Paper Ref	Sheet	Percentage Mark Awarded
FD2	1 of 31	64%

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An apparatus for protecting an optical device and kit of parts and method for the same.

✓1

Field of Invention

The present invention relates to an apparatus for protecting an optical device. In particular, the prevent invention relates to an apparatus for protecting an optical device from contamination. The present invention further relates to a kit of parts and a method for the same.

✓1

Background

For many years now, large factories for making, processing and packing various food and consumer items have automated as many of the production processes as possible to keep down our labour costs. This has results in some very complicated robotic production lines.

Figure 1 shows a known example of such a production line. In particular, Figure 1 shows a known configuration for imaging, in a field of view 3 of a camera 1, objects 6 on a conveyor belt 5. These production lines include various sensors and cameras that are monitored by multiple automated systems to continually check all the processes are running smoothly. For example, a camera 1 may be used to check the size or presence of manufactured objects 6 on a conveyor belt, or to confirm that packaging has been correctly applied to an item.

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Many of the industrial processes may generate steam, dust or fumes, etc. in quite large quantities. Although some factories have fume extraction systems and manual cleaning takes place throughout the day, there can still be a significant build-up of contaminants on items located around the factory. This particular problem is found for the video cameras installed to monitor many of the automated processes.

In fact, it may be a daily event for the buildup of contamination on a lens 2 of such a camera to reach the point where the collected images can no longer be used as required to automatically identify or measure objects. For some critical cameras, this can even cause an entire production line to be automatically shut down until an engineer is able to establish which camera is dirty and manually clean it. This loss of production may prove costly.

Some potential solutions currently aim to solve this problem. For instance one solution is to fit the camera with a small visor 4 on top. Another known solution to prevent the accumulation of dirt is to shield the camera by placing more and/or larger visors around it. Further some cameras are placed inside a tube to shield the camera (i.e. with the camera lens directed out of the open end of the tube).

However, all these known solutions/ shields do not catch all of the dirt and in certain cases (especially when using a simple tube) actually provided pockets of

space where more dirt could accumulate over time. These extra shielding components may also make it much more difficult to access the camera lenses to manually clean them.

Another known apparatus for protecting a camera from contamination is shown in **Figure 2.** In particular, Figure 2 shows a solution in which an install air nozzle 13 is installed near one side of a camera 10 to blast a continual air flow 12 of compressed air over the camera lens 11, with the idea being that the airflow will simply blow any unwanted material off the camera lens. However, with such an apparatus it is likely that contaminants would be picked up in the airflow and deposited on the camera lens. In particular, droplets of oily material maybe carried by the air towards the camera lens at high speed and may then then firmly stick to the lens, causing an oily build-up which may be even worse than the contamination encountered without any airflow.

Finally, another solution is shown in **Figure 3**. Figure 3 shows the use of a mechanical wiper 23 (like the windscreen wiper on a car) to clear debris. In this apparatus, the camera 20 is placed inside a sealed box 21 with a clear window 22 that is wiped by the wiper. Nozzles 24 near the box are used to squirt a cleaning liquid onto the outside of the window. Such apparatuses may be useful for outdoor security and surveillance cameras, however they would not be suitable for indoor use as dispensing a cleaning liquid is not appropriate inside, for instance inside a

factory processing food. Furthermore, the wiper could scratch the window over times.

Thus, it is desirable to provide an apparatus for solving at least the issues above and preventing contamination of an optical device. ✓3

Summary

Provided herein is an apparatus with an inlet and an outlet for receiving and expelling, respectively, a compressed gas. This prevents contamination build up in front on an optical sensor of a device.

In particular, provided herein is an apparatus for protecting an optical device from contamination. The apparatus comprises a box configured to at least partially surround the optical device to protect the optical device from an external environment. The box comprises:

an inlet for receiving compressed gas, an outlet for expelling the compressed gas; and a channel between the inlet and the outlet for carrying the compressed gas between the inlet and the outlet and for carrying contaminants away from the optical device through the compressed gas.

The box is configured to receive the optical device and align an optical sensor of the optical device with the outlet for the optical sensor in use to transmit and/or receive optical data to objects external to the outer box.

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A path of the channel is at least in front of the optical sensor for the compressed gas to collect contaminants in front of the optical sensor, carry the contaminants to the outlet and to prevent the contaminants from being deposited in front of the optical sensor. In other words, the compressed gas is configured to flow in front of the optical sensor.

Thus, the apparatus provided herein advantageously prevent contamination from occluding the view of an optical sensor of an optical device. In effect, the apparatus may fully protect an optical device, such as a camera, from being contaminated, but in particular, at least the optical sensor is protected from contamination. ✓1

The provision of an inlet, channel and an outlet to carry compressed gas, such as air, means that any contaminants which have gather in the box may be efficiently expelled from the box, thereby protecting the camera device from being contaminated.

Further, the expulsion of the gas through the outlet stops most dust, debris or other contaminants from entering the outlet in the first place, which means it doesn't get deposited in front of the optical sensor. ✓1

As described above, the box is configured to receive the optical device and align an optical sensor (such as a camera imaging device) of the optical device with the outlet for the optical sensor in use to transmit and/or receive optical data to objects external to the outer box. That is, by aligning the optical sensor of the device with the outlet, the optical device has as clear, uninterrupted view outside of the box. That is, there may be no physical obstruction (such as a wall) between the optical sensor and the outside environment. As such, optical quality, such as image quality may be fair superior to cases with the optical device behind a wall. ✓½

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2½

Furthermore, as indicated above, a path of the channel is at least in front of the optical sensor. As defined, this advantageously allows the compressed gas to collect contaminants in front of the optical sensor as it flows from the inlet to outlet and carry the contaminants to the outlet. Thus, providing the flow path at least in front of the optical sensor, contaminants are prevented from being deposited in front of the sensor would you reduce optical quality of the sensor.

Thus, by providing the outlet in front of the optical sensor and providing the path of the channel (that is, for instance the terminating part of the path) at least in front of the optical sensor, the optical quality of the optical sensor is unhindered by the apparatus with the optical device itself is protected from contamination.

In an example, the box may be referred to as an outer box, and optionally the apparatus further comprises an inner box. The inner box is configured in use to be received at least partially by the outer box. That is, the inner box, or at least a side of the inner box, may be inserted into the outer box. The inner box itself may be configured to receive the optical device, that is, instead of inserting the optical device directly into the outer box, the optical device may be inserted into the inner box. The inner box, containing the optical device, may then be inserted into the outer box. ✓½

The inner box comprises an optically transparent window. The optically transparent window is on a side of the inner box aligned with the outlet of the outer box. That is, in use, with the inner box inserted into the outer box the optically transparent window is aligned with the outlet of the outer box. ✓½ Of course, the outer box may be larger than the inner box to accommodate the inner box. The optically

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transparent window is aligned with the outlet so that the optical sensor is again provided an optically transparent path, but with the added protection from contamination provided by the optically transparent window. Thus, for instance, advantageously with a camera as an example, light may unobstructedly enter the outlet, pass through the optically transparent window and be imaged by the camera sensor. ✓½

Furthermore, as described with the expulsion of the compressed gas through the outlet above, with the optically transparent window of the inner box also being provided, the expulsion of the gas prevents the contaminants from depositing on the optically transparent window.

Optionally, the inner box is removably received by the outer box. Thus, the inner box may be easily removed from the outer box for easily cleaning of the inner box and in particular for easy cleaning of the optically transparent window. ✓½

In use, the inner box may be (firmly) secured to the outer box using at least one fixing. This may prevent any excessive movement of the optical device in use, thereby preserving high quality optical data from the optical device. ✓½

In the example with the inner box being provided, the channel may be formed between inner sides of the outer box and adjacent outer sides of the inner box. That is, inner sides of the outer box may be the sides of the outer box which receive

the inner box and which are not directly exposed to the external environment. The outer sides of the inner box may be the sides of the inner box which directly face the inner sides of the outer box (and which are opposite the inner sides of the inner box, the inner sides of the inner box being the sides of the inners box closes to the optical device in use.

By forming the channels between the outer sides of the inner box and inner sides of the outer box the compressed air may be flow between the boxes and collect any contamination which has been deposited between the boxes. Thus, the optically transparent window may be kept clean. ✓½

Optionally the inner box comprises an optically transparent, non-stick coating on an outer surface of the optically transparent window. The outer surface may be the surface of the optically transparent window closest to the outlet (and therefore uninterruptedly exposed to the external environment through the outlet). The transparent, non-stick coating on the outer surface of the optically transparent window may reduce the adhesion of contaminants, which makes it easier to clean if necessary. ✓½

The optically transparent window may be a a glass window. Glass is optically transparent to the visible light spectrum and is therefore a suitable material to use. For instance, to when in an example with the optical device being a camera.

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Optionally, the outer box is configured to completely enclose the inner box. It is understood that completely enclose mean enclose the inner box, expect for the outlet which is open to the external environment. By completely enclosing the inner box with the outer box contaminates are prevented from entering the inner box, therefore protecting the optical device. ✓½ ✓½

Optionally, the outer box comprises a hinged door on a side of the outer box, configured to allow the outer box to be opened to insert or remove the inner box containing the optical device. For instance, the hinged door may be on a side of the apparatus opposite the side with the outlet. Thus, the inner box may be easily inserted and removed from the outer box. ✓½

In a different examples, the outer box and the inner box share a common side having a portion configured to be opened and closed for the optical device to be directly inserted into the inner box. Again, this side may be opposite the side of the outer box with the outlet. By providing a common side the optical device may easily be inserted into the inner and outer boxes. ✓½

Optionally, the channel comprises an air acceleration zone configured to increase a flow of the compressed gas in front of the optical sensor. it is important to prevent build-up of contamination in front of the optical sensor of the optical device. Thus, by accelerating the compressed gas in front of the optical sensor any deposited contamination may be dislodged and carried out through the outlet. Furthermore,

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by accelerating the gas inside of the apparatus, rather than providing a higher flow rate at the inlet, which would require more energy by for instance a pump compressing the air, less energy is required to increase the flow rate. ✓½

Optionally, the air acceleration zone comprises a change in cross sectional area of the channel. The change in cross-sectional area of the channel, and in particular a reduction in the cross section, may force the gas into a smaller volume, thereby increasing flow rate. ✓½

Optionally, the outlet is positioned on a front side of the box and the inlet is positioned on a different side of the box. A width of the channel on the front side of the box is narrower than a width of the channel on the different side of the box to change the cross-sectional area of the channel. The change in the cross-sectional area of the channel, which may be for instance by a factor of about two, results in the gas flow increasing after the gas turns the corner (e.g., the corner of the sides with the outlet and the inlet) and moves along the narrower channel towards the outlet (and the optically transparent window). ✓½

Optionally, the channel comprises a curved guide for guiding the compressed gas around corners of the box and for accelerating the compressed air. Thus, the curved guides may (further) accelerate the gas to remove contamination from the channel and therefore from in front of the optically transparent window.

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Optionally, the channel between the inlet and the outlet comprises a shutter. The shutter may prevent the compressed gas from exiting the box through the outlet. That is, when closed, the shutter may prevent the compressed gas from exiting the outlet and when open the shutter may allow the compressed gas to entering the inlet and pass through the channel to the outlet. The shutter may be closed to start and stop the flow of the compressed gas (e.g. to save air when not needed). ✓½

Optionally, the inlet comprises a filter for preventing contaminants from entering through the inlet. Thus, for instance, when using a dedicated air pump to provide the compressed gas, the filter may be provided to produce gas that is clean enough (e.g. not introducing further contaminants though the inlet). ✓½

The box (i.e., the outer box) may comprise a second inlet for receiving the compressed air. The second inlet may be provided on an opposite side to the first inlet. Thus, at least substantially two sides of the optical sensor (or inner box if used) may receive the compressed gas. Thus, may increase volume of compressed gas flowing through the channel(s), thereby increasing the effectiveness of the apparatus to remove the contaminants. The channels between the inlet and the outlet and the second inlet and the outlet may meet at the outlet such that a path of both of the channels is at least in front of the optical sensor for the compressed gas to collect contaminants in front of the optical sensor, carry the contaminants to the outlet and to prevent the contaminants from being deposited in front of the optical sensor. ✓½

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Optionally, there is provided a second shutter between the second inlet and the outlet for preventing the compressed gas from exiting the box through the outlet. Thus in an example with both channel comprising shutters, the shutters may both be closed, blocking all airflow, or one or the other of the shutters may be closed so that the compressed gas flows over the optically transparent window from only one side.

Optionally, the outlet is a tubular outlet. The tubular outlet may provide a shape/configuration which matches a shape and/or configuration of the optical device, such as a lens of a camera also being tubular (having a circular cross section).

Optionally, the apparatus further comprises a pressure regulator connected with the inlet. The pressure regulator may advantageously set and maintain a flow rate of compressed gas entering the inlet.

The optical device may be a camera, and the optical sensor may be the optical sensor of the camera used for capturing images.

Also provided herein is a kit of parts comprising the apparatus according to any preceding claim, and an optical device. For instance, the optical device is a

camera. The kit of parts may further comprise a compressed air device configured to provide the compressed air to the inlet, such as a pump. The kit of parts may advantageously be assembly to provide an assembly for preventing contamination of the optical device.

Also provided herein is a method for protecting an optical device from contamination, comprising, connecting the any of the examples of the apparatus above, inserting an optical device into the apparatus; and providing the compressed air to the inlet by the compressed air device. The method may advantageously protect the optical device from contamination.

Brief description of drawings

Reference is made to the following drawings, by way of example only, in which:

Figure 1 shows a known configuration for imaging objects on a conveyor belt;

Figure 2 shows a known apparatus for protecting a camera from contamination;

Figure 3 shows another known apparatus for protecting a camera from contamination;

Figure 4 shows an apparatus disclosed herein for protecting a camera from contamination;

Figure 5 shows another apparatus disclosed herein for protecting a camera from contamination;

Figure 6 shows a front part of the another apparatus disclosed herein for protecting a camera from contamination. ✓2

Detailed description

Figure 4 shows an apparatus for protecting an optical device 40 from contamination. For instance, the optical device may be a camera, and the apparatus may fully protect the camera in for instance a factory setting from getting contaminated. In this example, the optical device is a camera, but any suitable optical device may be protected such as a laser device.

In this example, the camera is received by an inner box 41. This inner box may house the camera. The inner box may be provided with an optically transparent window 42 such as a clear glass window at the front, near a lens 48 of the camera, to allow the camera to image objects through the glass window. That is, the optically transparent window may provided an unobstructed view for the camera to image objects external to the apparatus.

The inner box may be placed inside a slightly bigger box, which may be referred to as a box 48 or an outer box. That is, the inner box may be removably received by the outer box. In use, the inner box may be firmly secured to the outer box by for instance fasteners or fixings (not shown). The inner box and outer box may

therefore be secured boxes together to prevent movement of the boxes and therefore the camera in use.

The outer box may comprise at least one inlet 46. In this example the outer box comprises two inlets. The inlets may be provided at a top and bottom of the outer box (in regard to the camera being correctly oriented in use) so that one inlet faces the ground and other inlet faces a ceiling (of for instance a factory). Of course, the inlet may be placed on any side of the outer box. The inlets may be configured to be on opposite sides of box to each other.

The inlets may be configured for receiving a compressed gas 46, such as compressed air. Furthermore, the box may comprise an outlet 47 for expelling the compressed air. The outlet may be a (large) tubular opening for expelling that gas. The outlet may be at a front side of the box.

The outlet may be positioned so that it is aligned with the optically transparent window of the of the inner box, to allow the camera to 'see' out of the apparatus and thereby collect images of externally located objects. Light thus may reach the camera by passing along the tubular opening in the outer box and through the optically transparent window of the inner box.

To keep the window clean, a channel 47 is provided between the inner and outer boxes. That is, inner sides of the outer box and outer sides of the inner box may form the channel. The channel may otherwise be referred to as a gap. When gas

is pumped into this air gap via the inlets, it travels along the gap to the outlet (opening) at the front of the outer box, from which it is then expelled (as shown by the arrows).

For compactness, the outer box may be as small as possible, but the gap between the inner and outer boxes may be configured to be wide enough to carry the required volume of air to the opening. The inlet(s) may be connected to a compressed air supply to provide the compressed gas. This connection may be made via a pressure regulator so to set and maintain the required flow rate of gas.

It would, however, be equally possible to use a (dedicated) air pump to provide the air supply, provided it produces air that is clean enough. The clean air could be produced by providing a filter to remove any contaminants (see Figure 5). Alternatively, a pressurised bottle of air or any other suitable gas could be used.

As shown by the arrows in Figure 4, the compressed gas may be expelled from the opening in the outer box. This expulsion of air may stop most dust, debris or other contaminants from entering the opening in the first place, which means it doesn't get deposited onto the glass window of the inner box. This may also keep the optically transparent window clear over prolonged periods of time.

Furthermore, as the inner box may be removably received by the outer box, the inner box may be removed for cleaning the optically transparent window. Also a transparent, non-stick coating may be applied to the outer surface of the glass window to reduce the adhesion of contaminants, which makes it easier to clean if necessary.

Different flow rates may be provided to the inlet. Although using a higher airflow rate may give better protection against the ingress of contaminants, it also consumes more compressed air, which in turn requires more electricity to run the air compressor. Thus, to passively increase air flow instead an air acceleration zone may be provided as part of the air path (channel) formed inside the apparatus to increase the speed of airflow over the glass window.

In particular, as shown in Figure 4, a narrow gap (g2) between the inner and outer boxes at the front of the apparatus ma be provided and a wider gap (g1) provided in the top and/or bottom channels/regions fed by the inlets. This change in the cross-sectional area of the channel (air gap) (by a factor of about two for example) may result in the air speed increasing after the air turns the corner and moves along the narrower gap towards the optically transparent window.

While this works effectively it may result in some turbulent (uneven) airflow over the window.

Figure 5 shows another example of an apparatus for protecting an optical device from contamination. Due to the potential turbulence curved air guides may be provided 161, as shown in Figure 5. These curved air guides may help guide the flow of air around the corners whilst also restricting the air gap to cause air acceleration.

Further, it may also be advantageous to be able to start and stop the airflow (e.g. to save air when not needed). As such one or each of the inlets may be provided with a shutter (e.g., an upper shutter 170 for one inlet and a lower shutter 171 for another). The shutters may slide back and forth to block the airflow from the upper and lower inlets respectively. These shutters may both be closed, blocking

all airflow, or one or the other of the shutters may can be closed so that air flows over the window from only the top or bottom direction. **Figure 6** shows part of this another apparatus with the upper shutter closed, so that airflow (flow of the compressed gas) from above is prevented.

Further, as described above, the apparatus may include only one air inlet and a single shutter.

Referring back to Figure 4, the inner box in this example is completely enclosed by the outer box. In particular, the back 49 of the outer box is attached by hinges 50 to the rest of the outer box. This allows the outer box to be opened to insert or remove the inner box containing the camera whenever required.

However, as shown in Figure 5 the inner and outer boxes could instead share a common back wall (in a closed position 180 and an open position 181) having a portion that can be opened and closed so that the camera may be directly inserted into the inner box.

Also, although approximately cuboid-shaped boxes as shown, it would of course be possible to use inner and outer housings of any size and shape. Furthermore, as noted above, while this apparatus is is described for protecting one particular type of camera, it could also be used with other cameras and even different types of optical devices, such as laser devices that emit a light beam, light level monitors, etc. As will be appreciated by the person skilled in the art, the size of the protection apparatus may be matched to the size of the device that is being protected.

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Figure 5 also shows the air filters 100 described above, that may be added to ensure any contaminants in the compressed air supply are removed before the compressed air is injected into the apparatus.

Furthermore, while the above example is provided with an outer box and an inner box, in another example (not shown) the shape of an optical device (such as a camera) may be modified to act as an inner box, with the camera lens effectively forming the optically transparent window.

Alternatively, outer box may be shaped to provide the necessary air gap in use when a known camera is located inside it. The camera may then be placed directly inside the outer box with the air gap (channel) formed between the camera and the outer box providing the channel that extends from the air inlets to the (outlet) opening to carry the flow of air for keeping the camera lens (optical sensor) clean.

Except where mutually exclusive features in any embodiment may be combined and/or removed.

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Intro + Des

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Claims

1. An apparatus for protecting an optical device from contamination, comprising:

an box configured to at least partially surround the optical device to protect the optical device from an external environment, wherein the box comprises:

an inlet for receiving compressed gas;

an outlet for expelling the compressed gas; and

a channel between the inlet and the outlet for carrying the compressed gas between the inlet and the outlet and for carrying contaminants away from the optical device through the compressed gas,

wherein, the box is configured to receive the optical device and align an optical sensor of the optical device with the outlet for the optical sensor in use to transmit and/or receive optical data to objects external to the outer box, and

wherein a path of the channel is at least in front of the optical sensor for the compressed gas to collect contaminants in front of the optical sensor, carry the contaminants to the outlet and to prevent the contaminants from being deposited in front of the optical sensor. ✓12

2. The apparatus according to claim 1, wherein the box is an outer box and wherein the apparatus further comprises an inner box configured in use to be received at least partially by the outer box, wherein the inner box is configured to receive the optical device, and wherein the inner box comprises an optically transparent window, the optically transparent window being on a side of the inner box aligned

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with the outlet of the outer box in use, preferably wherein the inner box is removably received by the outer box. ✓2

3. The apparatus according to claim 2, wherein the channel is formed between inner sides of the outer box and adjacent outer sides of the inner box.

4. The apparatus according to any of claims 2 to 3, wherein the inner box comprises an optically transparent, non-stick coating on an outer surface of the optically transparent window. ✓1

5. The apparatus according to any of claims 2 to 4, wherein the optically transparent window is a glass window. ✓1

6. The apparatus according to any of claims 2 to 5, wherein the outer box is configured to completely enclose the inner box. ✓2

7. The apparatus according to claim 6, wherein the outer box comprises a hinged door on a side of the outer box configured to allow the outer box to be opened to insert or remove the inner box containing the optical device. ✓1

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8. The apparatus according to claim 6, wherein the outer box and the inner box share a common side having a portion configured to be opened and closed for the optical device to be directly inserted into the inner box.

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9. The apparatus according to any preceding claim, wherein the channel comprises an air acceleration zone configured to increase a flow of the compressed gas in front of the optical sensor.

✓1

10. The apparatus according to claim 9, wherein the air acceleration zone comprises a change in cross sectional area of the channel.

✓1

11. The apparatus according to claim 10, wherein the outlet is positioned on a front side of the box and the inlet is positioned on a different side of the box, and wherein a width of the channel on the front side of the box is narrower than a width of the channel on the different side of the box to change the cross-sectional area of the channel.

12. The apparatus according to any preceding claim, wherein the channel comprises a curved guide for guiding the compressed gas around corners of the box and for accelerating the compressed air.

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3½

13. The apparatus according to any preceding claim, wherein the channel between the inlet and the outlet comprises a shutter configured to close to prevent the compressed gas from exiting the outlet. ✓1

14. The apparatus according to any preceding claim, wherein the inlet comprises a filter for preventing contaminants from entering through the inlet. ✓½

15. The apparatus according to any preceding claim, wherein the box comprises a second inlet for receiving the compressed air. ✓½

16. The apparatus according to claim 15, wherein a second channel between the second inlet and outlet comprises a second shutter for preventing the compressed gas from exiting the outlet. ✓½

17. The apparatus according to any preceding claim, wherein outlet is a tubular outlet.

18. The apparatus according to any preceding claim, wherein the apparatus further comprises a pressure regulator connected with the inlet. ✓½

19. A kit of parts comprising the apparatus according to any preceding claim, and an optical device. ✓1

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20. The kit of parts according to claim 19, wherein the optical device is a camera. ✓1

21. The kit of parts according to claim 19 or 20, further comprising a compressed air device configured to provide the compressed air to the inlet.

22. The kit of parts according to claim 21, wherein the compressed air device is a pump. ✓½

23. A method for protecting an optical device from contamination, comprising:

connecting the apparatus according to any of claims 1 to 18 to a compressed air device;

inserting an optical device into the apparatus; and

providing the compressed air to the inlet by the compressed air device.

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Claims 28

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Abstract

An apparatus for protecting an optical device and kit of parts and method for the same.

Provided herein is an apparatus for protecting an optical device from contamination. In particular the apparatus may protect a camera lens from contamination such as dust which would otherwise occlude the imaging sensor of the camera. The apparatus comprises a box (43) configured to at least partially surround the optical device (40), the box comprising, an inlet (44) for receiving compressed gas (46); an outlet (47) for expelling the compressed gas; and a channel (47) between the inlet and the outlet for carrying contaminants away from the optical device. Also provided herein is a kit of parts comprising the apparatus and a method for using the apparatus.

[Figure 4]

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✓3

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Abstract

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Document B (Unannotated drawings)

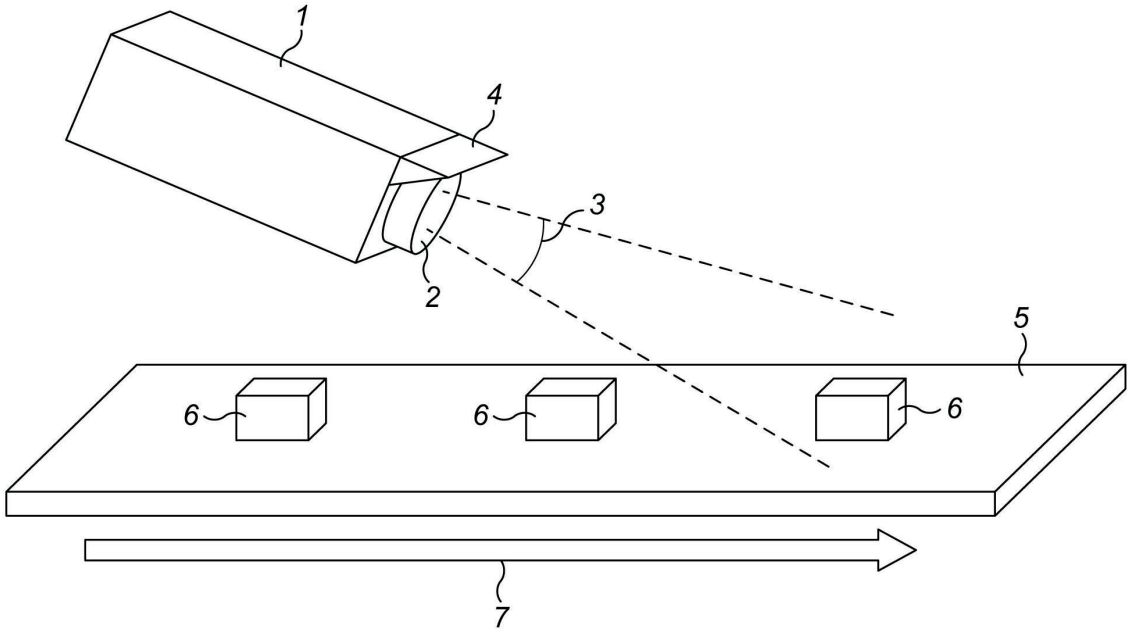

FIG. 1
(Prior Art)

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Document B (Unannotated drawings)

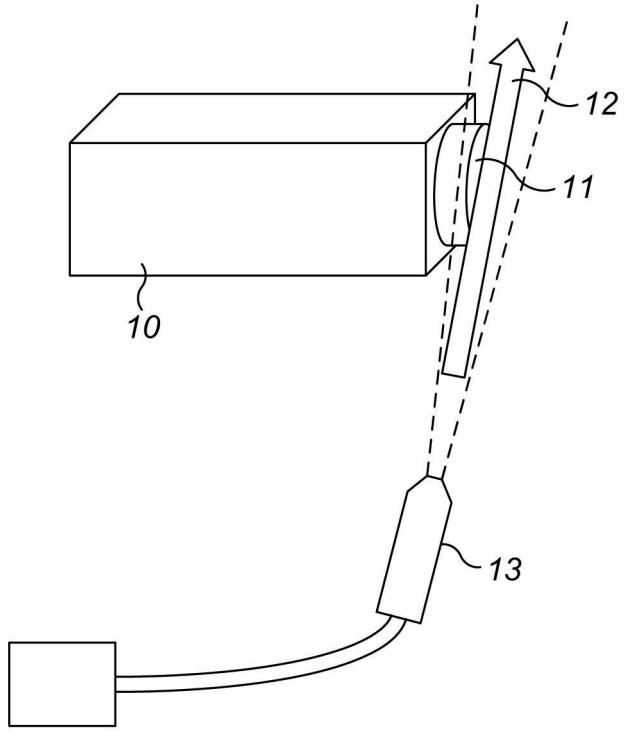

FIG. 2
(Prior Art)

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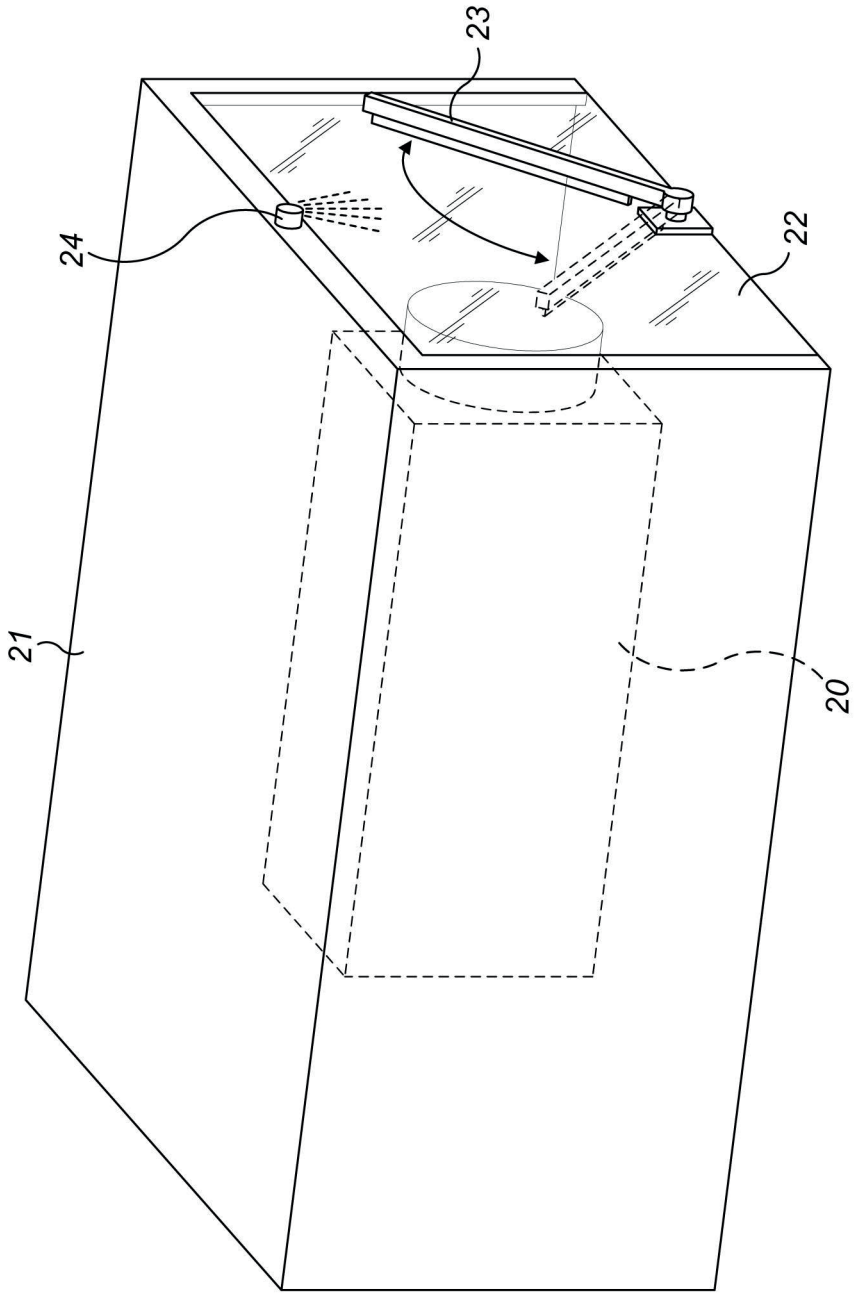

FIG. 3 (Prior Art)

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Document B (Unannotated drawings)

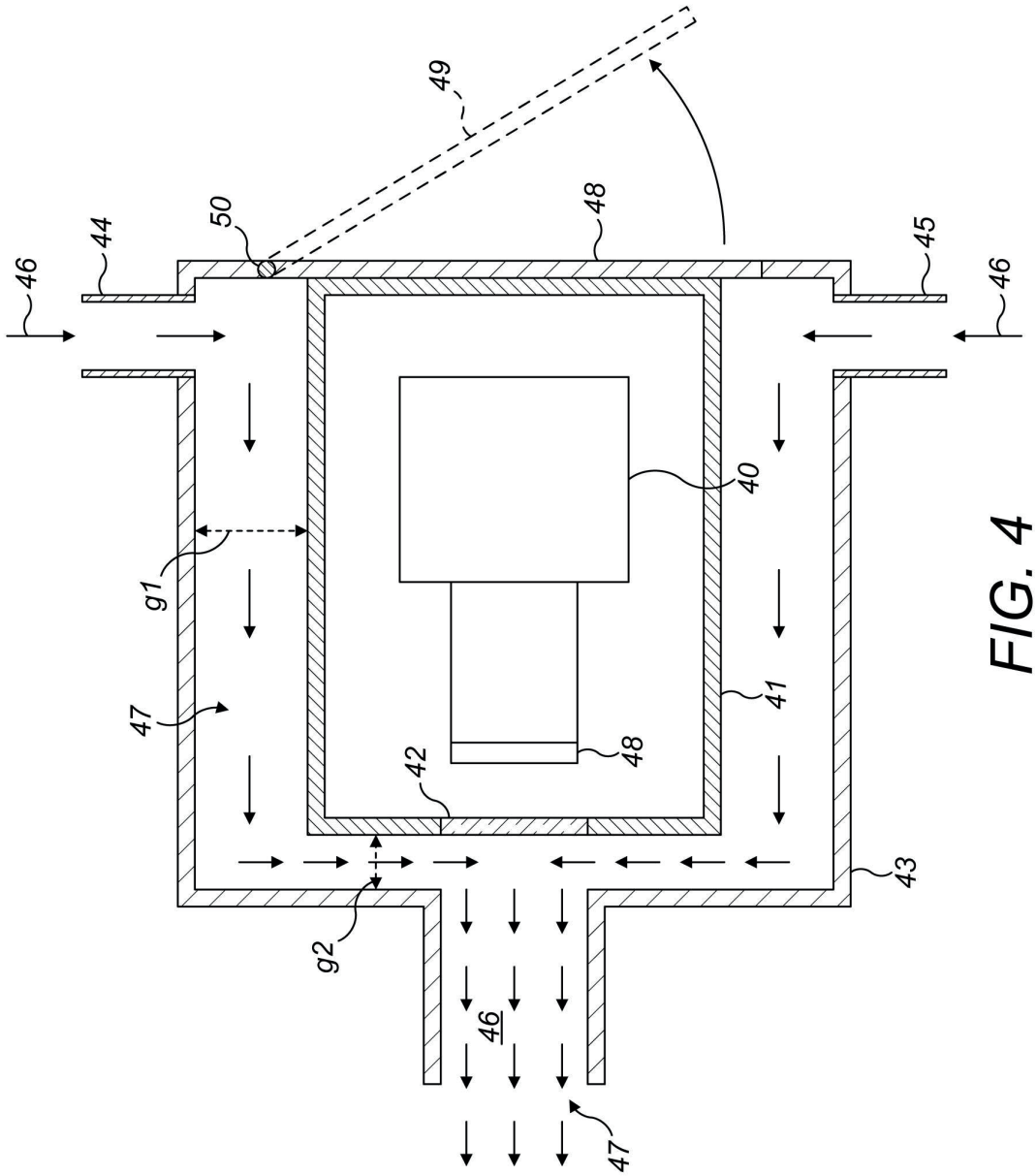

FIG. 4

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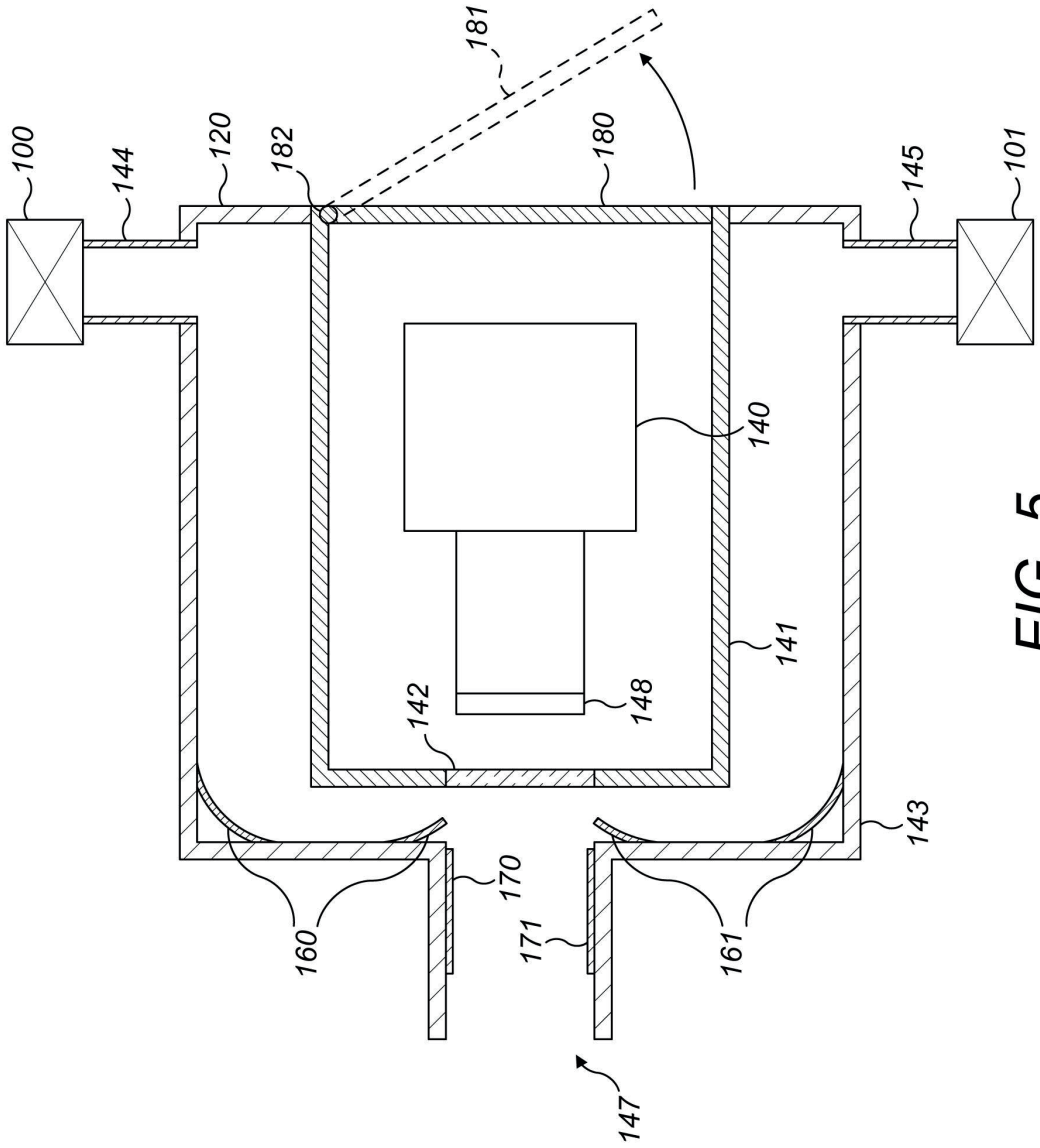

FIG. 5

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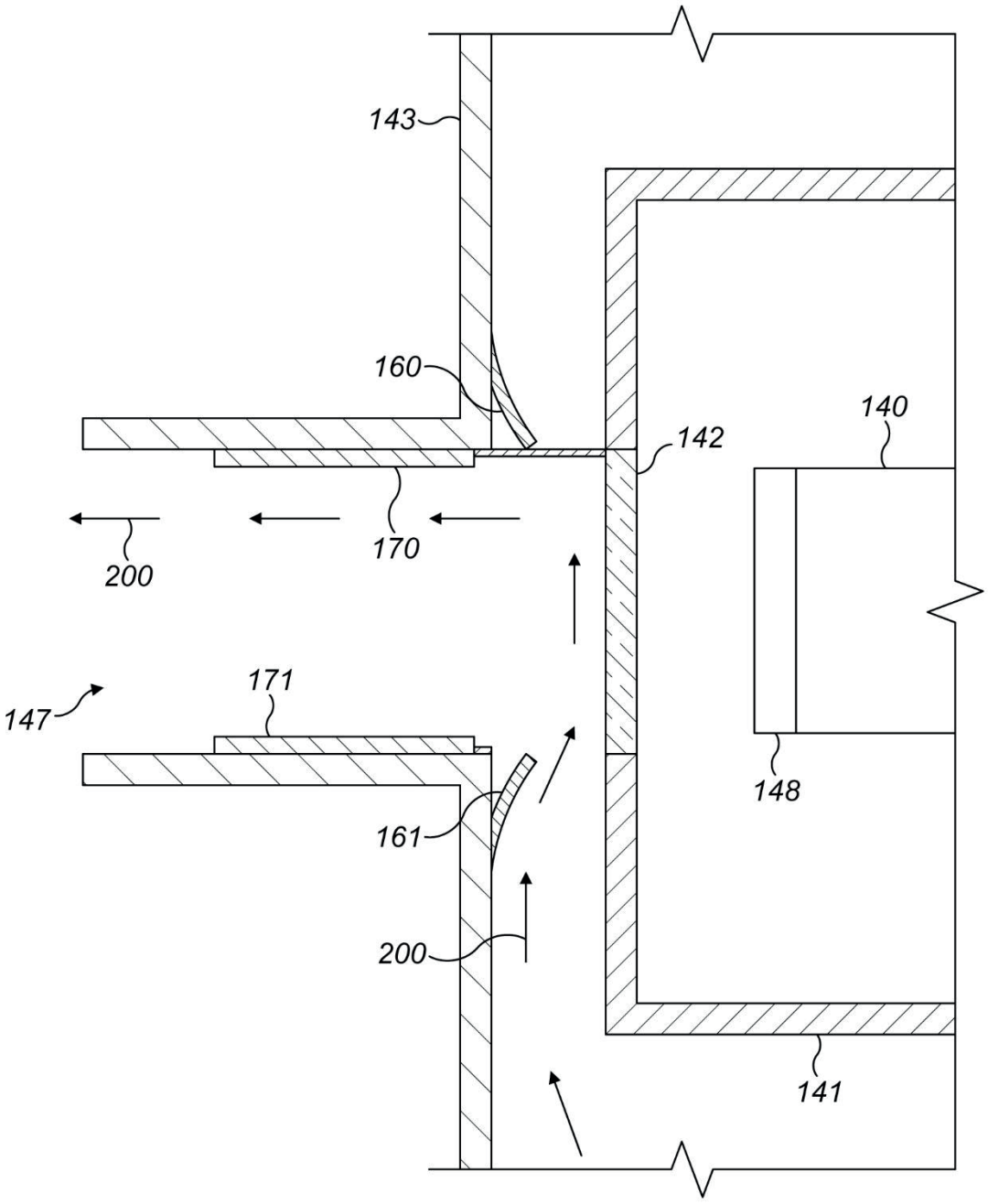

FIG. 6

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