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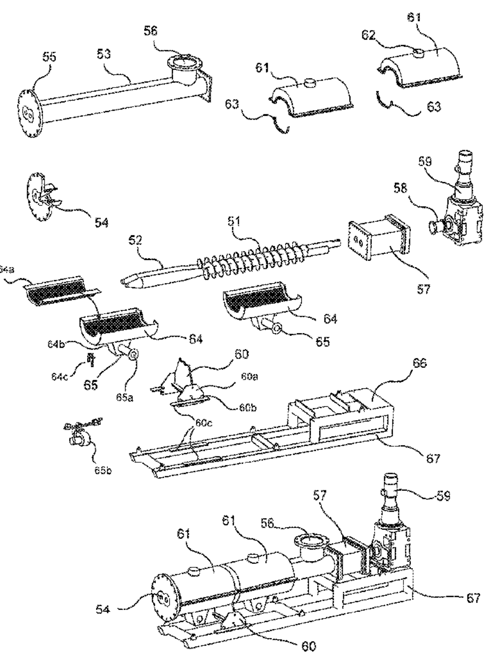

FIG 4

(57) **Abstract:** A Heated Airlock Feeder is disclosed. Heated Airlock Feeder allows for the continuous feeding of solid, shredded plastic into a reactor tube surrounded by clamshell burner boxes. Inside of the reactor tube, two augers, one with right hand flights and one with left hand flights are welded to smooth augers to create two continuous augers that push solid plastic material, liquid plastic material and molten plastic material through two small holes. As the plastic is in its molten state while being forced through the two small holes, an airlock is formed preventing air form entering the system. As the solid, shredded plastic is fed into the system, an airlock is formed allowing for the continuous feeding of the system. The clamshell burner boxes allow for convection and radiant heat allowing for even, continuous heat.

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HEATED AIRLOCK FEEDER UNIT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention improves on extruder technology as it allows for the continuous feeding of the reactor while using much less power, thus increasing efficiency and lowering the cost of production for the fuel product. This application relates to an apparatus that is part of a reuseable fuel processing unit. This apparatus allows for the continuous feeding of plastic into the unit since the apparatus described herein creates a process by which heat is tolerated in an anaerobic environment, atmospheric pressure does not leak in and out of the apparatus, air does not leak into the apparatus, and plastic in solid and heated liquid form does not cause problems within the apparatus downstream from the feeder.

Discussion of Known Art

The use of feeder airlock systems in re-useable energy apparatus is known. Examples of known devices include U.S. patent No. 5, 762,666 to Amrein et. al, U.S. patent No. 3, 151, 784 to Tailor, and U.S. patent No. 3, 129,459 to Kullgren et. al. These patents teach airlocks with side gates (Amrein et. al.), a rotary feeder to an airlock using vanes (Tailor), and an extruder using electric heat (induction) (Kullgren). The Tailor device teaches a rotary style apparatus in which steel vanes are mounted to a shaft and spin inside a machined round housing. An opening is in the top and bottom of the housing to allow material to flow in and out of the housing. The vanes block the difference pressures between the inlet and outlet. There are four limitations with this design. The first is that it will not tolerate heat as it will expand and allow the pressures to leak. The second is that the vanes act as pockets and also carry the atmosphere from the inlet to the outlet. The third concerns the rotation velocity. The rotation velocity must be slow to allow time for the material to fall out of the discharge or material will be carried back around and prevent refill from the inlet. The forth is that this device will not allow for a molten material like hot plastic.

The Amrein device teaches a feeder airlock system using two valves, with a hopper or pipe between them to allow material fill. Although this design tolerates heat, it allows the atmosphere to enter the feeder from the inlet and pass through to the discharge. This is a limitation as atmospheric gases may not be allowed in some processes as they will cause problems downstream. A second limitation with this device is that it will not allow for a molten material like hot plastic.

The Kullgren device teaches an induction heated extruder. This extruder employs induction heating with the use of electric coils. Limitations with this apparatus are that it does not create an airlock so it does not allow for the continuous feeding of plastic material and it requires a thick long barrel that requires very high horsepower to achieve the internal pressure and heat necessary to melt the plastic, translating into a high power requirement.

SUMMARY

Plastic waste material is shredded and fed into a pyrolysis reactor. Applying heat above 350 degrees Celsius will cause the shredded plastic material to melt and vaporize. The Heated Airlock System is the apparatus in which the shredded plastic material is fed into the pyrolysis reactor. The main components of the heated airlock feeder system are the drive, coupling, gearbox, augers, housing, burner boxes, expansion cart, and support frame. It has been discovered that the prior art did not allow for the continuous feeding of heated plastic into the feeder while maintaining an air lock. Preferred examples of the disclosed invention include:

Existing gear boxes, designed as short as possible to reduce material and labor on fabrication, have limited function with this utility patent application, as the short gear boxes are limited on taking a cantilever load as the force of trying to hold a long heave shaft puts extreme pressure on the leading bearing resulting is reduction of the life of the bearing or requiring a heavy duty bearing to handle the force. If a heavy duty bearing is used, this results in a larger bearing creating large pockets in the gear box housing. The larger pocket reduces the ability of the housing to support the bearing, so in turn the housing will be made thicker. This increases the cost of a standard gear box. This design extends the space between the bearings and reduces load on the bearings. By spacing the bearings further apart, the cantilever load is reduced, the bearing size can be smaller and the housing can be thinner, reducing the overall cost and improving the performance. The further apart the points on connection on the bearings, the straighter the alignment on the shafts, reducing wear and increasing the life of the gear box;

A flat bar attached between the cart and the frame that allows for the apparatus to expand and contract due to heat transfer as this apparatus incorporates thinner material in the reactor allowing for better heat transfer;

Two heater zones, allowing plastic material to be transformed from a solid and shredded state to a liquid state; the solid and shredded plastic material at the start of the feeder and the liquid state at the end of the feeder. Between the shredded solid state and the liquid state exists plastic material in a molten state. The molten plastic material is thick and sticky and allows for the formation of the required pressure to create the airlock necessary to keep air from entering the reactor; and,

The use of vapor gas (natural gas or syn-gas) and clamshell burners allowing for the external heat to be allowed in the processing of the plastic material whereas prior art used electric heater bands and internal pressure, resulting in high power consumption, to produce the heat required to process the plastic material. The use of vapor gas and clamshell burners allows for less power consumption, faster processing time, and more accurate and consistent heat production.

The use of clamshell burners allows heat to be generated over the entire exterior surface of the penetrating pipe and allowing for access to the reactor tube. The use of the clamshell burners allows for a low profile to the interior reactor reducing the amount of space between the heat source and the penetrating pipe surface, increasing the heat transfer without increasing the BTU value required by a burner system. The clamshell design combines both convection heat and radiant heat producing an even heat source around the penetrating pipe. The combining of the two types of heat is accomplished with the use of a perforated screen running the entire length of the penetrating tube and one third of the way up on the bottom inside of the clamshell burners. This design also prevents hotspots that normally occur in burner boxes. Another difference in this system compared to existing systems is that the igniting source is inside the clamshell burner box next to the perforated screen. The system contains flame sensors as well as a fan pressure switch to ensure airflow. Dual gas streams are used by adjusting the gas quantity or the air quantity, whereas existing systems use complicated air control dampers to adjust the air and gas ratio, that may cause uneven burning of the fuel creating irregular flame size. The clamshell design that is part of the Heated Airlock Feeder is not lined with refractory on all surfaces, but only on the top half of the clamshell. The fact that the lower half of the clamshell is not lined with refractory allows any heat build-up to dissipate through the entire box surface. This design also reduces the chance of auto-ignition of the mixed gas.

It should be noted and understood that while the above and other advantages and results of the present invention will become apparent to those skilled in the art from the following detailed description and accompanying drawings, showing the contemplated novel construction, combinations, and elements herein described, and more particularly defined by the appended claims, it should be clearly understood that changes in the precise embodiments of the herein described invention are meant to be included within the scope of the claims, except insofar as they may be precluded by the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate preferred embodiments of the present invention according to the best mode presently devised for making and using the instant invention, and in which:

Figure 1 depicts the entire re-useable energy apparatus which the Heated Airlock Feeder is a part of.

Figure 2 depicts the shaded Heated Airlock Feeder with the remaining part of the re-useable energy apparatus faded.

Figure 3 depicts the augers that are in Heated Airlock Feederthat are also depicted in Figure 4 at 51.

Figure 4 depicts the Heated Airlock Feeder in its completed form and broken down by its parts.

Figure 5 depicts the Char Separating Column in its completed form and broken down by its parts.

Figure 6 depicts the Char Discharge System in its completed form and broken down by its parts.

DETAILED DESCRIPTION OF PREFERRED EXEMPLAR EMBODIMENTS

While the invention will be described and disclosed herein connection with certain preferred embodiments, the description is not intended to limit the invention to the specific embodiments shown and described here, but rather the invention is intended to cover all alternative embodiments and modifications that fall within the spirit and scope of the invention as defined by claims included herein as well as any equivalents of the disclosed and claimed invention.

The utility patent this application describes allows the application of back pressure to the feed material between the cold material and the heated, melting material (molten plastic). The main components of the Heated Airlock Feeder system are the drive, coupling, gearbox, augers, housing, clamshell burner boxes, expansion cart, and support frame. Figure 1 depicts the entire assembly of the re-usable energy reactor system. Figure 2 depicts the Heated Airlock Feeder that is part of the entire assembly of the re-useable energy reactor system. The drive system is a standard off-the-shelf helical gear drive with a high torque ratio Figure 4 at 59. The gear drive is selected with the vertical footprint to reduce the system's overall length Figure 4 at 59. This drive is connected to a standard sheer coupling. This coupling is design to separate under overloading conditions to protect the gearbox. The coupling consists of two augers. The two augers Figure 4 at 51 are custom constructed. These augers are also depicted in Figure 3. These augers are a machined three-part system. The first part of the augers are the drive shafts depicted in Figure 3 at 51a and 51b, one drive shaft being longer than the second drive shaft. These are elongated axially rotatable. The middle section of the augers are elongated, axially rotatable screws each having an elongated shaft with outwardly extending helical flighting along the one-half of the length of each shaft starting at the gear box Figure 3 at 51 and connecting to a axially rotating smooth surface auger where the smooth part of each auger at the output side of the apparatus are machined so that the space between each auger and the elongated tubular barrel housing is less than 1 inch Figure 3 at 52.

These augers are located inside Figure 4 at 53 which is inside Figure 4 at 61. One auger has left-hand flights, the other auger has right hand flights that overlap the left hand flights. One of the augers Figure 4 at 51 is longer than the other to protrude through the gearbox and connect to the drive coupling located in the gear box Figure 4 at 57. The augers are constructed from solid materials with connection slips for machining purposes. The augers are constructed in segments to reduce the material and labor cost to fabricate the assembly. The segments are also interchangeable for simpler fabrication. The gear drives in the gearbox 57 are keyed into the shaft and sealed on both sides. The gearbox consists of double lip seals, bearings and spur gears. The length of the gearbox is extended to carry the can ti lever load of the screw flights Figure 4 at 51 and 52.

All surfaces are machined on the contacting side of both items Figure 4 at 51 and 52 after welding. The housing Figure 4 at 53 is pre-welded before machining the interior to require a straight design. The connecting flanges at both ends and the inlet match the gearbox and the reactor bolt pattern. Figure 4 at 54 is machine tapered to reduce the outlet area to increase back pressure inside the Heated Airlock Feeder (Figure 4). This feeder assembly is welded to a reactor matching flange Figure 4 at 55 and then welded to the body of Figure 4 at 53. Figure 4 at 52 is welded to Figure 4 at 51 and then this entire assembly slides through the body of Figure 4 at 53 and protrudes flush to the end of Figure 4 at 54, the outlet ports. The gearbox and the assembly housing rest on the support frame Figure 4 at 67. This assembly is bolted in the back is the main anchor point for the entire reactor. As the heated airlock feeder expands due to the heat it expands lengthwise. To address the expansion, this apparatus is supported with a cart Figure 4 at 60 to allow the machine to expand, without creating stress on the supports. Existing art used shorter sections that are bolted together and constructed from a very thick material to absorb the heat. This design used a thinner material for better heat transfer but requires a moveable support system.

The solid, shredded plastic material (environmental temperature) is fed into the Heated Airlock Feeder at 56 on Figure 4, the heat is applied at 61 on Figure 4, and the heated plastic material which is in a molten state is created from the solid shredded plastic material (environmental temperature) at where 51 connects to 52 in Figure 4. 51 and 52, a continuous auger is located inside 53 which is located inside 61. The airlock is created at the end of 52 in

Figure 4 from the back pressure from the solid, shredded plastic material (environmental temperature) pushing on it.

This apparatus is used to induce heated plastic material into the main reactor and act as an airlock at the same time. By applying back pressure on the fed plastic material, between the solid, shredded plastic material and melting material (molten plastic material), a dead spot depicted on Figure 4 at 52 is created. At 52 there are no flights on the shaft. This dead spot created by this process, depicted on Figure 4 at 52, allows molten plastic material to build up pressure by the incoming solid, shredded plastic material (environmental temperature) being fed into the apparatus at 56 on Figure 4. This area 52 also has a larger shaft area, which fills the void between 52 and 53. This larger shaft increases the pressure inside creating an airlock effect. The discharge of the airlock feeder is also restricted at 54 on Figure 4 by the two openings that are greatly reduced in size compared to the opening where the solid, shredded plastic material (environmental temperature) is fed at 56 on Figure 4. When the feeder is shut down, the plastic material remains inside the feeder in area at 52 on Figure 4 because even as the feeder augers at 51 on Figure 4 continue to rotate, the plastic material will not be pushed out from the housing at 53 on Figure 4. The reason for this is because the heated molten plastic material is only pushed out when new solid, shredded plastic material (environmental temperature) is introduced. The incoming plastic material creates pressure and forces the molten plastic material in area 52 to be displaced. This means that when the airlock feeder cools off, the remaining plastic material will turn to a solid and seal until the next run. When the next run occurs, this plastic material will melt when reheated and allow the augers at 51 on Figure 4 to rotate.

This apparatus also heats the plastic material to a vapor and liquid state with a clamshell burner at 61 on Figure 4. The heating source for this airlock feeder are two clamshell heaters Figure 4 at 61through65. These two clamshell heater boxes produce the heat needed to make the airlock seal and start the vaporization of the plastic inside the feeder. The plastic material is heated from the discharge end to mid-way of the airlock feeder. By having two heater zones, the material is transformed from a liquid state on one end, to the shredded state on the other. Between this transition exist a molten plastic material. This molten plastic is thick and sticky and forms the needed pressure to create an airlock affect. This clamshell boxes come in contact with the airlock feeder with the seal Figure 4 at 63. This allows for greater expansion of the housing

Figure 4 at 53 from the clamshell fire boxes because of boxes are insulated on the inside, not allowing the metal to expand as on the outside. The Heated Airlock Feeder has two clamshell box burners. One box covers Figure 4 at 52 of the internal auger, and the other heats the auger at 51 of the auger. The advantage of two clamshell heater box burners is demonstrated on startup and shutdown of the reactor. Allowing the auger Figure 4 at 51 to cool to a point that a plastic seals is achieved to create the airlock needed for start-up a shut down. The molten plastic cools into a solid around the auger and the housing, sealing off the feeder. The ability to cool rapidly is also a big advantage of using clamshell heaters. The burners' flame can be extinguished and the fans may continue to run to cool the housing Figure 4 at 53.

The clamshell burner boxes are used as the heated airlock feeder requires a continuous even supply of heat to produce molten plastic. The correct amount of controlled heat is vital to the process for consistent material flow. Processes of this nature require heat from all directions. The need for a high velocity airflow in a circular box would suffice for this process. Heater boxes with process structures penetrating through the box will also require a seal system to prevent leaks. Expansion of the penetrating structure in both length and diameter was considered in this design. The ability to both heat and cool are required in this process. The penetrating structure needs support capability to prevent damage to the heater box seals. The penetrating structure (pipe or tube) would need to be supported outside the heater boxes. Due to heat expansion on the penetrating structure a mobile support is required. The requirement for controlling the expansion direction is also needed to prevent warpage of the penetrating structure and deflection that would damage the heater box seals requiring a controlled support system to restrict deflection in the direction that might damage the equipment.

Furnace heater boxes are used in many processes to produce heat required for incinerating, cooking, melting, and for other heat required processes. When a cylinder or tube penetrates a heater box, problems with uneven heating, seal leakage and expansion may occur. Also the need to access the penetrating tube are pipe is required. A clamshell design was implemented for these reasons. The clamshell design allowed for a circular shape to match the profile of the penetrating pipe or tube. This close profile along with high velocity airflow ensures even heating around the penetrating pipe. The clamshell design has a very low profile interior to reduce the amount of space between the heat source and the penetrating pipe surface, increasing the heat transfer without increasing the BTU value required by a burner system. Compared to a standard burner box where a burner is attached on one side of the box at a distance not allowing an open flame to come into contact with the penetrating pipe, this design uses very small flame points to distribute the heat one third of the way around the penetrating pipe. This reduces the total BTU value. This design combines both types of heat, convection and radiant, producing an even heat source around the penetrating pipe. A perforated screen Figure 4 at 61a was used that distributes the gas fuel and controls the flame height while allowing airflow through the heater box. A standard off-the-shelf burner package can be used to supply both the gas and air mixture for igniting. The difference in this system is the igniting source is inside clamshell burner box next to the perforated screen. A flame sensor is used to ensure ignition and a fan pressure switch is used to ensure airflow. Dual gases can be used by adjusting the gas quantity or the air quantity. Existing systems use complicated air control dampers to adjust the air to gas ratio, causing uneven burning of the fuel creating irregular flame size. The air velocity and pressure must be at a fixed rate to insure the mix gas exits the perforated holes as needed as not to allow for the mix gas to ignite under the perforated screen. This design overcomes this problem by stopping the gas flow and allowing the air to continue when the temperature is over a given set-point. When the system cools to a low set-point gases are allowed back into the mix and reignited. This control is achieved with a standard PIO controller with thermocouples to indicate internal temperatures. The clamshell design allows for access to the refractory liner that is installed only on the top half of the clamshell. All known heater boxes are normally lined with refractory on all surfaces. The lower half of this clamshell has no refractory liner, allowing any heat buildup to dissipate through the box surface and it ensures that the surface temperature remains below the auto ignite point. The perforated screen acts as a pressure regulator between the mixed gas and the flame above. This chamber is being fed with ambient air and mixed gas, both at ambient temperature. This keeps the lower half of the clamshell cooler. Without refractory on the lower clamshell, refractory replacement is not needed. The radiant heat from the flame is not in contact with the bottom portion of the penetrating tube Figure 4 at 53. The airflow from the burner forces air around the penetrating to carrying heat completely around the penetrating to because of natural disturbance. The movement of this air regulates the radiant heat surface of the penetrating tube by pulling excessive heat into the airstream forcing the air around the penetrating tube through an exhaust port. The perforated screen has small flames running the entire length and one third around the penetrating tube. This prevents hotspots that normally occur in burner boxes. By heating the penetrating tube in all directions expansion occurs in all directions. To prevent deflection or misalignment of the penetrating tube while being heated, the expansion direction is controlled with a support system. The support attaches to the expansion tube and prevents movement from unwanted directions. The cart consists of cam followers that are pinched between two structural flat bars, one on each side of the cart. The cart width is designed so that it is within one-eighth of an inch in between the width of the two structural flat bars so that it drops between the structural flat bars and ensures lateral movement. The cam followers (rollers) support the weight of the penetrating tube while preventing it from expanding up or down. This allows for the control of expansion direct action is in a lateral movement only. Typical pipe support rollers allow expansion in multiple directions. This design restricts expansion to lateral movement only keeping the penetrating tube from misaligning. The assembly is mounted on a steel skid mount frame Figure 4 at 67. The clamshell heater boxes consist of an upper Figure 4 at 61 and lower Figure 4 at 64 section. These sections are connected with a matching bolted flange and a seal chamber, Figure 4 at 63 that encompasses the penetrating tube. The gas air inlet box is mounted on the bottom section Figure 4 at 64 to allow air gas mix into the lower section. The lower section has a perforated metal screen Figure 4 at 64a welded 3 inches above the lower section Figure 4 at 64. This acts as an air chamber to distribute mixed air and gas through the perforated screen. The amount and diameter of the holes in the perforated screen are vital to control the flame height while allowing the volume of gas and air mix to pass through. The lower clamshell Figure 4 at 64 also has an air mixture box Figure 4 at 65 and the burner connection port Figure 4 at 65a connected to it. The mixer box Figure 4 at 65 has a flared configuration to distribute the air gas mix evenly under the perforated screen Figure 4 at 64a. The mixer box figure 4 at 65 creates some back pressure to the air gas mixture which ensures a consistent gas air ratio for each opening in the perforated screen Figure 4 at 64a. A standard off-the-shelf burner can be connected to the port Figure 4 at 65a. The standard burner igniter, along with the flame indicator, is located to the top of the perforated screen Figure 4 at 64a. An access pipe Figure 4 at 64b is used to penetrate through both the lower clamshell Figure 4 at 64 and the perforated screen Figure 4 at 64a, for an igniter and for the flame sensor Figure 4 at 64c to be mounted. A continuous pilot light Figure 4 at 64c is installed through this pipe and stops above the perforated screen Figure 4 at 64a. The pilot light proof of flame is required to indicate a flame is present until gas is allowed into the air gas mixture. When the heat set point is reached the gas alone, from the air gas mixture, ceases while the fan continues to run and push fresh air through the burner box. The pilot light continues to run in this phase of the heating process. Control of the heat is used with a PID controller. This controller is fed by thermocouples located on the top clamshell Figure 4 at 61. A wide range of temperatures can be achieved and controlled with this type of process. The ability to switch between fuel gases is also possible with this design. Two sets of solenoid valves located on the burner Figure 4 at 65b and have adjustable orifices to allow a fixed amount of gas to enter into a consistent amount of air. Natural gas mixed with air requires a different air mix ratio then syn-gas would require with the same air volume. Adjustment of the fixed orifices allow for switching between the gases. The expansion of the penetrating tube Figure 4 at 53 is controlled by the cart support Figure 4 at 60. This cart consists of heavy metal plate construction, resting between two flat bar retainers Figure 4 at 60b that are welded to a frame Figure 4 at 67. This allows the cam followers to roll on a smooth surface, preventing up and down movement. The cart width is only 118" less than the space between the flat bars Figure 4 at 60c, preventing side to side movement and up and down movement while allowing left to right movement only.

By preheating and vaporizing the plastic biomass material under positive pressure and high heat, the main reactor depicted in Figure 1 is shortened by about 40 feet to acquire the same performance as a standard reactor section would do. This reduces the reactor (Figure 1) expansion length along with the auger Figure 4. This reduction in size increases the torque in this area as the auger is shorter. The auger on the upper reactor depicted in Figure 1 at 1 is where the most torque is required due to the large amount of liquid plastic contained within the reactor. The further the plastic travels down the reactor depicted in Figure 1, the more plastic material is converted to vapor and the less the auger has to work.

The burner boxes depicted in Figure 4 at 61 are in two section. This allows for controlled heat zones. This control is needed to maintain the airlock effect during startup and shut down of the reactor. As the reactor heats up, it will start to build pressure inside. This pressure will look for a way out of the reactor. First is the heated reactor feeder that is the apparatus that is the subject of this patent application depicted in Figure 4 and the second and third areas where the pressure may leave the system is at the ash discharge depicted in Figure 6 and at the and the ash separator depicted in Figure 5. The char discharge in Figure 6 is a seal with slide gates preventing vapor loss. The char separator depicted in Figure 5 allows the vapors to be removed.

This design is modular construction for quick shop assembly and quick installation. This also allows for easy maintenance in the field. The modular design can be completely assembled and tested in the shop.

While the invention above has been particularly shown, described and illustrated in detail with reference to preferred embodiments and modifications thereof, it should be understood that the foregoing and other modifications are exemplary only, and that equivalent changes in form and detail may be made without departing from the true spirit and scope of the invention claimed, except as precluded by prior art.

WHAT IS CLAIMED IS:

1. An apparatus that is part of a reusable fuel processing unit, the assembly being used to induce plastic into the main reactor and act as an airlock at the same time allowing for the continuous feeding of plastic into the reactor, comprising:

a drive, coupling, gearbox, augers, elongated tubular barrel housing, two clamshell burner boxes, expansion cart, and support frame, where;

the drive system is a standard off-the-shelf helical gear drive with a high torque ratio, where;

the gear drive is selected with the vertical footprint to reduce the system's overall length, where;

the drive is connected to a standard sheer coupling, where;

the coupling is designed to separate under overloading conditions to protect the gearbox, where;

the coupling consists of two augers that are custom constructed, one being left-hand flights, the other being right hand flights where one of the augers is longer than the other to protrude through the gearbox and connect to the drive coupling, the augers being constructed from solid material with connection slips for machining purposes and where the augers are connected to a gearbox, where;

the gearbox in which the augers are connected consist of gear drives that are keyed into the shaft and sealed on both sides of the gearbox, the gearbox consists of simple lip seals, bearings and spur gears, where the length of the gearbox is extended due to the reload of the screw flights so as machines at the end can socket fit inside the other and be welded solid, the screws being machined on the outside after welding, and placed within a housing, where;

the elongated tubular barrel housing is pre-welded before machining the interior to require a straight design so connecting flanges at both ends and the inlet match the gearbox and the reactor bolt pattern and one side is machine tapered to reduce the outlet area to increase back pressure inside the heated airlock theater where this feeding is welded to a reactor matching flange, where;

the augers are located within an elongated tubular barrel that allows for plastic material input and output at either end of the elongated tubular barrel, where;

the assembly of the auger and elongated tubular barrel is surrounded by two split assembly clamshell heater boxes, one covering one end of the auger and the other covering the other end of the auger, that produce the heat that allow the airlock to seal and start vaporization of the plastic inside the feeder, these clamshell heater boxes coming into contact with the airlock feeder allowing for greater expansion of the housing from the clamshell heater boxes due to the fact that they are insulated on the inside so the metal does not expand on the outside, where;

the entire apparatus described above is bolted to a cart allowing the apparatus to expand and contract, where;

the cart that the apparatus is bolted to rests on a frame.

2. The two augers of claim 1 where the augers are located inside of the elongated tubular housing, where;

the longer of the two augers extends into the gearbox and is connected in the gearbox to provide rotation, where;

the augers are elongated, axially rotatable screws each having an elongated shaft with outwardly extending helical flighting along the one-half of the length of each shaft starting at the gear box and ending in a smooth surface where the smooth surface has the same diameter as the augers with the outwardly extending helical flighting, where;

the two augers' flighting overlap to provide rotation of the outwardly extending helical flighting in opposite direction and, where;

the smooth part of each auger at the output side of the apparatus are machined so that the space between each auger and the elongated tubular barrel housing is less than 1 inch.

3. The elongated tubular housing of claim 1 where the connecting flanges at both ends of the elongated tubular barrel housing match the gear box and the reactor bolt pattern, where;

the end that feeds further down in the reactor tubing is machine tapered to reduce the outlet area to increase back pressure inside the invention, where;

this feeder assembly is welded opposite the gear box end to a reactor matching flange.

4. The two clamshell burner boxes of claim 1 where each clamshell burner box consist if an uppers and a lower section that are both circular of 180 degrees, where;

each of the clamshell burner boxes are connected with a matching bolted flange and a seal chamber that encompasses the elongated tubular barrel housing, where;

the gas air inlet box is mounted on the bottom of the elongated tubular barrel housing to allow air gas mix into each of the clamshell burner boxes' lower section, where;

the lower section has a perforated metal screen welded 3 inches above the lower section, where;

the air acts as an air chamber to distribute mixed air and gas through the perforated screen, where;

the amount and diameter of the holes in the perforated screen are vital to control the flame height while allowing the volume of gas and air mix to pass through, where;

the lower clamshell burner box also has an air mixture box and a burner connection port connected to it, where;

the mixer box has a flared configuration to distribute the air gas mix evenly under the perforated screen, where;

the mixer box creates back pressure to the air gas mixture which ensures a consistent gas air ratio for each opening in the perforated, where;

an access pipe is used to penetrate through both the lower clamshell and the perforated screen where;

a continuous pilot light is installed.

5. The cart of claim 1 consisting of heavy metal plate construction, resting between two flat bar retainers that are welded to a frame allowing the cam followers to roll on a smooth surface, preventing up and down movement.

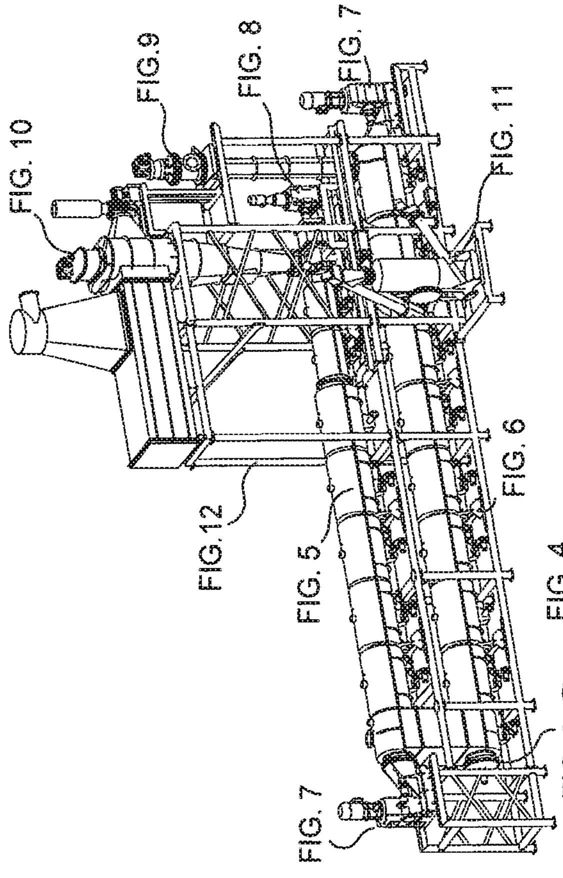

FIG. 1

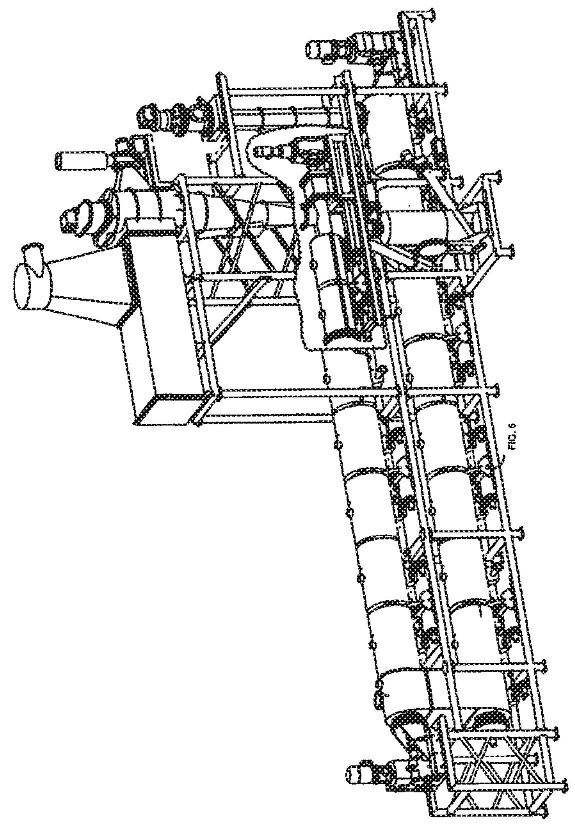

FIG. 2

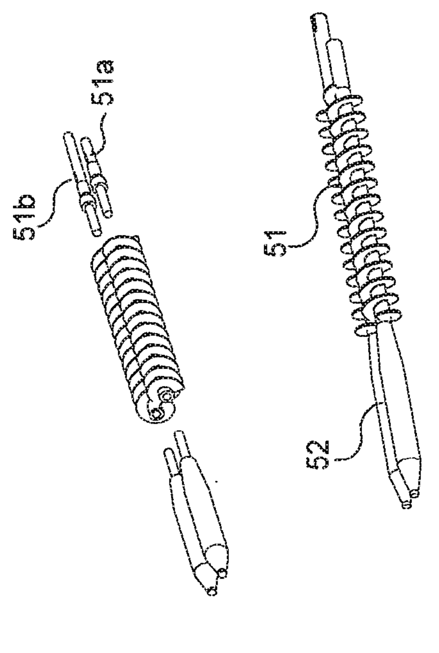

FIG.3

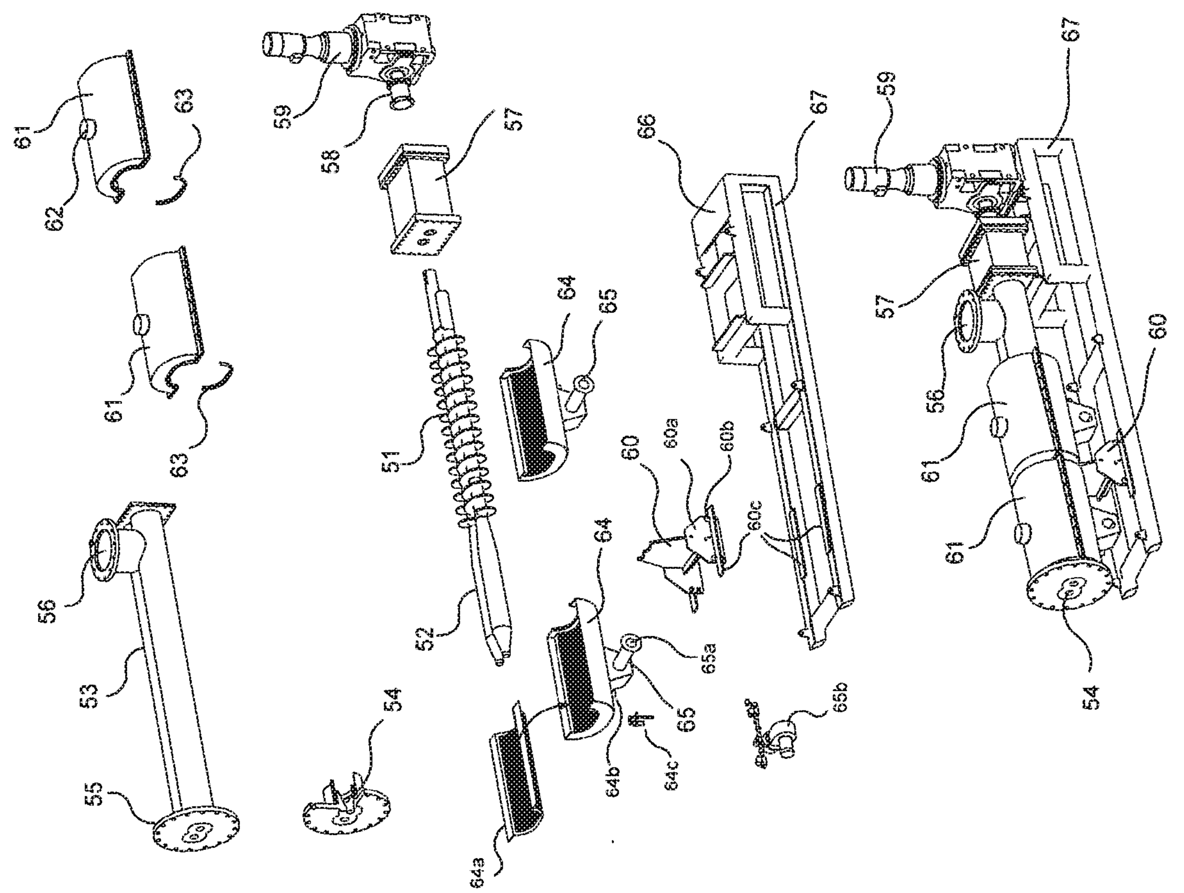
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FIG 4

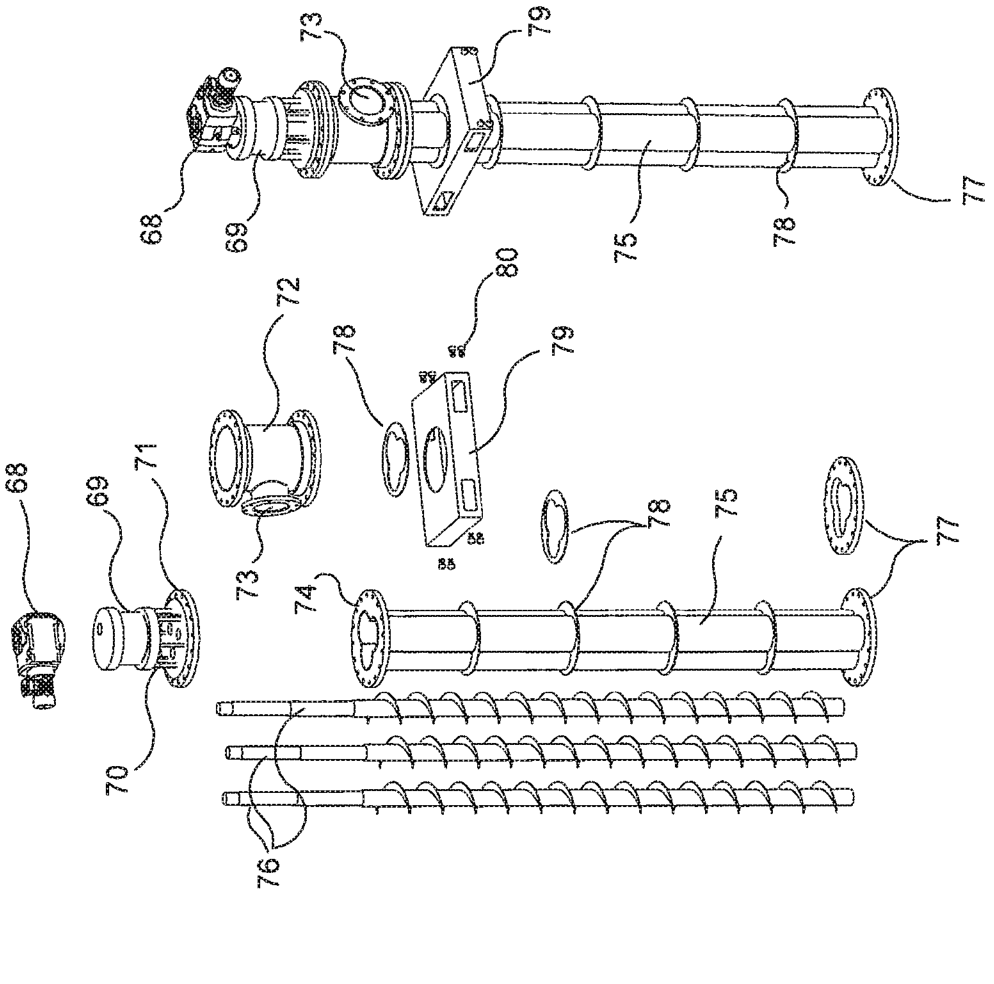

FIG 5

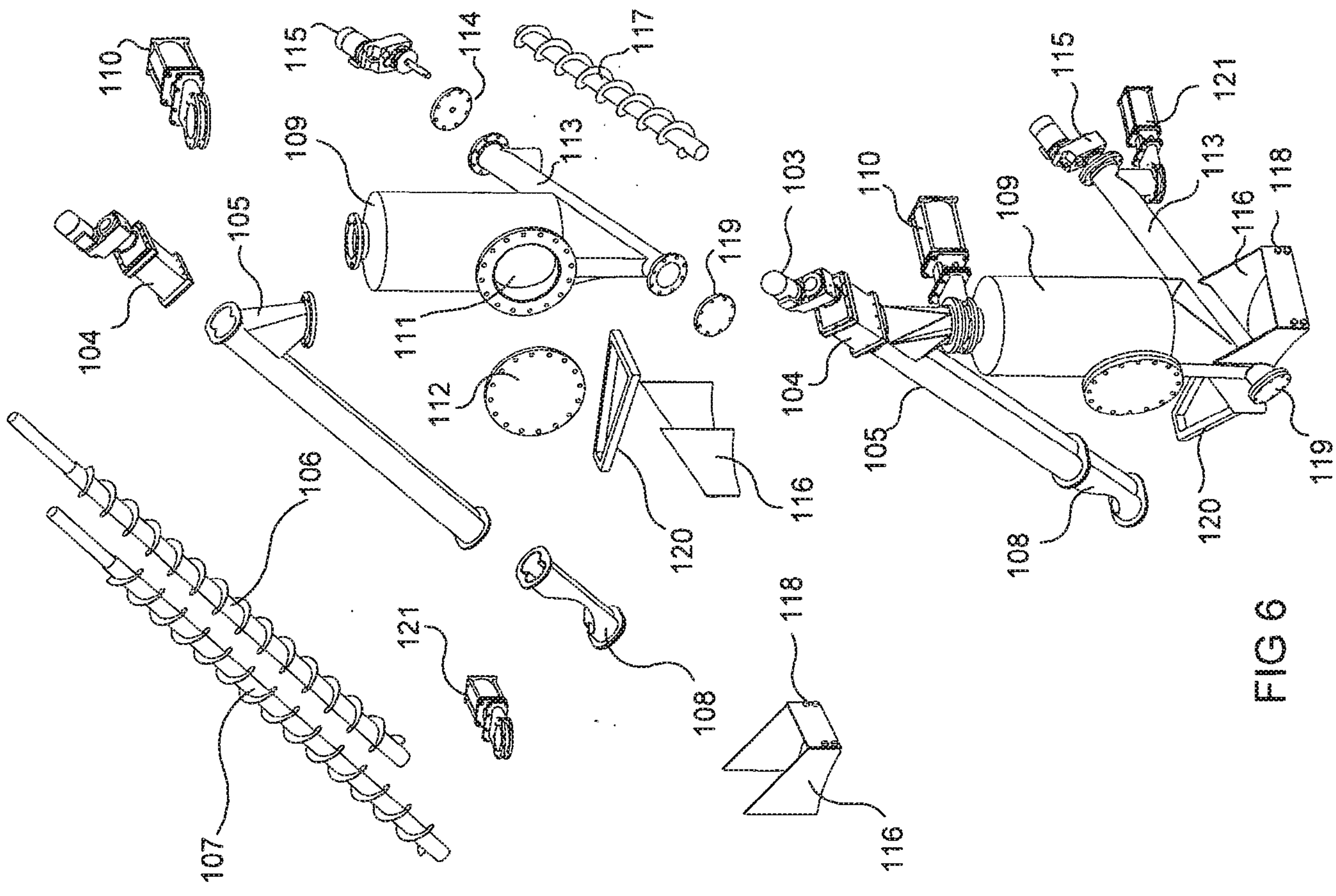
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FIG 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/053667

A. CLASSIFICATION OF SUBJECT MATTER

C10G 1/10(2006.01)i

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)
C10G 1/10; F23G 5/12; B01D 3/02; C10B 47/20; C10B 57/00; B09B 3/00; C10B 57/18; C10B 31/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: airlock, feeder, reusable, plastic, split, separated, plurality, auger, heater, barrel, housing, gear, clamshell, screw flight

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008-0286557 A1 (TUCKER, RICHARD D.) 20 November 2008 See paragraphs [0032]-[0044]; claims 18-35; and figure 2A.	1-5
A	US 2012-0024687 A1 (BRATINA, JAMES E. et al.) 02 February 2012 See paragraphs [0022]-[0028]; and figure 1.	1-5
A	US 2013-0299333 A1 (TUCKER, JERRY et al.) 14 November 2013 See paragraphs [0042]-[0045]; and figures 3-7.	1-5
A	US 5720232 A (MEADOR, WILLIAM R.) 24 February 1998 See column 2, line 48 - column 4, line 65; and figure 1.	1-5
A	US 5129995 A (AGARWAL, KEDAR B.) 14 July 1992 See claims 1-11; and figure 1.	1-5

☐ Further documents are listed in the continuation of Box C. ☒ 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
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"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
12 September 2017 (12.09.2017)	**12 September 2017 (12.09.2017)**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/IB2017/053667

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