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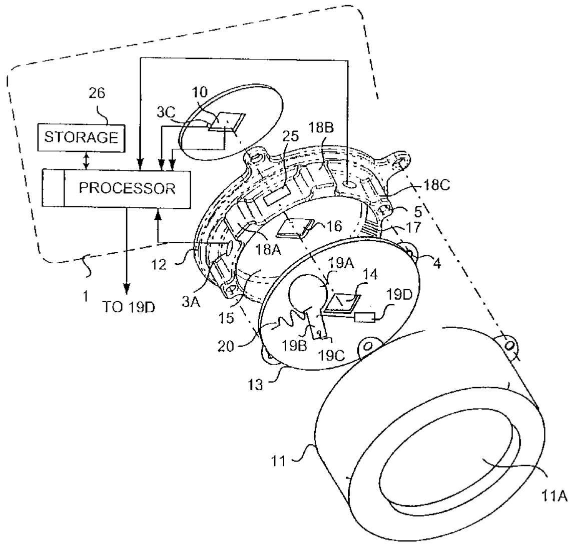
(54) **Title:** INFRARED CAMERA SYSTEM



(57) **Abstract:** The invention relates to an IR camera comprising an IR Focal Plane Array comprising a number of detector elements as sensor means; an optical system focusing an object onto said Focal Plane Array; signal processing system connected to said Focal Plane Array; a modular building comprising: a camera housing provided with said Focal Plane Array and said signal processing system; an absorbent/emitting shielding device connected to said camera housing; and an optical focusing system being removably mounted to said shielding device. The IR-camera further comprises: program means in said processing system to adapt the signals from said detector elements in said Focal Plane Array to features in surroundings of said Focal Plane Array and information means to feed information about amended features in said surroundings to said program means in said signal processing system.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Infrared camera system

TECHNICAL FIELD

This invention relates to an infrared camera system having an array of sensor element, called Focal Plane Array (FPA), and its design. It also relates to the heat transform in the camera.

The invention also relates to an absorbent/emitting shielding, a shutter without position sensor provided in the system, and data/information regarding different optical elements to be connected to the system. It also relates to the design of the coupling between the FPA and the absorbent shielding.

The camera also comprises a signal processing system connected to the FPA. The processing system is provided with a program to adapt the interpretation of the signals from each detector element to features in the surrounding of the FPA, and means to feed information about amended features in the surrounding to the signal processing system.

BACKGROUND

IR-cameras are usually very expensive devices, since their manufacture is rather complicated and need individual mechanical adjustments. There is a need for cheep and exact IR-cameras, particularly of the temperature measuring kind. There is also a need for an IR-camera, which the handling person of the camera can exchange parts of it himself and make smaller adjustments.

IR-cameras need to be calibrated. This is particularly due for IR-cameras having an array of sensor elements, such as a focal plane array (FPA), preferably of un-cooled type, i.e. cameras with a small amount of movable elements. One strives to have as few movable elements as possible and also to have as few elements as possible in the system, which are dependent upon the mechanical position particularly of moving parts.

Calibration of an IR camera is commonly done at the manufacturer. Normally, a re-calibration must be done as soon as an exchange of some vital optical elements have been done, or some movable parts have been displaced. Therefore, the camera has up to now been sent to the manufacturer in order to make this re-calibration. This is a drawback for the users of the camera and there is a wish to provide a system, in which the calibration could be made in an easy way, preferably automatically.

Since it is a camera having an IR recording made by a non-moving sensor system the calibration is provided on the signals from the individual sensor elements in the FPA.

To ensure that the image quality and/or temperature measurement accuracy is good enough the infrared camera system has to compensate for several factors associated to the optical concept. For example it can be parameters that compensate for non-uniformity, transmission loss, vinjetting, different lens temperatures, spectral characteristics, focus compensation and other features.

Another problem is that IR cameras using any shuttering/flag device to normalize or calibrate the infrared image information from the detector need to know when the shuttering device is in the optical path, protecting the detector from detecting radiation from objects outside the system, to be able to calibrate. Standard solution to this is to have sensors of various kinds detecting the position/location of the shuttering device. Another solution is to wait during a predetermined time after activating the shuttering device. This makes the normalization and calibration time rather long.

The fact that the presented image and temperature values must first be compensated for the different lenses and filters used has several drawbacks. The user of infrared cameras must send the system away for calibration if he/she gets a new lens or filter.

The need and design of an absorbent shielding in IR-cameras is well known. Uncooled FPA detector elements have to be kept on a stable temperature, defined within some range, emerging from IR radiation and the internal heat generated by the electronic circuits inside the IR camera. There had earlier always had to be some heat sink between the FPA and the camera housing in order to get rid of the excessive heat. The heat sink solutions so far are accompanied with mechanical mounting and time consuming alignment difficulties, which earlier had to be made by the manufacturer. The detector and FPA housing are very sensitive for any pressure changes due to heat expansion of the mounting of the heat sink and the camera housing. The changes are detected as flames in the IR image.

The need and design of an absorbent shielding in IR cameras is well known. Unwanted IR radiation outside the focused IR energy from the system optics has to be either redirected away from the detector device or the FPA or to be absorbed by the inner housing by the baffles and absorbent shielding. Various designs exist with either very high demand on the emissivity of the inner surface and/or complicated geometry to eliminate stray light reaching the IR detector or FPA.

One common way to solve the problem with the shielding is to introduce several baffles at calculated intervals between the entrance aperture and the detector entrance window following the shape of the optical bundle. Such baffles are inserted during the manufacturing process and greatly increase the cost of the baffle. The inserted baffles should be infinitely thin since the edges give rise to an additional source of scattering.

DESCRIPTION OF RELATED ART

There are some known shielding arrangements. US-A-5,227,782 and US-A-5,315,116 describe that any radiation outside the optical bundle could be reflected into an optical cavity and reflected out of the system after several surface reflections predicted by means of ray trace. Approach with advanced geometrical solutions to redirect or retro reflect the stray light back through the optics are described in US-A-5,994,702 and 5,298,752. Approach with advanced absorbing surface cavities and microstructures are described in UA-A-5,196,106.

US-A-6,144,031 describes a thin-walled shielding in front of an un-cooled infrared sensor, which can be of radiometric type. The shielding is comprised in a vacuum chamber together with the infrared sensor. The optics comprises a relay optic cell, which is fixedly mounted on the camera housing, and an imaging optical assembly, which is detachable, such as an assembly having a short focal length and an assembly having a long focal length can be interchanged. However, in each case the path of marginal rays leading from the relay cell entrance aperture to the FPA is unchanged.

OBJECTS OF THE INVENTION

An object according to the invention is to provide high precision IR cameras to a low cost and adapted to be produced in high volumes.

Another object of the invention is to provide IR cameras, which are self calibrated, or easily calibrated by the person handling the camera.

Still another object of the invention is to provide an IR camera, in which its different parts are easily exchangeable.

Another object of the invention is to provide an IR camera, in which it is ensured that the customer does not need to send the equipment away for calibration when he/she has acquired a new lens or filter. This will make it possible for the customer to start using the new lens/filter directly.

Still another object of the invention is to provide an IR camera, which makes the radiometry and the image calibration more accurate.

Another object of the invention is to provide an IR camera, in which the number of components and cost are reduced but which has an improved system performance.

Still another object of the invention is to provide an IR camera having a low cost absorbent shielding suitable for high volume IR cameras without causing any considerable loss of measuring accuracy.

Yet another object of the invention is to provide an IR camera, in which the time consuming mounting and alignment procedure to the camera housing is avoided.

THE INVENTION

The invention relates to an IR camera comprising:

a. an IR Focal Plane Array comprising a number of detector elements as sensor means;
b. an optical system focusing an object onto said Focal Plane Array;
c. signal processing system connected to said Focal Plane Array;
d. a modular building comprising:
d1. a camera housing provided with said Focal Plane Array and said signal processing system;
d2. an absorbent/emitting shielding device connected to said camera housing; and

d3. an optical focusing system being removably mounted to said shielding device.

The IR-camera further comprises:

- program means in said processing system to adapt the signals from said detector elements in said Focal Plane Array to features in surroundings of said Focal Plane Array:
- information means to feed information about amended features in said surroundings to said program means in said signal processing system.

The IR-camera could also comprise a Focal Plane Array holding device providing a thermal coupling directly from said Focal Plane Array to the absorbent shielding, and pressing means pressing said holding device against said shielding.

A cavity provides said absorbent shielding. It has a first aperture at one end wall turned to said Focal Plane Array, and a second aperture at another end wall for the beam path from said object to said Focal Plane Array. The cavity has a ratio of dept to width such that all stray light outside the optical path to the Focal Plane Array has to be reflected at least three times inside the cavity before it can go through the first aperture to reach the Focal Plane Array. The cavity is preferably approximately cylindrical, and the dimension of the cavity is at least 1 to 5 and has a radius being at least 3 times the width of any of the apertures. The Focal Plane Array has preferably a small size. A coating with a high absorption coefficient could be provided on an approximately cylindrical inside wall of the cavity. A simple wedge geometry of the inner cylindrical walls could further increase the absorption inside said cavity.

The holding device of the Focal Plane Array is pressed against the shielding, for example with screwed joint in order to provide direct thermal contact between two thermally conducting devices, for example metallic. Thus, according to one aspect of the invention the detector housing is floating in relation to the camera housing, to which it belongs. All the heat exchange is provided through the shielding and the radiation losses through the optics. This is in contrary to earlier solutions, where there has been a heat bridge between the enclosure for the Focal Plane Array and the camera housing in order to remove the excessive heat.

A shutter means could be provided between the optical focusing system and the Focal Plane Array.

By using the IR detector itself to detect when the detector signal has reached a predicted and/or steady state from the time the shutter close signal has been activated, there is no need for position sensors. It makes also a fast calibration since the waiting time from providing the shutter close signal until the steady state of the detector signal is optimal.

This method can be used even with a none moving part shutter solution.

In one aspect of the invention the lens package or the filter is equipped with a device making it possible for the infrared camera to get the data associated with the lens/filter from the lens/filter itself. The data (information) stored using the device could be, but are not limited to, non-uniformity correction, transmission, vinjetting parameters, compensation matrixes, spectral characteristics, lens/filter part number, lens/filter serial number and/or focus compensation.

When the lens/filter is mounted to the infrared camera for the first time the camera automatically downloads (transfer) or interprets the data from the device integrated in the lens/filter and uses the new data to compensate for the specific characteristics of that lens/filter. The camera can, but does not have to, store the data so that next time the lens/filter is used and identified the data are already stored in the camera and do not need to be downloaded again. However, it is also possible to make the readings of the characteristics of the optics continuously. It is also possible to have the data on a card readable for the camera when inserted in a reading device in the camera.

The method for storing information about the lens/filter can be of any kind for example electronic device such as a memory, optic or magnetic (bar) code, mechanical part that makes it possible for the camera to identify specific information for the lens/filter. The information may also be downloaded from an external computer, or from the Internet.

With the data stored in the lens or filter there is no need to send the system for a complementary calibration. Also the customer will be able to acquire new types of lenses and filters that were not designed when he/she acquired the infrared camera. When he/she mounts the lens/filer to the camera for the first time the system will automatically read what type of lens or filter it is and what parameters the image and temperature measurement values should be corrected with.

The lens or filter could also be equipped with a temperature sensor in combination with the device storing the lens/filter data. The temperature sensor will then give the infrared camera information of the lens/filter temperature, which can be used for focus compensation, transmission compensation, which could be different for different temperatures, distance calculations etc.

In a configuration including several lens packages mounted on each other each data may be transmitted from each package through one or more other packages to the camera. The camera can then perform the calibration based on the accumulated data received from all the lens packages.

ADVANTAGES

The modular building of the IR-camera makes is easy both to manufacture and makes it easy to handle by the person handling the IR-camera.

Since all lenses are more or less unique, a solution where every lens could have their own unique parameters stored with the lens identity and witch would result in that the camera don't have to be sent away for calibration is a great benefit for the customer. Customer with more then one camera could save cost when it's possible to have the same lens for several cameras.

A customer who has more then one camera can save cost when different lens/filter can be used on all the cameras, i.e. when the lens/filter is no longer specific for the camera.

In combination with a temperature sensor mounted into the lens/filter the compensation of different parameters can be stored with a reference temperature.

The infrared camera is preferable handheld in order to point to different objects that have thermal anomalies or is to be inspected. The method to use such device to point out faulty parts or areas when performing inspections of electrical installation or buildings is easy to manage.

Both the shielding and shutter arrangements reduces the manufacturing cost for the camera.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for further objects and advantages thereof, reference is now made to the following description of examples of embodiments thereof - as shown in the accompanying drawings, in which:

FIG. 1A shows an explosive view of an embodiment of the system according to the invention;

FIG. 1B shows a perspective view, partly in section, of the optics holder in FIG 1A;

FIG. 1C shows a section through the system and shows the beam path of a ray outside the beam path from the object,

FIG. 1D shows a section through a part of the system showing another embodiment of the aperture in the shielding device,

FIG. 2A, 2B, 2C show diagrams to illustrate the function of a shutter in accordance with one aspect of the invention; and

FIG. 3 shows a second embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG 1A, 1B, and 1C, an IR camera comprises an IR Focal Plane Array 10, below called FPA, as sensor means. The FPA comprises preferably micro-bolometers as sensor elements and is preferably of radiometric type, i.e. the sensed temperature is measured. An optical system, comprising lenses 11A, 11B, and a filter 11C, is inserted in an individual housing 11 for the optics and focuses an object (not shown) onto the Focal Plane Array 10.

THE MODULAR BUILDING

The IR camera is modularly built. The FPA 10 is provided in a camera housing 1, which does not include the optical focusing system as an integral part. An absorbent/emitting shielding 12 is preferably removably connected to the camera housing 1, for instance by being screwed onto the housing 1. The housing 11 for the optics is removably mounted to the shielding device 12 also for example by means of screws. A shutter arrangement disk 13 is provided between the optical focusing system and the Focal Plane Array 10 and is supported by the shielding device 12, e.g. by means of screws in protruding ears 4, 5 at the outside of the shielding device and the shutter arrangement disk 13 (shown only in FIG 1A). The shutter arrangement provides a wall of the cave design of the shielding device having an aperture for the beams from the camera objective.

A signal processing system 2, such as a computer, is connected to the FPA 10 in the camera housing 1. The processing system 2 comprises a software program, which adapts the signals from detector elements in the FPA to features in the surrounding of the FPA. The signal processing system can communicate with devices (not shown) outside the camera through a communication device 2'. The communication could be provided wireless by a communication link, as illustrated. The communication device 2' could also comprise a keyboard, through which the person handling the camera could enter control signals to the processing system 2. Sensors 3A, 3B, 3C, 3D, 3E feed information about amended features in the surrounding of the FPA 10 to the signal processing system 2. The sensors 3B, 3C, 3D, and 3E could be temperature sensors provided on the shielding device 12, the FPA 10, the shutter arrangement disk 13, and the lens system, respectively.

THE ABSORBENT SHIELDING 12

The absorbent shielding 12 eliminates the need of intermediate baffles or any other geometry between the entrance aperture 14 in the shutter arrangement 13 and the window 16 in front of the FPA 10. The absorbent shielding 12 comprises a cavity, which preferably is cylinder formed. It could also have a polygon-formed wall or the like. The window 16 is provided in one end wall 15 of the absorbent shielding 12. The other end wall of the shielding is provided by the shutter arrangement 13 with its aperture 14. All stray light outside the optical path to the FPA 10 has to be reflected at least three times inside the absorbent shielding before it can reach the FPA 10. The absorbent shielding has therefore an increased ratio of dept to diameter. The diameter is large in relation to the width of the beam path to the FPA 10, e.g. 5 times the width of the aperture 16. The choice of the ratio of the depth to diameter is made possible by choosing an FPA 10 having a small size.

Thus, the dimensioning of the shielding cavity is depending upon the depth, the radius of the cavity, and also upon the size of the FPA, because the intention is to force the beams having such a angle of incidence to the cavity that they do not reach the FPA directly to make at least three reflections inside the cavity before they could reach the FPA. This is achieved with a relation between the diameter in relation to depth of the cavity being greater than 5 and having a radius being at least 3 times the width of any of it apertures..

The inside baffle of the shielding cavity could preferably have a coating with a high absorption coefficient. Therefore, there is no considerable energy left after about three reflections against the cavity walls. FIG 1C shows a section through the system according to the invention and shows an example of an off axis beam SB, which is reflected four times at different depth against the inside walls of the shielding before it has reached the FPA 10. The ratio depth/radius has been designed to reach the goal at least three reflections.

Reflection from the edge of the aperture 16 could sometimes cause some problems. In dependence of its size there will be a contribution to the image gradient in dependence of how black it is. If it is very black this contribution could be more or less neglected, but if the blackness have been deteriorated then there will be a problem. Thus, this problem will be increased with aging of the camera. As illustrated in FIG 1D, this problem could be avoided if the size of the aperture opening 16A is increased in relation to the size shown in FIG 1C and a thin plate 16B having an aperture 16C is inserted in the opening 16A.

In order to further increase the absorption of the inner cylindrical walls they could be a coated by a simple wedge geometry illustrated at 17. This geometry could be provided by simply threading the walls. The walls could thus be threaded vertically or horizontally or have a combination of such threads. Thereby a still better absorption could be reached. Such threading also leads to that the absorption coefficient of the coating of the inside walls is less critical. The multiple reflections at the inside walls of the absorbent shielding will thereby increase to at least five resulting in that practically no energy is left of the off axis rays.

The improvement of heat sink for the FPA 10 with its TE-cooler 10A is realized through a thermal coupling directly from the FPA 10 to the absorbent shielding 12, through a FPA holding device 10B. Thus, the holding device 10B is pressed against the shielding 12, for example with screwed joint from the shielding to the holding device (not shown). Therefore, it is direct thermal contact between two thermally leading devices, which are preferably metallic. Thus, according to one aspect of the invention the detector housing 10, 10A, 10B is floating in relation to the camera housing 1. All the heat exchange is provided through the shielding and the radiation losses through the optics.

This eliminates all previous solutions to the heat sink problem, which all resulted in mechanical systems having time consuming mounting and testing of the heat sink. Because of the inventive highly emissive absorbent shielding 12 the heat is emitted through it and the heat transparent optics 11A, 11B, 11C. The temperature of the FPA 10 and the absorbent shielding 12 is thereby kept at about the same temperature with a very small temperature gradient. The exchange of radiation between the absorbent shielding 12 and the FPA 10 is thereby kept low.

In order to keep track of the temperature differences the three temperature sensors 3B on the absorbent shielding, 3C at the FPA 10 (3C could in the practice be one particular of the sensor elements in the FPA), 3D provided on the shutter arrangement disc 13 in the vicinity of a shutter 19. The temperature of the shutter 19 is practically the same as the temperature of the shutter disc. The processing device 2 is provided with a program loop, which makes compensations of the signals from the FPA elements as a function of the measured temperatures. If the temperatures deviate from each other larger than a predetermined value, then an alarm signal could be set indicating that something wrong has occurred.

Thus measures have been provided in order to make the temperature inside the camera as alike as possible. Thus, also the absorbent shielding 12 is made rather massive having projections 18A, 18B, 18C etc at some distances around its outside. The optics housing 11 is mounted onto the shielding projections, for example slipped or screwed. The optics housing 11 has therefore inwardly protruding guides 7, 8, one set for each outwardly protrusion 18A, 18B etc of the absorbent shielding, adapted to be set on each side of its protrusion. The temperature of the FPA 10 and the absorbent shielding 12 is thereby kept at the same temperature with a very low temperature gradient. The exchange of radiation between the absorbent shielding 12 and the FPA 10 is thereby kept low. This is achieved by having a high thermal mass and good thermal conduction of the absorbent shielding 12 at the same time as the shielding 12 is an emissive heat sink to the FPA 10.

Thus, the multiple choice of improvements stated above are all contributing to an excellent result. They incorporate in one single low-cost design for a dual purpose absorbent/emitting shielding suitable and necessary for high volume production. The design of the absorbent shielding 12 is easily built and could easily be manufacture either by casting or by welding some parts together. However, the design of the absorbent shielding is in fact based on a demand to be manufactured by casting in order to avoid high precision demands on the intermediate shielding.

THE SHUTTERING DEVICE

The IR camera uses a shuttering/flag device 19 to normalize or calibrate the infrared image information from the FPA 10. The shuttering/flag device 19 is formed like a spade having a round disk 19A on a handle 19B. The size of the disk 19A is such that it covers an area larger than the size of the aperture 14. The end of the handle turned from the disc is pivoting around an axis 19C. The device 19 is normally spring loaded by a draw spring 20 to be kept from covering the aperture 14. The spade 19A is drawn by a controllable draw element 19D to cover the aperture 14 at normalization or calibration procedure. This procedure is controlled by the processing device 2 at predetermined times or when needed in accordance with predetermined conditions.

However, there is a need to know when the shuttering/flag device 19 is completely in the optical path, protecting the FPA 10 from detecting radiation from objects outside the system, in order to be able to calibrate. According to one aspect of the invention, the FPA 10 itself or some part of it is used to detect when the signal from at least one detector element in the FPA 10 has reached a predicted and/or steady state from the time a shutter close signal has been activated. This avoids the need for position sensors for the spade, which otherwise cause trouble.

Instead of the movable shutter 19 a "none moving part" shutter solution could be provided, i.e. a window comprising for example liquid crystals could be placed in the aperture 14. This window is normally transparent but can be controlled to be opaque when a calibration is to be done.

FIG 2A, 2B and 2C illustrate that the shutter function could be indicated by means of histograms. FIG 2A illustrates the histogram of the signals from at least one sensor element of the FPA 10 at normal conditions, i.e. with the aperture 14 open and the camera looking at an object to be monitored or recorded. FIG 2B illustrates the histogram from the signals from at least one sensor element of the FPA 10, or a combined signal from a few of them or from all, when the shutter is completely closed. It is to be observed that the aperture 14 is provided in a non-focused part of the beam path from the object to the FPA 10.

FIG 2C illustrates the sub-area AVG-detector signal from at least one of the FPA sensor elements, from t1 to t2 when the shutter is open, from t2 to t3 when the shutter is closing to be closed, from t3 to t4 when the shutter is fully closed and the calibration and normalization measurement can take place, and from t4 and further on when the shutter 19 has been opened again. Thus, after that the control signal has been sent to the shutter control at t2, then the shutter system waits until the histogram in FIG 2B has been reached, or when the signal in FIG 2C has reached its continuous level at t3 after its building-up time between t2 and t3. Thereafter, the calibration or normalization is provided.

This kind of shutter procedure makes the calibration more accurate and fast than the common procedure where a predetermined delay time is provided after the control signal. The shutter procedure in accordance with this aspect of the invention thus gives an optimal calibration cycle time. It also can give an alarm if something has failed with the control of the shutter or a failure has been provided on the shutter itself, because the histogram and/or the signal will then be wrong. The shutter could have been bent or something like that such that radiation could come through the aperture 14 even if the shutter should be closed. The shutter 19 has very few parts and it needs very few adjustments in the production, which reduces manufacturing costs.

THE OPTICS HOUSING 11

The optics housing 11 comprising the lens package 11A, 11B and/or the filter 11C is in the embodiment shown in FIG 1C equipped with at least one device 22 making it possible for the infrared camera to get data associated with optics. The device 22 is shown in the embodiment to be positioned in the lower part of the housing 11.

However, information about the optics could also be placed on the optics itself, for example on its holder 11 D. The data (information) provided on the optic system 11A, 11B, 11C using the device 22 could be, but are not limited to, non-uniformity correction, transmission, vinjetting parameters, compensation matrixes, spectral characteristics, lens/filter part number, lens/filter serial number, and/or focus compensation.

When the housing 11 comprising the optics 11A, 11B, 11C is mounted to the infrared camera for the first time the camera automatically downloads (transfers) or interprets the data from the device 22 integrated in the optics, for example the lens/filter system, and uses the new data to compensate for the specific characteristics of the optics. The optics could also be of the reflection kind using curved mirrors. The down-loading is provided from a small device 22, which could be a small sender, deriving the information about the optics inside the housing 11 and sending it over to at least one receiver 3A mounted between two of the projections 18A, 18B. The transmission between the device 22 and the receiver 3A is preferably non-wired. Thus, the method for storing information in the device 22 about the optics in the optics housing 11 can be of any kind for example electronic device such as a memory, optic or magnetic (bar) code, or a mechanical part that makes it possible for the camera to identify specific information for the optics. The received signal(s) are transferred from the receiver 3A to the processing device 2 in the camera housing 1. The processing device 2 can, but does not have to, store the data in its storage 26 so that next time the same optics is used and identified the data is already stored in the camera and does not need to be downloaded again.

It is of coarse possible to have a continuous reading of the optics parameters through the transmit/receive system 22 and 3A. Also the temperature of the absorbent shielding 12 via a temperature sensor 3B could be read continuously. Also the temperature of the optics could be sensed continuously by a temperature sensor 3E and be transferred through the transmit/receive system 22 and 3A, which can in combination with the device store the lens/filter data. The temperature sensor 3E will thus give the infrared camera information of the lens/filter temperature, which can be used for focal compensation, transmission compensation, which is different for different temperatures, distance calculations, different refractive index for different temperatures etc.

Thus, the continuos reading of the optics and its temperature could be provided. The sending from the sender 22 could be such that the parameters are changed in dependence of the temperature. The program in the processing device 2 could make such a calculation using the data about and the temperature of the optics.

The storage 26 used for storing the optics data can be any suitable electronic device such as a fixed but erasable memory, e^2-prom or the like.

With the data stored in the lens or filter, or other kind of optics, such as a reflecting system, there is no need to send the whole camera system for a complementary calibration. Also the customer will be able to acquire new types of lenses and filters that were not yet designed when he/she acquired the infrared camera. When he/she mounts the optics to the camera for the first time the system shown in the embodiment shown in FIG 1C will automatically read what type of lens or filter it is. The program in the processing device 2 will calculate what parameters the image and temperature measurement values should be corrected with. The processing device 2 then makes the necessary amendments in the interpretation of the signals from each of the sensor elements in the FPA 10. The processing device 2 then presents the calculated image on a display 7.

The advantage of having the information about the optics is that the user of the camera does not keep track of what optics belongs to what camera. However, this feature could be provided in other ways. FIG 3 illustrates an embodiment, in which the optics with its optics housing 11' is mounted onto the camera. The camera housing 1' is provided with a reading device 30, in which a card having for example a magnetic strip or being a smart card 31 could be inserted. The card 30 is loaded with data about the optics and could be delivered together with the optics. It is however also possible to deliver a particular code with a new package of optics, which code the handling person of the camera can insert on the keyboard 2'. This code is then used by the processing device 2 to amend the signals from the FPA 10 in a suitable way in order to adapt the camera to the new optics.

Although the invention is described with respect to exemplary embodiments it should be understood that modifications can be made without departing from the scope thereof. Accordingly, the invention should not be considered to be limited to the described embodiments, but defined only by the following claims, which are intended to embrace all equivalents thereof.

We claim

1. An IR camera comprising:

a. an IR Focal Plane Array comprising a number of detector elements as sensor means;
b. an optical system focusing an object onto said Focal Plane Array;
c. signal processing system connected to said Focal Plane Array;
d. a modular building comprising:
d1. a camera housing provided with said Focal Plane Array and said signal processing system;
d2. an absorbent/emitting shielding device connected to said camera housing; and
d3. an optical focusing system being removably mounted to said shielding device.

2. An IR camera according to claim 1, further comprising:

- program means in said processing system to adapt the signals from said detector elements in said Focal Plane Array to features in surroundings of said Focal Plane Array:
- information means to feed information about amended features in said surroundings to said program means in said signal processing system.

3. An IR camera according to claim 1, comprising
a Focal Plane Array holding device providing a thermal coupling directly from said Focal Plane Array to said absorbent shielding;
pressing means pressing said holding device against said shielding.

4. An IR camera according to claim 1, comprising:

- a cavity providing said absorbent shielding;
- a first aperture at one end wall of said cavity turned to said Focal Plane Array;

- a second aperture at another end wall of said cavity for the beam path from said object to said Focal Plane Array;
- said cavity having a ratio of dept to width such that all stray light outside the optical path to said Focal Plane Array has to be reflected at least three times inside said cavity before it can go through said first aperture to reach said Focal Plane Array.

5. An IR camera according to claim 4, wherein

- said cavity comprises an approximately cylindrical internal wall;
- the dimension of said cavity having a relation between the diameter in relation to depth of said cavity being greater than 5 and having a radius being at least 3 times the width of any of said apertures.

6. An IR camera according to claim 4, comprising a Focal Plane Array having a small size.

7. An IR camera according to claim 4, wherein said shielding comprises said cylindrical internal wall and said end wall comprising said first aperture as an integral piece adapted to be cast.

8. An IR camera according to claim 4, comprising
a coating with a high absorption coefficient on a cylindrical inside wall of said cavity.

9. An IR camera according to claim 5, comprising
a simple wedge geometry of an inside cylindrical wall to increase absorption inside said cavity.

10. An IR camera according to claim 1, comprising:

a normally open shutter between said optical focusing system and said Focal Plane Array;
activating means for providing a shutter close signal;
shutter means for closing the beam path from said object to said focal plane array after receiving said shutter close signal; and
indicating means indicating that at least one detector element in said Focal Plane Array has a steady state signal after that said shutter close signal has been provided.

11. An IR camera according to claim 10, wherein said indicating means is adapted to indicating a predetermined histogram design representing said steady state signal from said at least one detector element.

12. An IR camera according to claim 1, wherein

- said optical focusing system is provided with informative means belonging to said specific focusing system;
- downloading means is adapted to download a signal having relation to said informative means and to transfer it to said processing device; and
- adjustment means is adapted to adjust said infrared camera making use of said downloaded signal having relation to said specific focusing system.

13. An IR camera according to claim 12, comprising:
storing means storing said computed information based on said downloaded signal having relation to said optics;
restoring means restoring said stored information when said component is inserted again.

14. An IR camera according to claim 1, wherein

- said optical focusing system is provided with informative means belonging to said optical focusing system giving information of its features;

- downloading means adapted to download a signal from said informative means and to transfer it to said processing device;
- said processing device is adapted to adjust signals from detector elements in said Focal Plane Array in relation to said downloaded signals.

15. An IR camera according to claim 14, comprising:
storing means storing said computed information based on said downloaded signal having relation to said optics;
restoring means restoring said stored information when said component is inserted again.

16. An IR camera according to claim 12, wherein

- said optical focusing system is an exchangeable kind of system provided with a code,
- code reading means is provided for reading said code and adjusting calibration of said IR camera by making use of said code.

17. An IR camera according to claim 12, wherein
said information in said informative means regarding said optical focusing system is such that it can be transformed into start information for deriving at least one of the following features:

- non-uniformity corrections
- transmission parameters
- vinjetting parameters
- compensation matrixes
- special characteristics
- lens/filter part number
- lens/filter serial number
- focus compensation
- a combination of at least two of the features above.

18. An IR camera according to claim 12, comprising:
storing means storing said computed information based on said downloaded signal having relation to said optics;
restoring means restoring said stored information when said component is inserted again.

19. An IR camera according to claim 12, comprising
temperature sensor means providing calibration parameters for compensating optical features, such as focus, transmission, distance calculations.

20. An absorbent shielding provided in front of detector sensor means in an IR camera, comprising:

- a cavity;
- a first aperture at a first end wall of said cavity turned to said Focal Plane Array;
- a second aperture at a second end wall of said cavity remote to said first end wall for the beam path from said object to said Focal Plane Array;
- said cavity having a ratio of dept to width such that all stray light outside the optical path to said Focal Plane Array has to be reflected at least three times inside said cavity before it can go through said first aperture to reach said Focal Plane Array.

21. An absorbent shielding according to claim 20, wherein

- said cavity has an approximately cylindrical internal wall;
- the dimension of said cavity having a relation between the diameter in relation to depth of said cavity being greater than 5 and having a radius being at least 3 times the width of any of said apertures.

22. An absorbent shielding according to claim 20, comprising said cylindrical internal wall and said end wall comprising said first aperture as an integral piece adapted to be cast.

23. An absorbent shielding according to claim 20, comprising a Focal Plane Array having a small size.

24. An absorbent shielding according to claim 20, comprising a coating with a high absorption coefficient on a cylindrical inside wall of said cavity.

25. An absorbent shielding according to claim 20, comprising a simple wedge geometry of said inner cylindrical walls to increase the absorption inside said cavity.

26. An absorbent shielding according to claim 20, comprising

- a Focal Plane Array holding device in the vicinity of said first aperture providing a thermal coupling directly from a Focal Plane Array to said absorbent shielding;
- pressing means pressing said holding device against said shielding.

27. A shutter for an IR camera an optical focusing system and a Focal Plane Array as detecting system for said camera, comprising:
activating means for providing a shutter close signal;
shutter closing means for closing the beam path from said object to said focal plane array after receiving said shutter close signal; and
indicating means indicating that at least one detector element in said FPA has a steady state signal after that said shutter close signal has been provided.

28. A shutter according to claim 27, wherein said indicating means is adapted to indicating a predetermined histogram design representing said steady state signal from said at least one detector element.

29. An optical focusing system for an IR camera an optical focusing system and a Focal Plane Array as detecting system for said camera, comprising:

- specific means associated to said specific focusing system;
- downloading means to download a signal having relation to said specific means; and
- adjustment means to adjust said infrared camera making use of said downloaded signal having relation to said specific focusing system.

30. An optical focusing system according to claim 29, wherein

- each optical component, such as each lens and filter, in said optical focusing system is provided with specific means giving information of its features;
- said downloading means being adapted to download a signal from said specific means and to transfer it to said processing device;
- said processing device is adapted to adjust signals from detector elements in said Focal Plane Array in relation to said downloaded signals.

31. An optical focusing system according to claim 29, wherein

- said optical component is an exchangeable kind of component provided with a code,
- code reading means is provided for reading said code and adjusting calibration of said IR camera by making use of said code.

32. An optical focusing system according to claim 29, wherein said information regarding said optics is such that it could be transformed into start information for deriving at least one of the following features:

- non-uniformity corrections

- transmission parameters
- vinjetting parameters
- compensation matrixes
- special characteristics
- lens/filter part number
- lens/filter serial number
- focus compensation
- a combination of at least two of the features above.

33. An optical focusing system according to claim 29, wherein
storing means storing said computed information based on said downloaded signal having relation to said optics;
restoring means restoring said stored information when said component is inserted again.

34. An optical focusing system according to claim 29, comprising
temperature sensor means providing calibration parameters for compensating optical features, such as focus, transmission, distance calculations.

35. A method to build an IR camera comprising:
a modular building by

a. providing a camera housing having an IR Focal Plane Array comprising a number of detector elements as sensor means, said camera housing having signal processing system connected to said Focal Plane Array;
b. connecting an absorbent/emitting shielding device removably to said camera housing; and
c. mounting an optical focusing system focusing an object onto said Focal Plane Array removably to the combined camera housing and shielding device.

36. A method according to claim 35, further comprising:

- inserting program means in said processing system adapting signals from said detector elements in said Focal Plane Array to features in surroundings of said FPA;
- feeding information about amended features in said surroundings to said program means in said signal processing system.

37. A method according to claim 35, further comprising:

- providing a normally open shutter between said optical focusing system and said Focal Plane Array;
- providing a shutter close signal;
- closing the beam path from said object to said focal plane array after receiving said shutter close signal; and
- indicating that at least one detector element in said FPA has a steady state signal after that said shutter close signal has been provided; and
- then making a calibration procedure.

38. A method according to claim 37, wherein said indicating is done by studying a histogram and indicating when a predetermined histogram design is provided from said at least one detector element representing said steady state signal.

39. A method according to claim 35, comprising: providing said absorbent shielding as a cavity having a cylindrical internal wall and having a first aperture at one end wall of said cylindrical internal wall turned to said FPA and a second aperture at another end wall of said cavity for the beam path from said object to said FPA, said cavity having a relation between the diameter in relation to depth of said cavity being greater than 5 and having a radius being at least 3 times the width of any of said apertures.

40. A method according to claim 39,

dimensioning said cavity such that all stray light outside the optical path to said FPA has to be reflected at least three times inside said cavity before it can go through said first aperture to reach said FPA.

41. A method according to claim 39, comprising
setting said FPA floating inside said camera housing and in thermal mechanical fix contact with said absorbent shielding.

42. A method according to claim 39, wherein casting said cylindrical wall and said end wall comprising said first aperture as an integral piece.

43. A method according to claim 39, providing said shutter in said other end wall having said second aperture in said shielding.

44. A method according to claim 39, providing a coating with a high absorption coefficient on a cylindrical inside wall of said cavity.

45. A method according to claim 39, providing a wedge geometry of said inner cylindrical walls to increase the absorption inside said cavity.

46. A method according to claim 35, comprising:

- providing said optical focusing system with specific means associated to said specific focusing system;
- downloading a signal having relation to said specific means; and
- adjusting said infrared camera making use of said downloaded signal having relation to said specific focusing system.

47. A method according to claim 35, wherein

- providing each optical component, such as each lens and filter, in said optical focusing system with specific means giving information of its features;

- downloading a signal from said specific means and to transfer it to said processing device;
- adjusting signals from detector elements in said Focal Plane Array in relation to said downloaded signals.

48. A method according to claim 35, wherein

- providing a code on said optical component being an exchangeable kind of component;
- reading said code; and
- adjusting calibration of said IR camera by making use of said code.

49. A method according to claim 35, wherein
transforming said information regarding said optics into start information for deriving at least one of the following features:

- non-uniformity corrections
- transmission parameters
- vinjetting parameters
- compensation matrixes
- special characteristics
- lens/filter part number
- lens/filter serial number
- focus compensation
- a combination of at least two of the features above.

50. A method according to claim 35, comprising:
storing said computed information based on said downloaded signal having relation to said optics; and
restoring said stored information when said component is inserted again.

51. A method according to claim 35, comprising:

sensing temperature in said IR camera; and
providing calibration parameters for compensating optical features, such as focus, transmission, distance calculations.

52. A method to detect when an optical component in a beam path from an object to a focal plane array (FPA) in an infrared camera influences said adjustment of said infrared camera, and to adjust said infrared camera, **characterized** by

- providing said optical component with specific means associated to said special kind of component,
- downloading a signal having relation to said specific means,
- adjusting said infrared camera making use of said signal having relation to said specific means.

53. A method according to claim 52, **characterized** by

- examine if said optical component is an exchangeable kind of component,
- examine if said specific means is a code provided on said component,
- examine if said code is stored in said infrared camera,
- adjusting a calibration of said infrared camera by making use of said code.

54. A method according to claim 52, **characterized** by
providing said code such that it could be transformed into start information for deriving at least one of the following features:

- non-uniformity corrections
- transmission parameters
- vinjetting parameters
- compensation matrixes
- special characteristics
- lens/filter part number
- lens/filter serial number
- a combination of at least two of the features above.

55. A method according to claim 52, **characterized** by storing said downloaded signal having relation to said specific means and/or features computed by means of said code for said component to be restored when said component is inserted again.

56. A method according to claim 55, **characterized** by optical or magnetical reading of said code.

57. A method according to claim 52, **characterized** by temperature sensing for providing calibration parameters for compensating optical features, such as focus, transmission, distance calculations.

58. A method for detecting when a shutter is provided in the beam path from an object to a focal plane array in an IR camera, **characterized** by

- detecting activation of a shutter close signal; and
- indicating when said FPA has a predetermined and/or steady state after said activation of said shutter close signal.

59. A method according to claim 58, wherein said indicating is done by studying a histogram and indicate when a predetermined histogram design is provided from said at least one detector element representing said steady state signal.

60. A method for providing shielding in an infrared camera having a focal plane array (FPA) as a recording means for an infrared beam from an object to be monitored, comprising:
providing a cavity having an approximately cylindrical internal wall and having a first aperture at one end wall of said cavity turned to said FPA and a second aperture at another end wall of said cavity for the beam path from said object to said

FPA, said cavity having a ratio of dept to radius being at least 1 to 5 and a radius being at least 3 times the width of any of said apertures.

61. A method according to claim 60, dimensioning said cavity such that all stray light outside said optical path to said FPA has to be reflected at least three times inside said cavity before it can go through said first aperture to reach said FPA.

62. A method according to claim 60, providing an FPA having a small size.

63. A method according to claim 60, providing a coating with a high absorption coefficient on a cylindrical inside wall of said cavity.

64. A method according to claim 60, providing a wedge geometry of said inner cylindrical walls to increase said absorption inside said cavity.

65. A method according to claim 60, providing said FPA in thermal mechanical fix contact with said end wall comprising said first aperture.

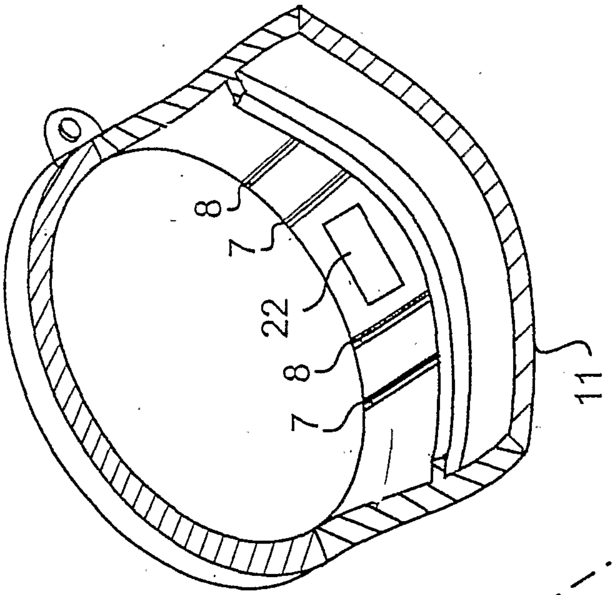
8
7
22
8
7
11

FIG 1B

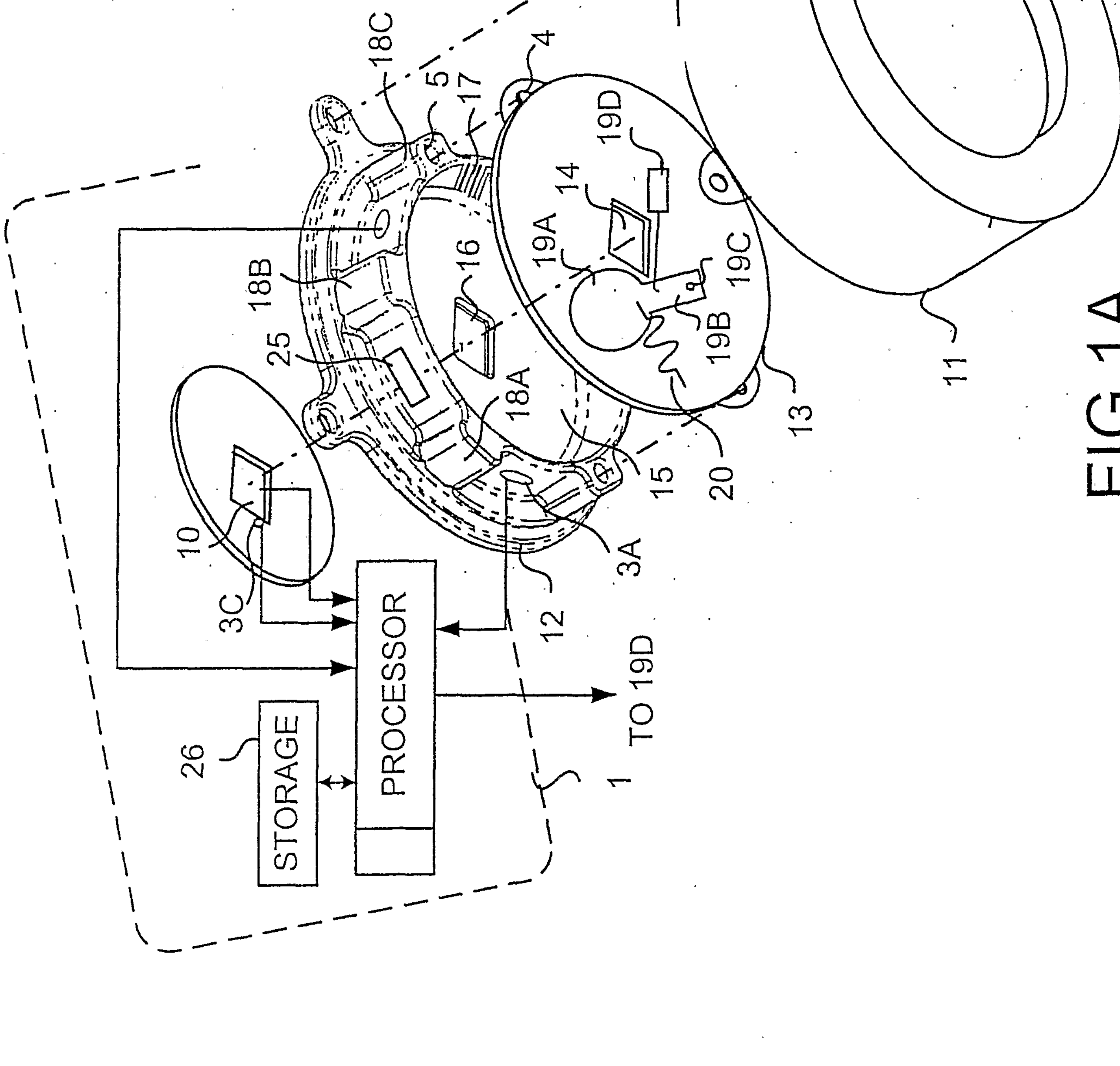
18C
5
17
4
19D
14
16
19A
18B
25
19C
19B
18A
20
13
15
3A
12
10
3C
11A
11
PROCESSOR
STORAGE
26
TO 19D
1

FIG 1A

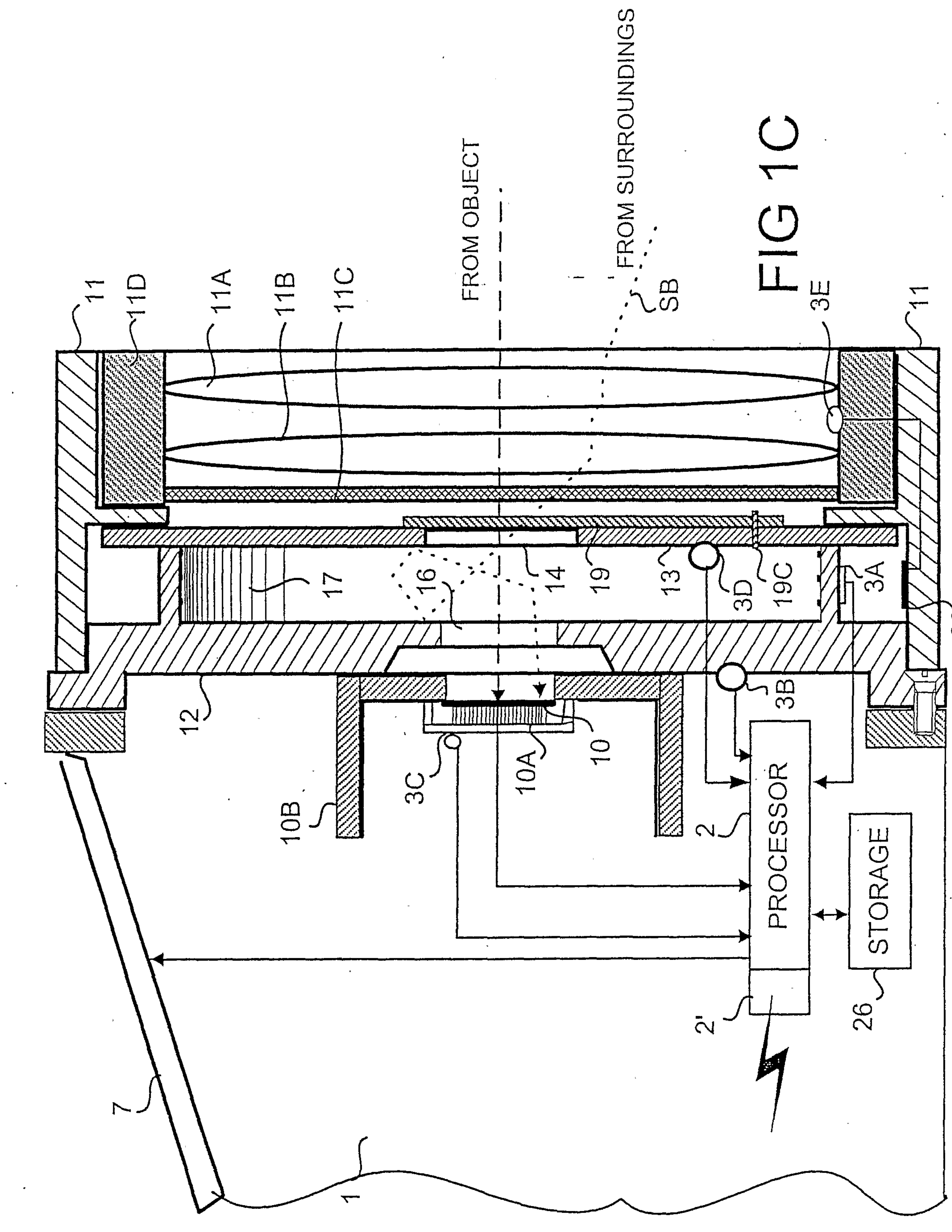
FROM OBJECT
FROM SURROUNDINGS
SB
11
11D
11A
11B
11C
3E
17
16
14
19
13
3D
19C
3A
22
12
3B
10
10A
3C
10B
2
PROCESSOR
STORAGE
26
2'
7
1

FIG 1C

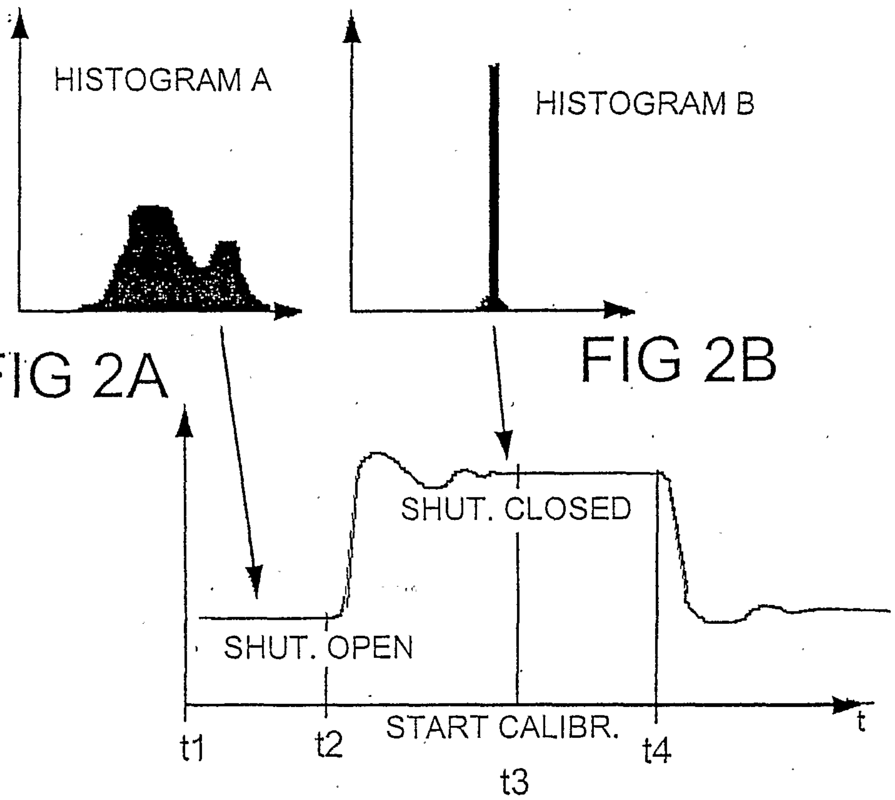

FIG 2A

FIG 2B

FIG 2C

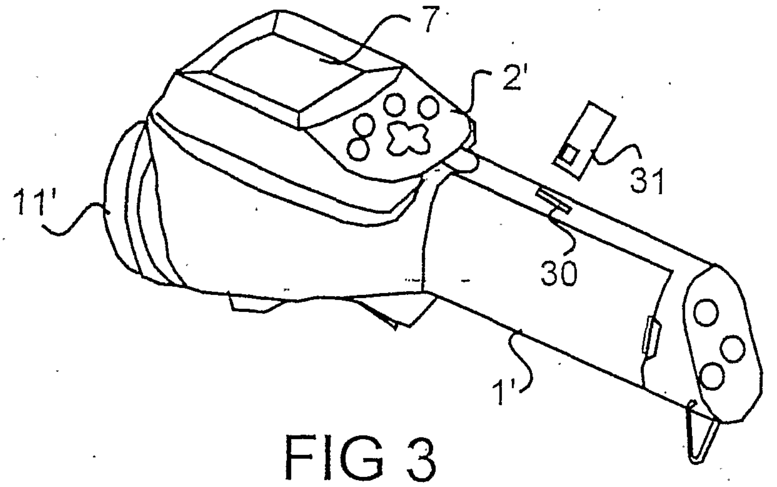

FIG 3

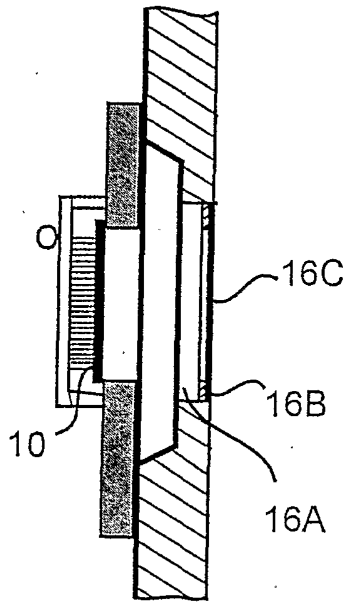

FIG 1D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00364

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01J 5/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2115143 A (BRITISH AEROSPACE PUBLIC LTD.CO), 1 Sept 1983 (01.09.83), page 2, line 27 - line 33 --	1,35
Y	EP 0417791 A2 (ULTRAKUST ELECTRONIC GMBH), 20 March 1991 (20.03.91), figure 1 --	1,35
Y	US 2357193 A (T.R.HARRISON), 29 August 1944 (29.08.44), page 7, line 60 - page 8, line 7, figure 6 --	1,35

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 June 2002	16 -08- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Jakobsson Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0992773 A2 (THOMSON-CSF OPTRONIQUE CANADA INC.), 12 April 2000 (12.04.00), column 3, line 26 - line 29	1-19,20-26, 35-51,60-65
X	column 6, line 34 - line 50	27-28,58-59
	--	
X	US 6144031 A (R.J.HERRING ET AL), 7 November 2000 (07.11.00), column 14, line 48 - line 67	27-28,58-59
	--	
X	US 3978281 A (G.J.BURRER), 31 August 1976 (31.08.76), abstract	27-28,58-59
	--	
X	US 4670653 A (C.MCCONKLE ET AL), 2 June 1987 (02.06.87), column 4, line 3 - line 12	27-28,58-59
	--	
X	US 5127742 A (J.FRADEN), 7 July 1992 (07.07.92), abstract	27-28,58-59
	--	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00364

Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-19,20-26,35-51,60-65(group I),27-28,58-59(group II)

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

I. Claims 1-19, 20-26,35-51, 60-65 relate to a modular built IR camera with an associated shielding device and method to build an IR camera with a connected shielding device.

II. Claims 27-28 and 58-59 relate to a shutter for an IR camera and a method for detecting the shutter.

III. Claims 29-34 and 52-57 relates to an optical focusing system for an IR camera provided with downloading means to download a signal in order to adjust the IR camera and a method to download and adjust the IR camera.

Group I also comprise in the dependent claims technical features of both groups II and group III.

The inventions according to group II and group III are not so linked as to form a single general inventive concept (PCT Rule 13.1) There is no technical relationship among those inventions involving one or more of the same or corresponding special technical features within the meaning of PCT Rule 13.2.

INTERNATIONAL SEARCH REPORT

Information on patent family members

06/07/02

International application No.

PCT/SE 02/00364

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2115143 A	01/09/83	DE 3305450 A	25/08/83
		FR 2521733 A	19/08/83
		GB 8304400 D	00/00/00
EP 0417791 A2	20/03/91	SE 0417791 T3	
		AT 91785 T	15/08/93
		DE 3930828 A,C,R	28/03/91
		DE 59002021 D	00/00/00
		DK 417791 T	13/12/93
		ES 2058713 T	01/11/94
US 2357193 A	29/08/44	NONE	
EP 0992773 A2	12/04/00	EP 0992772 A	12/04/00
		US 6294328 B	25/09/01
		US 2001045516 A	29/11/01
US 6144031 A	07/11/00	EP 0872718 A	21/10/98
US 3978281 A	31/08/76	NONE	
US 4670653 A	02/06/87	NONE	
US 5127742 A	07/07/92	NONE	