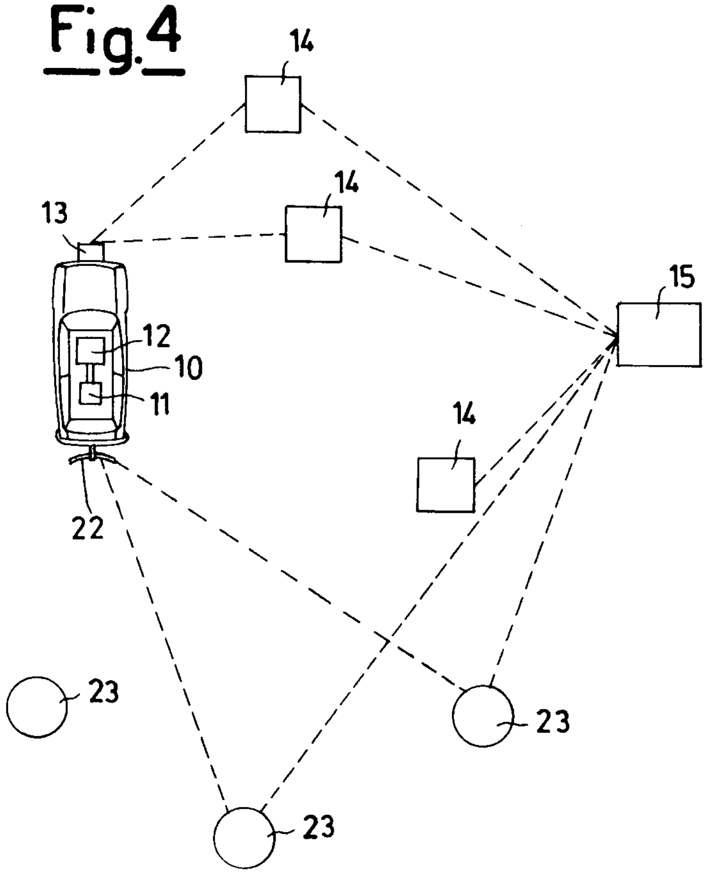


Fig.5

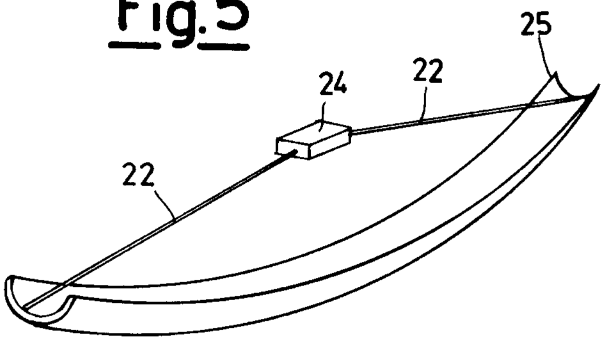


Fig.6

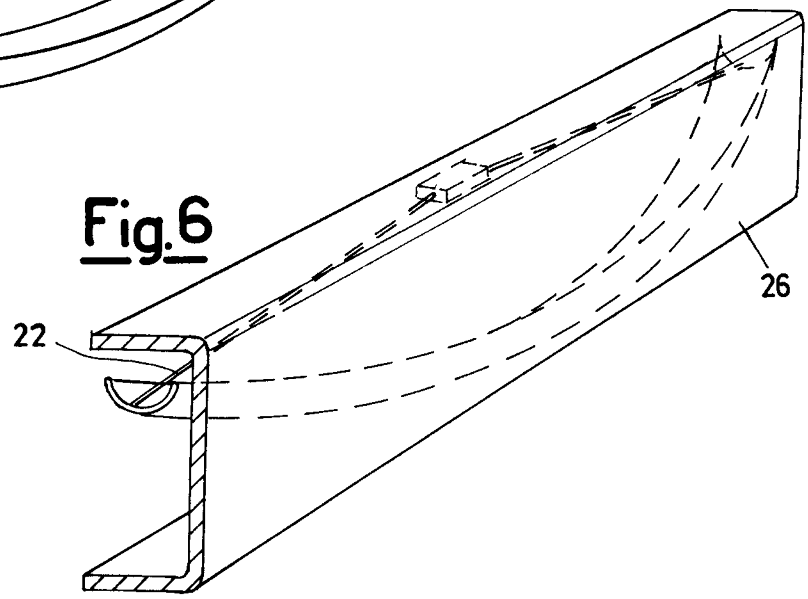
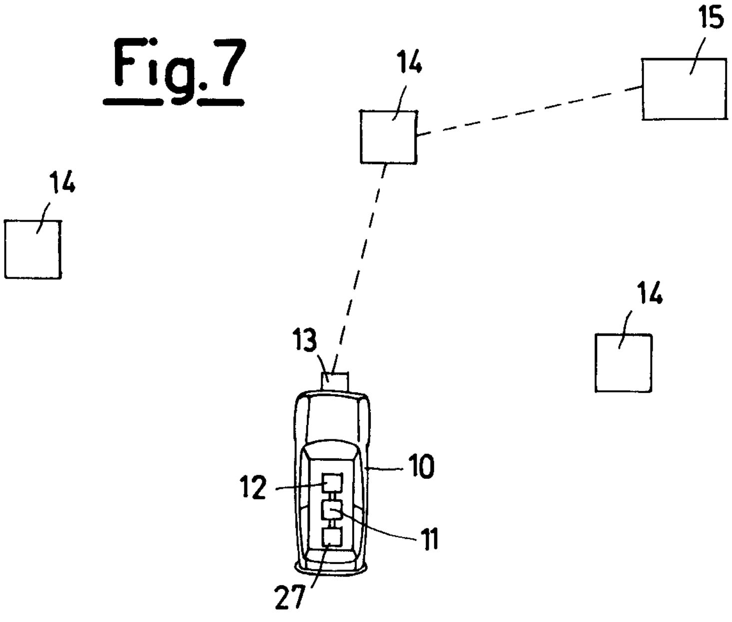


Fig.7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 20 1447

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	MACHINE DESIGN. vol. 62, no. 18, 6 September 1990, CLEVELAND US pages 78 - 79; 'STOLEN CARS PHONE HOME' * the whole document *	1,13-15	G08B25/10 G08G1/127
Y		2-4,6, 10-12	
Y	IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY. vol. VT-21, no. 3, August 1972, NEW YORK US pages 92 - 101; W.T.WARREN ET AL: 'Vehicle Location System Experiment' * page 92, right column, line 20 - page 93, left column, line 16 *	2-4	
X	EP-A-0 242 099 (ADVANCED STRATEGIES, INC.) * page 3, line 34 - page 4, line 2; claims 1-26; figure 1 *	1	
Y		6,12	
X	FR-A-2 541 801 (A.E.R.A.C.) * the whole document *	1,13-15	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
Y		10,11	G08B G08G
Y	US-A-4 408 882 (SHEEM) * column 1, line 25 - line 31 *	10,11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 AUGUST 1992	WANZEELE R.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document