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(54) **AIR COOLED HORTICULTURE LIGHTING
FIXTURE FOR A DOUBLE ENDED HIGH
PRESSURE SODIUM LAMP**

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See application file for complete search history.

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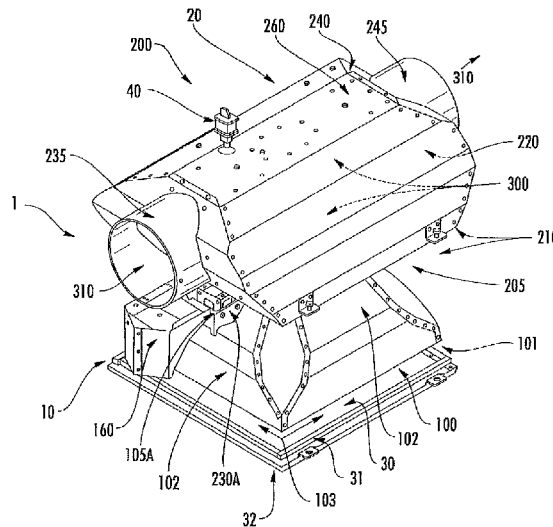
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(57) **ABSTRACT**

An air cooled double ended high pressure sodium lamp fixture for growing plants in confined indoor spaces. The fixture seals the lamp and heat generated by the same to a reflector interior. Flow disruptors create turbulence in a cooling chamber thereby enhancing thermal transfer into a cooling air stream that flows over and around the reflector's exterior side thereby convectively cooling the lamp using the reflector as a heat sink. The lamp is effectively maintained at operational temperatures and the fixture housing is insulated from the hotter reflector by a gap of moving cooling air, allowing use of the double ended HPS lamp in confined indoor growing spaces.

8 Claims, 6 Drawing Sheets



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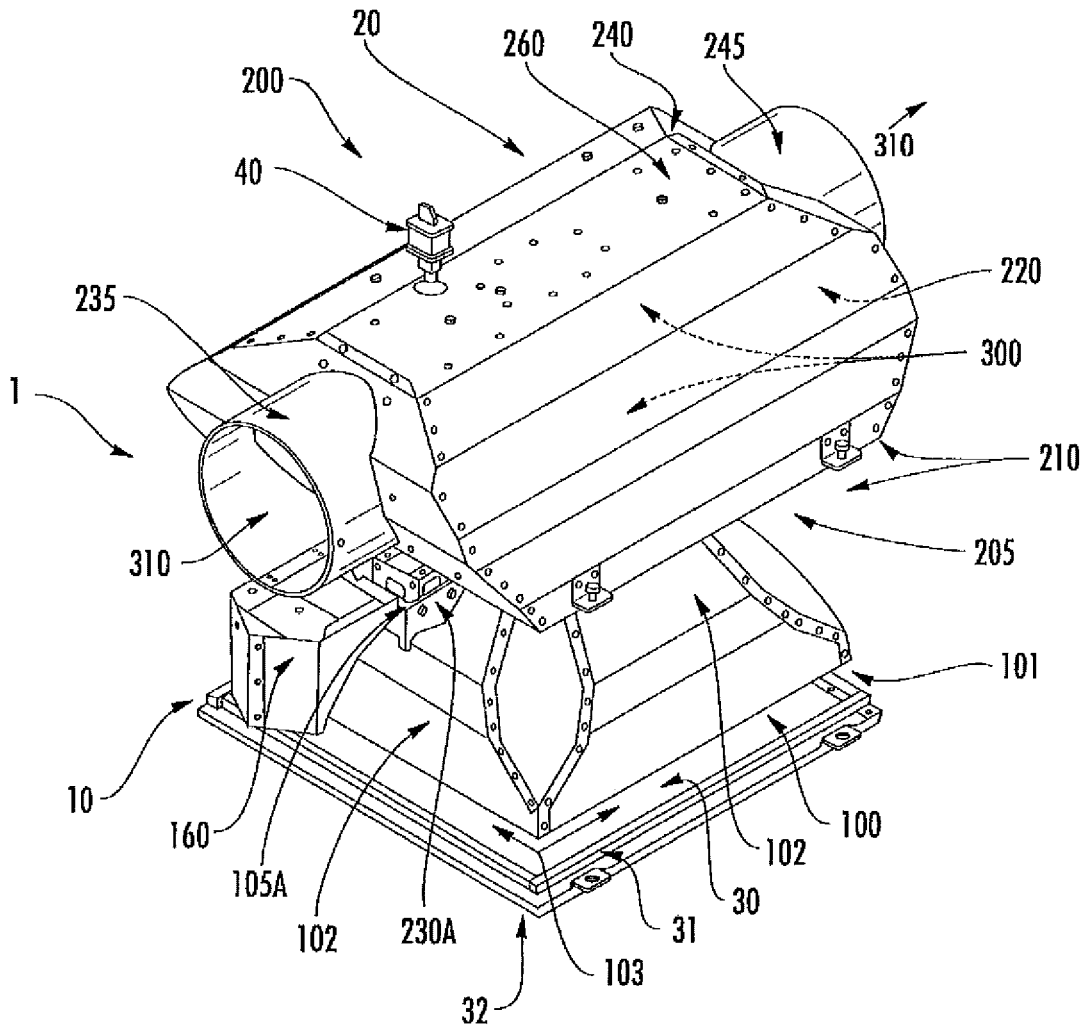


FIG. 1

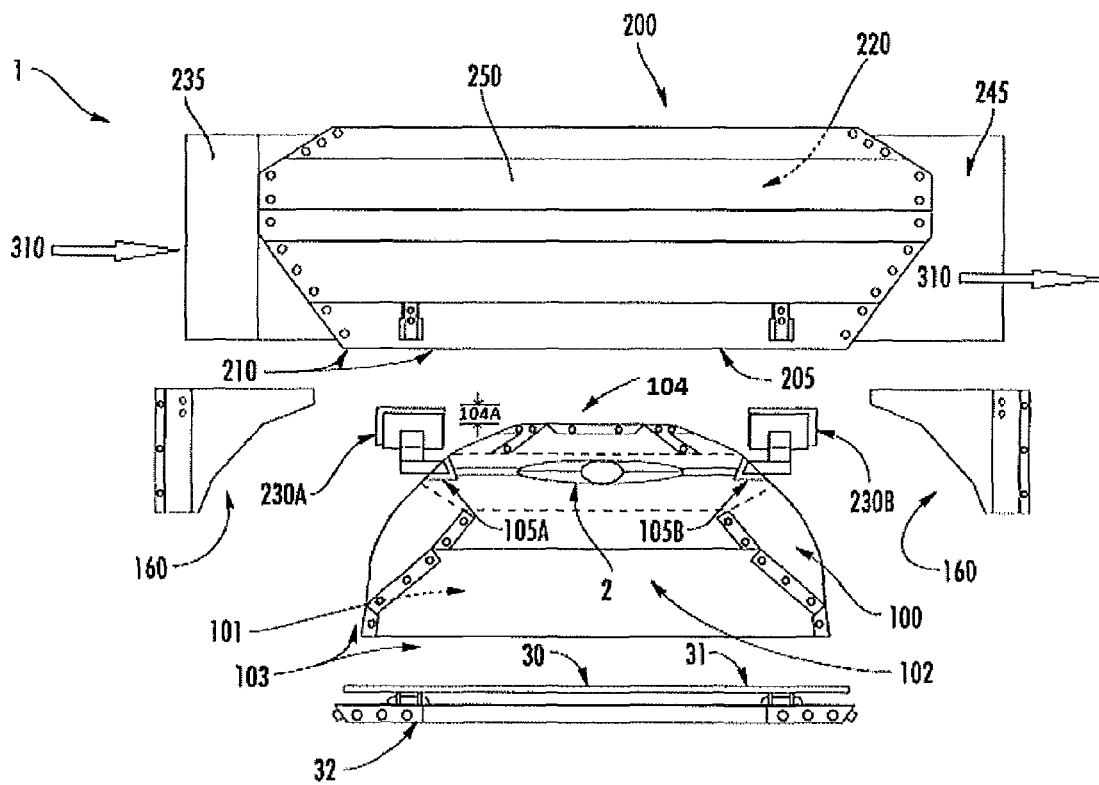


FIG. 2

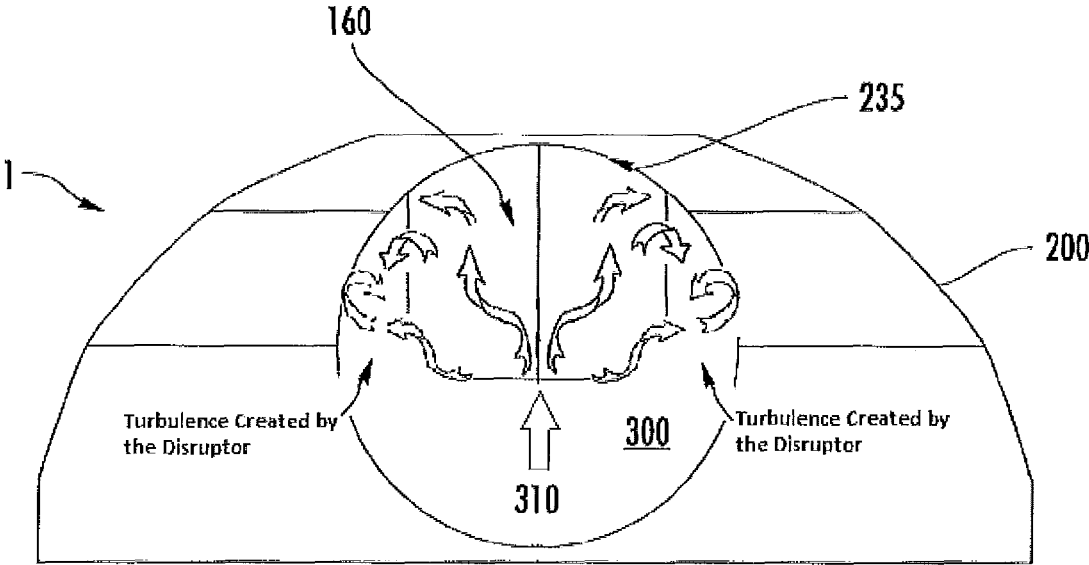


FIG. 3

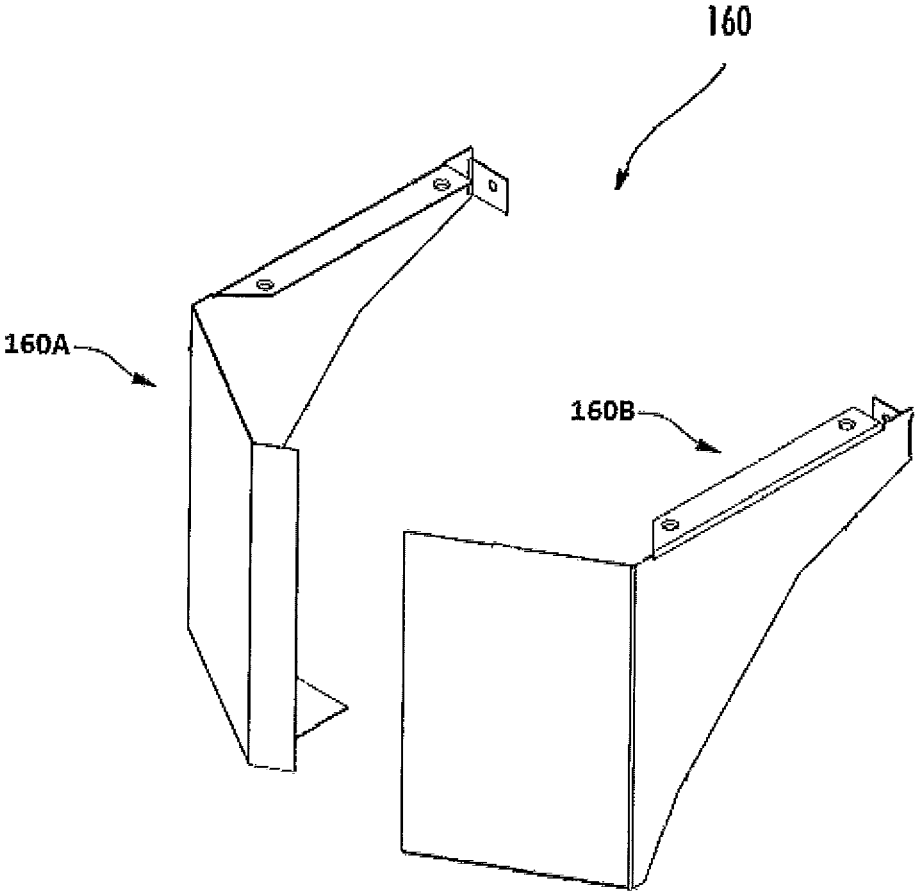


FIG. 3 A

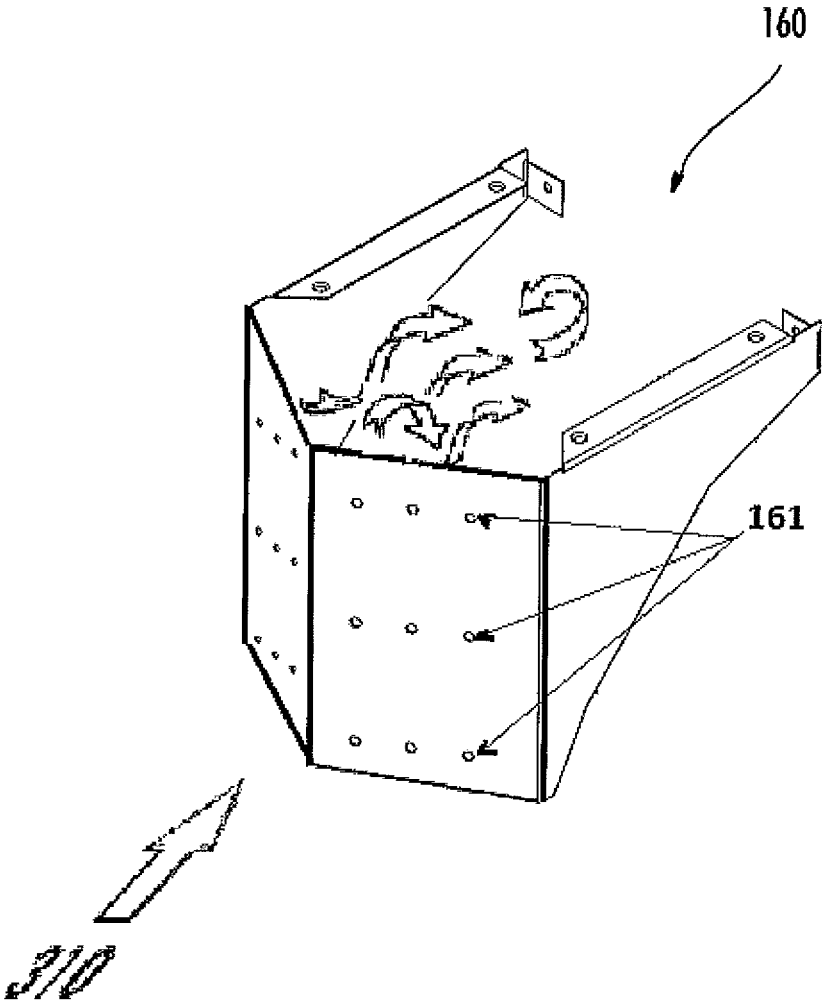
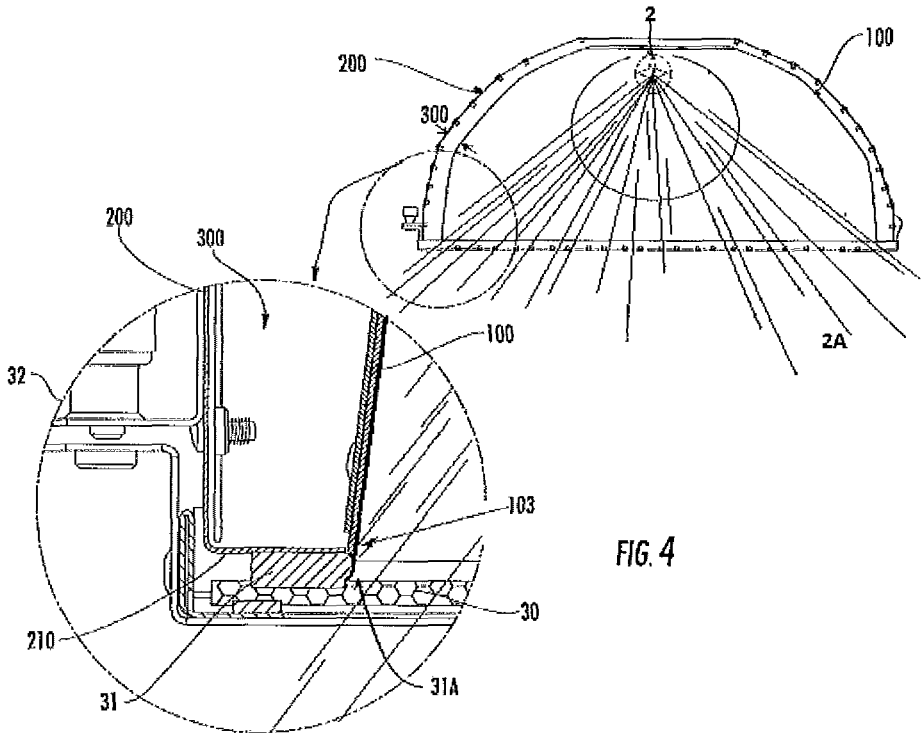


FIG. 3 B



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AIR COOLED HORTICULTURE LIGHTING FIXTURE FOR A DOUBLE ENDED HIGH PRESSURE SODIUM LAMP

RELATED APPLICATIONS

N/A

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

This invention relates generally to horticulture light fixtures for growing plants indoors, and particularly to an air cooled fixture used in confined indoor growing spaces that burns a double ended high pressure sodium lamp.

2. Description of Related and Prior Art

Horticulture light fixtures used for growing plants in confined indoor spaces must provide adequate light to grow plants, while not excessively raising the temperature of the growing environment. Removal of the heat generated by the fixture is commonly achieved by forcing cooling air around the lamp and through the fixture, exhausting the same out of the growing environment. The air used for cooling the fixture is not mixed with the growing atmosphere, as the growing atmosphere is specially controlled and often enhanced with Carbon Dioxide to aid in plant development and health.

Innovations in electronic ballast technology made feasible for use in the indoor garden industry an improved high pressure sodium 'HPS' grow lamp that is connected to power at each end of the lamp, thus the term "Double Ended". The double ended lamp as powered from each end is also supported by sockets at each end, thereby eliminating the need for a frame support wire inside the lamp as required in standard single ended HPS lamps. The absence of frame wire eliminates shadows that commonly plague single ended HPS lamps. The double ended lamp further benefits from a smaller arc tube that is gas filled rather than vacuum encapsulated. The smaller arc tube equates to a smaller point source of light, thereby improving light projection control and photometric performance. The double ended HPS lamp proves to be more efficient than its single ended HPS lamp equivalent, last longer than like wattage HPS lamps, and produces more light in beneficial wavelength for growing plants than any single ended HPS lamps of the same light output rating.

The double ended HPS lamp, with all of its light output performance advantages, has a significant particularity in operation, specifically when cooling the lamp. Operating temperatures at the lamp envelope surface must be maintained within a narrow operating range else the double ended HPS lamp's efficiencies in electrical power conversion into light energy are significantly reduced. When impacted by moving air, the double ended HPS lamp draws excessive electrical current which may cause failure or shutdown of the ballast powering the lamp. When bounded by stagnant air held at constant operating temperature the double ended HPS lamp proves more efficient in converting electricity to light energy and produces more light in the plant usable spectrum. This particularity in the double ended HPS lamp makes it an excellent grow lamp, but also thwarted earlier attempts to enclose, seal, and air cool the double ended HPS lamp to be used in confined indoor growing application due to the lamp's substantial sensitivity to moving cooling air.

Another challenges not resolved by the prior art involves sealing the glass sheet to the bottom of the fixture. The reflector interior temperatures when burning a double ended HPS lamp cause failures of gasket materials. Further, the ultraviolet and infrared light energies produced by the double ended

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HPS lamp degrade and make brittle rubber, neoprene, and most other gasket materials suitable for sealing the glass sheet.

Gavita, a lighting company from Holland produces various fixtures utilizing the double ended HPS lamp. The usual configuration includes a reflector with a spine, the spine having a socket on each opposing end such that the double ended lamp is suspended under a reflector over the plants. The reflector is not sealed from the growing environment, nor is there a housing enclosure or ducts to facilitate forced air cooling. The Gavita fixtures provide the benefit of the high performing double ended HPS lamp, but lacks air cooling capability which is necessary in many indoor growing applications as discussed above.

Based on the foregoing, it is respectfully submitted that the prior art does not teach nor suggest an air cooled horticulture fixture for a double ended HPS lamp suitable for growing plants in confined indoor growing spaces.

SUMMARY OF THE INVENTION

In view of the foregoing, one object of the present invention is to provide an air cooled double ended HPS lamp fixture for growing plants in confined indoor environments.

A further object of this invention is to provide a fixture construct wherein the excessive heat generated by the lamp is removed using a stream of forced air.

It is another object of the present invention to provide a stagnant air space around the lamp that is maintained at constant temperatures within the reflector during operation to prevent the lamp from drawing excessive current when subjected to temperatures differentials, or direct moving cooling air

Another object of the present invention is to provide a positive air tight seal between the fixture and the growing environment using a gasket that is protected from the lamp's damaging light.

This invention further features turbulence enhancement of the cooling air stream by a diverter that disrupts the air stream creating eddies over the top of the reflector.

Other objects, advantages, and features of this invention will become apparent from the following detailed description of the invention when contemplated with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Elements in the figures have not necessarily been drawn to scale in order to enhance their clarity and improve understanding of these various elements and embodiments of the invention. Furthermore, elements that are known to be common and well understood to those in the industry such as electrical power connection are not necessarily depicted in order to provide a clear view of the various embodiments of the invention, thus the drawings are generalized in form in the interest of clarity and conciseness.

FIG. 1 shows an isometric exploded view of the preferred embodiment of the inventive fixture;

FIG. 2 is a cutaway exploded side view of the fixture in FIG. 1;

FIG. 3 is a diagrammatically section end view of the fixture in FIG. 1;

FIG. 3A is a perspective exploded view of the flow disruptor in FIG. 1;

FIG. 3B is a perspective exploded view of the flow disruptor in FIG. 3A further including turbulators;

FIG. 4 is a cutaway corner of the fixture in FIG. 1 showing the compressively deformed shadowed gasket;

DETAILED DESCRIPTION OF THE DRAWINGS

As depicted and shown in the FIGs, a “heat sink” is a component used for absorbing, transferring, or dissipating heat from a system. Here, the reflector 100 acts as the “heat sink” for the lamp 2 which is isolated from the cooling air stream 310 within the reflector interior side 101. The reflector 100 convectively transfers heat generated by the lamp 2 into the cooling air stream 310. “Convectively transfers” refers to the transport of heat by a moving fluid which is in contact with a heated component. Here, the fluid is air, specifically the cooling air stream 310 and the heated component is the reflector 100. Due to the special prerequisite criteria that the double ended high pressure sodium (HPS) lamp 2 be isolated from moving air, and specifically the cooling air stream 310, the heat transfer is performed convectively from the reflector exterior side 102 to the cooling air stream 310. The rate at which the heat transfer can convectively occur depends on the capacity of the replenish able fluid (i.e. cooling air stream 310) to absorb the heat energy via intimate contact with the relatively high temperature at the reflector exterior surface 102. This relationship is expressed by the equation $q=hA\Delta T$, wherein, “h” is the fluid convection coefficient that is derived from the fluid’s variables including composition, temperature, velocity and turbulence. “Turbulence” referring to a chaotic flow regime wherein the fluid/air undergoes irregular changes in magnitude and direction, swirling and flowing in eddies. “Laminar” flow referring to a smooth streamlined flow or regular parallel patterns, generally having a boundary layer of air against the surface over which the laminar flow moves. When cooling with a heat sink device within a cooling medium such as air, turbulent flow proves more effective in transferring heat energy from the heat sink into the flowing air. Turbulent flow acts to scrub away the boundary layer or push away the stagnant layer of air that is closest to the heat sink, thereby enhancing the fluid convection coefficient increasing heat transfer. Turbulent flow also increases velocities and pressures on the surface to be cooled, increasing thermal transfer. The term “Turbulator” as referenced herein is a device that enhances disruption of a laminar flow into a more turbulent flow.

Referring now to FIG. 1-2, the preferred embodiment of the fixture comprises a reflector 100 captured within a housing 200 defining a cooling chamber 300 within the air space located between the reflector exterior side 102 and housing interior 220, the cooling chamber 300 being in air communication with a first duct and second duct. A cooling air stream 310 is disposed through the cooling chamber 300 between the first duct 235 and the second duct 245. Two lamp sockets 230A-B located partially through two opposing reflector apertures 105A-B provide the install location for the double ended HPS lamp within the reflector interior side 101. A flow disruptor 160 fixates over each socket 230A-B and aperture 105A-B diverting moving air from entering the reflector interior side 101 while further creating air eddies and local air turbulence within the cooling chamber 300 between the sockets over the reflector top 104 at the reflector’s 100 hottest spot, substantially above the lamp 2. The flow disruptor 160 interference with the cooling air stream 310 creates air eddies, increases local vortex velocities within the cooling chamber 300, scrubs away boundary layers of air proximal to the reflector exterior side 102 that reduce heat transfer, thereby enhancing convective heat transfer from the reflector 100 into the cooling air stream 310.

With reference to FIG. 1 and FIG. 2, the fixture 1 includes a housing 200, a reflector 100 captured within the housing 200, a cooling chamber 300 defined by the air space between the housing 200 interior and the reflector exterior side 102. The cooling chamber 300 being in air communication with a first duct 235 and second duct 245, located substantially on opposite sides of the housing 200. Between the first duct 235 and the second duct 245 flows the cooling air stream 310 through the cooling chamber 300, the cooling air stream 310 which is pushed or pulled by remote fan not shown but commonly used in the prior art, connected by hose or ducting to the first duct 235.

Before flowing over the reflector top 104, the cooling air stream 310 is split or deflected by the flow disruptor 160 enhancing turbulent flow thereby increasing thermal transfer from the reflector interior side 101, through the reflector 100, convectively transferring from the reflector exterior side 102 into the cooling air stream 310. The hottest area of the reflector 100 is the reflector top 104 directly above the lamp 2, which is the closest structure to the light source. As captured within the housing 200, the reflector 100 has a reflector top air gap 104A defined between the reflector top 104 and the housing interior 220. The reflector top 104 air gap 104A for the preferred embodiment using a 1000 watt double ended HPS lamp is $\frac{3}{8}$ of an inch, which provides ample cooling chamber 300 space for turbulent air movement as between the reflector top 104 and the housing interior 220 facilitating adequate cooling while maintaining an acceptably air insulated housing 200 exterior temperature.

By cutaway illustration with dashed lines in FIG. 2, the lamp 2 is shown installed by its ends into the sockets 230A-B within the reflector interior side 101 near the reflector top 104. The lamp 2 is shown oriented parallel to the cooling air stream 310, however, the robust design allows for the lamp 2 to be oriented within the reflector 100 at any diverging angle relative to the cooling air stream 310.

As shown diagrammatically by sectioned view in FIG. 3, cooling air directions being depicted by arrows illustrates the cooling air stream 310 as impacted by the flow disruptor 160. In operation, the cooling air stream 310 is being forced to move with a fan (not shown) either by fan push or fan pull through the first duct 235, then into and through the cooling chamber 300 to be exhausted out the second duct 245. The cooling air stream 310 is diverted and split by a flow disruptor 160 directing part of the air over one side of the reflector exterior 102, the other part over the other side of the reflector exterior 102. The diverted cooling air stream 310 is redirected within the fixture 1 such that moving air is discouraged from pressuring any apertures, gaps, or through holes in the reflector 100.

As depicted in FIG. 3 and shown in FIG. 3A, the flow disruptor 160 constructed to be deflecting and disrupting to moving air and arranged to attach over at least one socket 230 and enclose at least one aperture 105 such that cooling air moving through the cooling chamber 300 is diverted and disrupted into a more turbulent flow than a laminar flow regime. The preferred embodiment locates the flow disruptor 160 to encourage deflection of moving air away from the sockets 230 and aperture 105 as discussed above, essentially fulfilling two functions, creating turbulence within the cooling chamber 300 while also redirecting moving air away from reflector areas 100 that may be subject to leaks. The flow disruptor 160 location is not limited to enclosing the sockets 230 or apertures 105, as a flow disruptor 160 located within the first duct 235 or second annular duct 245, depending on which receives the incoming cooling air stream 310, is effective at introducing turbulence into the cooling air stream 310,

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and depending on which configuration may be preferred. Additional flow disruptors **160** working independently or in cooperation may be included within the cooling chamber **300** mounted to the reflector **100** or the housing **200**.

The preferred embodiment design of the flow disruptor **160** shown in FIG. **3A** is simply constructed from a first sheet metal portion **160A** and a second sheet metal portion **160B**, the preferred metal being steel over aluminum, as the thermal conductivity of the flow disruptor **160** is not as important as the costs associated with manufacture, but in practice both metals are suitable. As shown in FIG. **3A**, the flow disruptor **160** is impervious to moving air to facilitate the dual function of deflecting moving air away from the reflector apertures **105** while also creating turbulence within the cooling chamber **300**.

As shown in FIG. **1B**, an enhanced flow disruptor **160** having turbulators **161** illustratively depicted as rows of through holes. The turbulators **161** could also be fins, blades, vents, or grating, most any disrupting structure, redirecting channel, or obstacle for the cooling air stream **310** will cause turbulence and thereby increase thermal conductivity from the reflector **100** into the cooling air stream **310**.

As discussed above, the reflector **100** is a thermally conductive component of the fixture acting as a heat sink for the lamp **2**. The reflector **100** preferably is constructed from aluminum, which is the favored material because of its relatively high thermal conductivity, easily shaped and formed, and highly reflective when polished. The high thermal conductivity of aluminum provides beneficial heat transfer between the reflector interior side **101** to the reflector exterior side **102** thermally transferring or heat sinking through the reflector **100**. Steel is also a suitable material, however the lower thermal conductivity makes aluminum the preferred reflector **100** material.

As shown in the FIGs, openings, gaps, or spaces through the reflector **100** are filled, blocked, or covered such that the reflector interior side **101** is sealed from moving air. As assembled and captured within the housing **200**, a first socket **230A** is disposed to fill a reflector **100** first aperture **105A** sealing the first aperture **105A** from moving air. A second socket **230B** is disposed to fill the second aperture **105B** sealing the second aperture **105B** against moving air. The first socket **230A** and second socket **230B** constructed and arranged to cooperatively receive the ends of the double ended HPS lamp **2** as located within the reflector interior side **101** between the two sockets **230A-B**. As shown from the side in FIG. **2** and by depiction in FIG. **3**, flow disruptors **160** attach over the sockets **230A-B** and over both apertures **105A-B** within the path of the cooling air stream **310**. In this way, the flow disruptors **160** enclose any opening or space between either socket **230A-B** and aperture **105A-B** respectively, thereby diverting air moving through the cooling chamber **300** away from any potential opening into the reflector interior side **101**. Filling of each aperture **105A-B** by partial insert of each socket **230A-B** requires precise manufacturing tolerances or specially formed sockets **230** in order to prevent or substantially stop moving air from traveling around the socket **230** into the reflector interior side **101**. Heat resistant sealing mediums like metal tape or high temp calk are available to positively seal the aperture **105** to the socket **230** thereby diverting the cooling air path **310** from entering the reflector interior side **101**. However, high temperature sealing mediums tend to be expensive, and application of the sealing medium as performed manually is often messy, slow, and leaves one more step in the manufacturing process subject to human error. As discussed herein, the preferred embodiment utilizes flow disruptors **160** constructed from

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sheet metal that are impervious to air rather than sealing mediums. However sealing mediums if properly applied will work in the place of a flow disruptor **160** for the limited purpose of sealing the reflector interior **101**, but lack the aerodynamic structure necessary to disturb the cooling air stream **310** creating turbulence between the first socket **230A** and second socket **230B** for enhanced convective transfer of heat from the reflector **100** into the cooling air stream **310**.

In FIG. **4** a sectional view with a close up of the bottom corner of the fixture **1** showing by illustration the cooling chamber **300** as defined between the reflector **100** and the housing **200**. The cooling chamber **300** is shown in cross section demonstrating from top to bottom the relative size of air space between the reflector **100** and the housing **200** for the preferred embodiment. As shown, there is only one continuous cooling chamber **300**, however several smaller cooling chambers **300** split by disruptors **160** or mounting fins between the housing interior **220** and the reflector **100** provide greater control of the movement of the cooling air stream **310** through the fixture **1**.

The lower left close up view shown in FIG. **4** of the bottom corner of the fixture **1** demonstrates the lower lip **103** of the reflector **100** location as captured within the housing **200**, wherein the lower lip **103** is adjacent to and slightly extending below the housing lower edge **210**. As captured, the reflector's **100** lower lip **103** and housing lower edge **210** thermally transfer heat energy. This heat sinking occurring between the reflector's **100** hotter lower lip **103** and the housing **200** cooler lower edge **210** makes the lower lip **103** the coolest part of the reflector **100**, making for the most suitable place to seal the reflector **100** using a gasket **31**. A specially formed reflector lip **103** protectively shadows the gasket **31** from damaging light energy produced by the double ended HPS lamp **2** thereby preventing premature failure of the gasket **31** during operation. As compressed, the gasket seals against the housing edge surface slightly deforming **31A** to further seal against the reflector lip **103**. In this way, a double redundant seal is provided between the fixture interior and the growing environment, while also providing a positive air tight seal between the cooling chamber **300** and the reflector interior side **101** that is not as susceptible to premature seal failure.

As shown in FIG. **4**, the compressive sealing between the glass sheet **30** and the housing edge **210** with a gasket **31** sandwiched in between thereby seals the growing environment from the fixture interior. The gasket **31** being located relative to the reflector **100** such that the reflector lower lip **103** shadows or blocks direct light **2A** produced by the lamp from impacting the gasket **31**. As shown, the glass sheet **30** is held in place compressively by at least one latch **32** with enough compressive force to deform the gasket **31**. The deformed gasket **31A** sealingly contacts the lower lip **103** making a second redundant seal against the coolest part of the reflector **100** at the lower lip **103** which is shadowed and protected from the direct light energy produced by the lamp **2**. For the preferred embodiment the gasket **31** is constructed of a porous neoprene material, however many suitable heat resistant gasket materials may be used to construct the gasket **31**.

The inventive fixture as shown may have the cooling air pushed or pulled through the cooling chamber **300** by fan or other forced air apparatus. The robust fixture **1** cools effectively with either a negative pressure or positive pressure within the housing **200** due to the isolated reflector **100** interior side **101**. Two fans used in cooperation may be implemented without diverging from the disclosed embodiment, and linking fixtures together along one cooling system is also feasible, similar to current 'daisy chaining' configurations.

The foregoing detailed description has been presented for purposes of illustration. To improve understanding while increasing clarity in disclosure, not all of the electrical power connection or mechanical components of the air cooled horticulture light fixture were included, and the invention is presented with components and elements most necessary to the understanding of the inventive apparatus. The intentionally omitted components or elements may assume any number of known forms from which one of normal skill in the art having knowledge of the information disclosed herein will readily realize. It is understood that certain forms of the invention have been illustrated and described, but the invention is not limited thereto excepting the limitations included in the following claims and allowable functional equivalents thereof.

I claim:

1. An air cooled double ended high pressure sodium (HPS) lamp fixture **1** for growing plants in confined indoor growing spaces, comprising:

a housing **200** having an open bottom **205** circumscribed by a housing edge **210**, a first duct **235** being substantially aligned to a second duct **245**, and a housing interior **220**;

a reflector **100** captured within the housing interior **220**, the reflector **100** having a first aperture **105A** located in opposition to a second aperture **105B**, a reflector interior side **101**, a reflector exterior side **102**, a reflector top **104**, and an open bottom **106** circumscribed by a reflector lip **103**, the reflector lip **103** located adjacent to the housing edge **210** defining at least one cooling chamber **300** in the space between the reflector exterior side **102** and the housing interior **220**, the cooling chamber **300** being in air communication with the first duct **235** and the second duct **245**;

a first socket **230A** disposed to sealingly fill the first aperture **105A**, a second socket **230B** disposed to sealingly fill the second aperture **105B**, the first socket **230A** and second socket **230B** constructed and arranged to cooperatively receive the ends of the double ended HPS lamp **2** as located within the reflector interior side **101**;

a cooling air stream **310** disposed through the cooling chamber **300** between the first duct **235** and the second duct **245**;

a glass sheet **30** and gasket **31** disposed at least proximate to the reflector lip **103** to seal the reflector interior side **101** from the confined growing space;

at least one flow disruptor **160** disposed within the cooling air stream **310**, the flow disruptor **160** being constructed and arranged to disturb laminar flow of the cooling air stream **310** creating local turbulence within the cooling chamber **300** whereby enhancing convective heat transfer from the reflector **100** into the cooling air stream **310**.

2. An air cooled double ended high pressure sodium (HPS) lamp fixture **1** for growing plants in confined indoor growing spaces, comprising:

a housing **200** having an open bottom **205** circumscribed by a housing edge **210**, a first duct **235** being substantially aligned to a second duct **245**, and a housing interior **220**;

a reflector **100** captured within the housing interior **220**, the reflector **100** having a first aperture **105A** located in opposition to a second aperture **105B**, a reflector interior side **101**, a reflector exterior side **102**, a reflector top **104**, and an open bottom **106** circumscribed by a reflector lip

103, the reflector lip **103** located adjacent to the housing edge **210** defining at least one cooling chamber **300** in the space between the reflector exterior side **102** and the housing interior **220**, the cooling chamber **300** being in air communication with the first duct **235** and the second duct **245**;

a first socket **230A** disposed to fill the first aperture **105A**, a second socket **230B** disposed to fill the second aperture **105B**, the first socket **230A** and second socket **230B** constructed and arranged to cooperatively receive the ends of the double ended HPS lamp **2** as located within the reflector interior side **101**;

a cooling air stream **310** disposed through the cooling chamber **300** flowing from the first duct **235** to the second duct **245**;

a glass sheet **30** and gasket **31** disposed at least proximate to the reflector lip **103** to seal the reflector interior side **101** from the confined growing space;

at least one flow disruptor **160** enclosing the first socket **230A** and first aperture **105A**, the flow disruptor **160** being constructed and arranged to deflect the cooling air stream **310** from passing through the first aperture **105A** creating local turbulence within the cooling chamber **300** whereby enhancing convective heat transfer from the reflector **100** into the cooling air stream **310**.

3. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, wherein the flow disruptor **160** includes at least one flow turbulator **161**, the flow turbulator **161** being operable to receive a portion of the cooling air stream **310** and eject the same in turbulent flow.

4. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, further comprising a sealing element arranged to stop moving air from passing around a socket **230** through an aperture **105** into the reflector interior side **101**.

5. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, wherein the reflector lip **103** is located adjacent to and in substantial contact with the housing edge **210** such that heat is conductively transferred from the reflector lip **103** to the housing edge **210** thereby reducing gasket **31** temperatures.

6. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, wherein a gasket **31** located in the shadow of the reflector lip **103** compressively deforms between the glass sheet **30** and the housing edge **210** such that the gasket **31** makes a first air tight seal between the housing edge **210** and the glass sheet **30**, and a second air tight seal between to the reflector lower lip **103** and the glass sheet **30**, thereby making two air tight seals between the growing environment and the reflector interior side **101**.

7. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, wherein a gasket **31** located in the shadow of the reflector lip **103** compressively deforms between the glass sheet **30** and the housing edge **210** such that the gasket **31** makes an air tight seal between the housing edge **210** and the reflector lower lip **103**, thereby creating an air tight seal between the reflector interior side **101** and the cooling chamber **300**.

8. An air cooled horticulture fixture for growing plants in confined indoor spaces according to claim **1** or **2**, wherein the cooling air chamber **300** has a minimum air gap **104A** over the double ended HPS lamp of at least $\frac{3}{8}$ of an inch.