The following statement is a full description of this invention, including the best method of performing it known to us:

X618-73-3D-14P.C.
The invention relates to a device for collecting particulates and gases produced from thermal chemical reactions, and is particularly useful in connection with the collection of such products emitted into the atmosphere from the coke side of a coke oven chamber.

There has been an increasing public effort to minimize or prevent the pollution of the air caused by various industrial processes. More particularly, there have been long standing efforts to prevent pollution of the air by emissions from coke retorts or coke oven batteries when coal is carbonized in such industrial units and, after the coking cycle is complete, the coke is pushed from the oven into a quench car for cooling. Such efforts date at least as far back as January, 1906 when United States Patent 809,645 was issued. This describes a method for evacuating the gases and particulates from a series of retorts into a common conduit equipped with suitable openings and dampers but the emissions from the coke retorts were eventually conveyed outside to the atmosphere. Since that time numerous additional devices have been suggested in attempts to combat the pollution of the air by emissions from coke ovens. Reference is made to the devices disclosed in the United States Patents 3,630,852; 3,647,636; 3,367,844; 3,676,305; 3,715,282 and 3,716,457 which are characterized by having hoods with or without fan exhausting devices incorporated.
directly on or constituting a feature of either the coke guide, which is usually moved into abutting relation with a coke oven doorjamb to form a passageway across the coke guide platform and track directly beneath and parallel to the coke oven battery on the coke side and which prevents spillage of coke when it is pushed from the oven, or a hood or shroud is made a component or part of the quench car which is positioned on a track below the coke guide for receiving the hot coke and transporting it to a quench station. All of these devices are characterized by having such complicated apparatus which must be pushed along the profile of the coke ovens on the coke side of the battery together with the coke guide or quench car or both. In United States Patent 3,630,852 there is disclosed an enclosed chamber consisting of a roof which abuts the face of the coke oven battery on the coke side and a vertical wall extension of the roof which provides a sealed chamber for receiving the hot coke. This chamber is exhausted by means of a suction duct. No atmospheric air is permitted to come in contact with the coke in this arrangement. Also it would be impossible for workmen to survive under this hood because of the very high temperatures of the atmosphere which would be reached inside of such a hood. Also the gas pressure generated due to the high thermal condition which builds up inside the hood when the coke is pushed would create considerable pressure on the chamber and gases would vent through the coke escape slots. In United States Patent 3,716,457 a hood is provided which extends the length of the coke oven battery and which is open at the bottom. This hood is divided into cells or compartments. The upper part of each
cell is provided with a valved outlet connected to a suction line. Each compartment would be obliged to accept the gas pressure released by the pushing of a charge of coke from the oven and the volume represented by one compartment would not be able to accommodate the resulting increased volume of gases and the suspended particulates when the coke is pushed and the gases, including the atmosphere in front of the oven, increase by several orders of magnitude due to the high temperature of the coke (usually 1800-2000°F.). The compartment, even though it is under suction, is inadequate to accept the large increase in volume of the gases which are forced to migrate, as do the particulates, to either side of the particular compartment and enter the atmosphere outside of the hood. Also, this arrangement requires movable walls on the carriage of the coke guide.

There is a need for an apparatus which will cover the coke guide and quench car areas on the coke side of the coke oven battery and which will extend the entire length of the coke battery and which will accept the entire thermal volume caused by pushing an oven full of coke and which will also provide means for retaining and classifying the particulate matter inside the entrapment device, and which will draw off the gases and a part of the particulates by means of a suction line to a suitable scrubbing apparatus. At the same time this housing or entrapment area should be of a permanent or stationary nature and not be a part of the coke guide or coke quench car which should be permitted to move freely down their respective tracks laterally in front of the coke oven battery without being encumbered by the hoods, panels, suction ducts and other appurtenances.
The present invention is directed to a device or apparatus for trapping or collecting the fumes and particulates which are normally discharged into the atmosphere in a variety of thermal chemical reactions. The apparatus is particularly useful to accomplish these purposes in connection with the operation of a by-product coke oven battery in that it can collect the fumes from leaking seals on or around the doors which enclose the ends of the coke ovens, and also it can collect the fumes and particulates that are formed when the coke is pushed from the ovens after each cooking cycle. The fumes from the coke doors and the fumes and particulates which are generated when coke is pushed from a coke oven battery or which are generated from other industrial operations are collectively referred to herein and in the appended claims as "emissions". Our device or apparatus includes a housing which extends the entire length of the emissions-generating apparatus, and particularly of a coke oven battery on the coke side thereof.

In accordance with the invention there is provided apparatus for collecting emissions discharged into the atmosphere in the presence of high temperature gases produced by a high temperature chemical reaction comprising a housing having a ridged roof, end panels, and roof panels which are higher than the emissions source and which extend downwardly at substantially the same angle from each side of the roof ridge, at least one panel extending inwardly and downwardly from the lower edge of the roof panel on the side of the housing farthest from the emissions source, a substantially vertical wall member depending downwardly from the lower
edge of said other roof panel, to the top of the apparatus which is the source of emission, a deflector panel extending inwardly and upwardly from the lower edge of said substantially vertical wall member, a duct located in the ridge of the roof and having a progressively increasing cross-sectional area as it approaches a suction means located at the large end of said duct, and air scoops projecting from openings along the length of the duct.

The upper zone of the apparatus defined by all of the aforesaid panels serves as an expansion zone which not only helps to accommodate the thermal volume occupied by the hot gases generated when the coke is pushed from the oven but also affects the upward velocity of the emissions. This upper zone also provides a space for altering the path of the upwardly rising hot gases and entrained particulates into a circulating pattern which assists in classifying the particulates into fine particles (i.e. less than about one micron) which are evacuated, and coarse particles which fall to the ground for periodic cleanup.

The invention will be more completely disclosed and described in the following specification and accompanying drawings in which:

Figure 1 is a diagrammatic and perspective view, taken along the coke discharge side of a coke oven battery,
illustrating the emissions collecting apparatus positioned abutting the side and top of the coke oven battery and overhanging the coke guide and quench car areas along the length of the battery.

Figure 2 is a view along the line 2-2 of Fig. 1 showing, in cross-section, the emissions housing of the invention including the suction duct, as well as the coke guide and coke quench car.

Figure 3 is a graph showing the thermal expansion effect on the atmosphere within the emissions housing of the invention when coke is pushed from a coke oven at a temperature of around 1800°F.

Figure 4 is similar to Figure 2 but shows another modification of the invention.

Figure 5 is a fragmentary perspective detail of the suction duct and air scoops which form a part of the invention.

Referring to the drawings there is illustrated diagrammatically a coke oven battery generally designated by the numeral 10 having a plurality of parallel coke chambers or ovens 11. At the end of each coke oven is a door 11a which may be either self-sealing or which is luted, in accordance with the conventional practice, with a suitable clay or other refractory material to retain the gases insofar as is possible within the oven while the coal charge is being coked therein. The top of the coke oven battery consists of a buckstay 11b. On the coke oven side of the battery and just directly beneath the individual ovens is a track or bench 12 on which a coke guide car 13 is positioned. The guide car is equipped with side panels 13a.
and moves laterally along the coke oven side on rails 14. On still a lower level beneath the guide car and also running laterally of the coke oven battery is a quench car 15 which moves on track 16. All of the aforementioned components are standard equipment and well known to those skilled in the art. The overall housing which covers the coke guide and quench car runs longitudinally along the coke side face of the battery and laterally to include the quench car track, is shown generally at 20. This is referred to herein as an emissions entrapment structure. It is stationary with respect to the coke oven battery and features a peaked roof structure which is higher than the battery and which consists of roof end panels 22a at each end of the roof, and outwardly and downwardly extending roof panels 21 and 22. The first roof panel 21 extends outwardly and downwardly above the top of the coke oven battery and is supported by columns 27b which rest on and are fixed to the coke oven buckstay 11b to support this side of the roof structure. The second roof panel 22 extends outwardly and downwardly beyond the coke guide and quench car areas. A third panel 23 depends downwardly and inwardly from the lower longitudinal edge of roof panel 22 toward the quench car area but terminating outside of this area. A substantially vertical wall member 25 depends from the lower portion or edge of the first roof panel 21 down to the top of the coke oven battery buckstay 11b and preferably fits in a substantially gas tight fashion. Another substantially vertical wall 24 depends downwardly from the lower portion of the panel 23 to a position or plane between slightly above or even with the top of the quench car. Alternatively, and as shown in
Figure 4 this wall extends down close to the grade on which the quench car is positioned but is not in contact therewith in order that air currents may form a cross draft or upward draft inside of the housing structure when the coke is pushed from the oven, causing a thermal updraft within the housing. The apparatus also requires, when used in connection with a coke oven battery, an inwardly and upwardly extending thermal shield 27 positioned above the coke guide area and which can be affixed to the columns 27b which support the roof panel 21. This shield extends the entire length of the coke battery and may be constructed of steel with insulation such as calcium or magnesium silicate affixed to the underside and/or both sides. The area above this thermal shield or deflector panel 27 and under the roof panel 21 serves as a portion of the expansion zone B in the upper portion of the housing. It is essential that this thermal shield be mounted in an upwardly inclined position as shown in the drawing to achieve this purpose. This thermal deflector panel or shield 27 is affixed to the supporting columns 27b at one end and is supported from the roof truss 30 by means of a suspension rod 27a.

The roof panels 21, 22 and the panel 23 may be constructed of any suitable high temperature resistant material including corrugated alloy steel or temperature resistant vinyl-asbestos panels. The vertical wall panels 24 and 25 may also be constructed of steel or other rigid, high temperature resistant material, or they may be constructed of woven asbestos blankets or panels which can be reinforced and/or secured together by monel wire or other high temperature resistant wire. Monel is a Registered Trade Mark.
The emissions entrapment structure 20 also includes end panels 26 which are constructed of materials similar to panels 24 and 25. The quench car 15 travels along the track 16 in a right to left direction in the views shown in Figures 1 and 3 and therefore the wall or panel 26 must have a suitable hinged flap 32 or door which can be pushed up or opened if panel 26 extends below the level of the quench car in order that the car may leave the structure on its way to the quench tower.

The emissions entrapment structure 20 is also equipped in the upper area of the thermal expansion zone with a temperature resistant duct 28 which can be round, square, rectangular or other configuration. As is shown in the drawings, this duct is progressively tapered and has an increasing cross section as the duct approaches the suction side of a fan 29. When the enlarged portion of the duct leaves the emissions entrapment structure it is preferably provided with a transition piece 35 and a tubular duct portion 35a which leads to the fan 29. The particulate matter which passes through the fan is led to a gas scrubbing device or dust filtration apparatus which may be of the centrifugal or cyclone type or to an electrostatic precipitator. These are conventional devices and are not shown on the drawings. Alternatively, these devices may be positioned ahead of the fan 29.

Figure 5 shows an enlarged portion of a section of the exhausting duct 28 and the air scoops 28a which are positioned over openings therein. Preferably these scoops are formed by cutting diagonally a piece of pipe of a suitable diameter and each section of this cut pipe is welded...
to an opening in the duct in a manner such that the leading edges 28b of the scoops are opposed to the direction of air flow in the duct produced when the fan 29 draws a suction on the duct. This provides a streamline flow of the gases and particulate material through the scoops and through the duct in the direction of the fan. The duct holes and air scoops are appropriately placed in the duct so as to substantially equalize the static pressure in the duct throughout the length thereof to provide reasonably uniform exhaust throughout the length of the emissions entrapment structure.

The emissions entrapment structure 20 is supported by structural members 17, 18 and 27b on the outside of the structure and by structural members 30 and 31 on the inside of the overall structure. The fan 29 is also supported by suitable structure.

When the coke is pushed from an oven 10 in a manner depicted at 19, the coke passes through the coke guide 13 and drops into the quench car 15. Figure 3 shows the thermal expansion of the gases within the emissions entrapment structure 20 when about eleven tons of coke, at a temperature of around 2000°F., are pushed from an oven in less than one minute into the quench car 15. The peak thermal volume or load, represented by area A-4, reaches its maximum in less than 1 minute. This depends on the ram travel time A-1, i.e., the time required to push the coke from the oven into the quench car, the coke temperature, and the retention time A-2 of the quench car within the structure. For a given quantity of coke, the desired clearing time of the housing can be calculated and the
diameter of the suction duct 28 and the capacity of the fan 29 can be determined. Fan 29 is operated continuously and at a suitable volumetric flow (shown as A-3 in Figure 3), a total time shown as A-5 elapses to clear the thermal volume emission A-4 from the entrapment structure.

When the coke is pushed from the oven into the quench car, the gases expand rapidly and the particulates are directed upwardly into the expanded roof portion B of the emissions entrapment structure. This volume of gas and its upward velocity carries a considerable amount of the particulate matter toward the upper portion of the entrapment structure. Since this volumetric thermal load is much greater than the balanced air suction duct can absorb, the roof is designed as described herein to accommodate this over-load expansion. By calculating the thermal expansion load A-4 it is possible to design an emissions entrapment structure of suitable dimensions and capacity and including the upper expansion zone B, to accommodate the thermal load.

As is shown in Figure 2 of the drawings, a large portion of the expanded gas volume is reversed in flow in the upper portion of the entrapment structure and is directed back downward into the portions or areas of the upper structure defined by the roof panels 21 and 22, the panel 23 and the thermal deflector panel 27. The gases containing particulate matter are initially directed upwardly in the main thermal updraft in the center portion of the thermal expansion zone. The finer particles, i.e., those finer than about 1 micron, are directed upwardly toward the duct 28 and into the duct through the air scoops 28a.
and then downstream in the duct toward the exhaust fan 29 and thence to a scrubber of the type previously described.

The temperature resistant panels or walls 24, 25 and 26 contain the thermal load and also allow air to move under these wall panels to produce a cross draft and an upward draft of the thermal load into the expansion zone.

The thermal load per volume generated by a given amount of coke pushed from the oven can be determined by placing the quench oar into an enclosed structure such as a quench tower, and measuring the velocity of the upwardly directed gases and their temperatures at various portions inside the closed structure. This produces a figure which approximates the volume of the hot gases produced by a given quantity of coke. The emissions entrapment structure is then constructed of suitable proportions to contain this volume but must have the upper structure previously described in order to provide the expansion zone for the thermal volume and circulation of the hot gases and particulate matter in the desired fashion and to provide a partial classification and fallout of particulates in the manner described.

For a typical coke oven battery installation in which approximately eleven tons of coke are pushed from one oven into the quench oar, an emissions entrapment structure which will accommodate about four hundred thousand cubic feet of gas at the maximum temperature which is reached within the structure when the coke is pushed at a temperature about 1800°F., is provided. For a coke oven battery which contains forty ovens of average 20 in. width, each of which ovens will produce about ten or eleven tons of...
coke, the entrapment structure will be 176 ft. long and the 45° roof panels 21 and 22 will be 25 ft. and 22 ft. long, respectively. Panel 23 will be about 7 ft. in length. The entire roof structure overhangs the coke guide and quench car areas. The duct 28 will vary in cross-sectional area, and will have a dimension at the far end of the emissions entrapment structure of three ft. by six ft. and a dimension of six ft. by six ft. at the suction end of the structure. Fifty-nine air scoops 28a are provided and these are constructed from fourteen inch diameter round pipe by cutting the pipe diagonally and fitting each scoop to one of fifty-nine holes cut out of the duct. These are so positioned that the static gas pressure in the duct is substantially balanced throughout the duct when suction is applied. A six ft. diameter in-line fan having a capacity of about 140,000 cfm is employed, driven by a two hundred horse power motor. This has been found to be adequate to accommodate the maximum thermal volume developed when one ten or eleven ton load of coke is pushed from the oven. Obviously, if the amount of coke pushed from the oven is greater than ten to eleven tons, the housing will have to be appropriately sized and changes made in the dimensions thereof as well as in the capacity of the duct 28 and the fan 29.

The wall 24 and the end panels 26 are suspended or positioned so that the bottom edge thereof is either at about the same level of, or slightly above the top of the coke quench car, or they can be in a position just above the grade on which the track for the quench car has been laid.

While the emissions entrapment structure of the
invention has been particularly described herein in connection with the control of emissions from a coke oven battery including leakage of gases and particulates from the closed coke oven doors, it is to be understood that the apparatus of the invention can also be used in connection with other industrial operations employing a high temperature chemical reaction such as a blast furnace, electric steel furnace, etc. In those instances, the supporting structure for the emissions entrapment housing will have to be changed to suit the particular installation requirements. Therefore, the invention can be used in connection with many operations other than that specifically described herein.
The claims defining the invention are as follows:

1. Apparatus for collecting emissions discharged into the atmosphere in the presence of high temperature gases produced by a high temperature chemical reaction comprising a housing having a ridged roof, end panels, and roof panels which are higher than the emissions source and which extend downwardly at substantially the same angle from each side of the roof ridge, at least one panel extending inwardly and downwardly from the lower edge of the roof panel on the side of the housing farthest from the emissions source, a substantially vertical wall member depending downwardly from the lower edge of said other roof panel to the top of the apparatus which is the source of emission, a deflector panel extending inwardly and upwardly from the lower edge of said substantially vertical wall member, a duct located in the ridge of the roof and having a progressively increasing cross-sectional area as it approaches a suction means located at the large end of said duct, and air scoops projecting from openings along the length of the duct.

2. Apparatus according to claim 1, in which the emissions are from leaking doors and coke pushed on the coke side of a coke oven battery through a coke guide and into a coke quench car positioned to travel generally parallel to said battery and located to receive coke when it is discharged, the housing being disposed in front of and abutting the coke side of said battery and covering the coke guide and quench car areas along said battery, and its roof being higher than said battery.

3. Apparatus according to claim 2, in which said
other roof panel extends above at least the buckstay on the coke side of the coke oven battery, the roof panel on the side of the housing farthest from the emissions source extends above and beyond the quench car area, the substantially vertical wall member depends from the lower portion of said other roof panel down to the top of buckstay of said battery, and the inwardly and upwardly extending deflector panel overlays the coke guide area and extends the length of the housing.

4. Apparatus according to claim 2 or 3, in which a substantially vertical wall member depends from the lower portion of the said at least one panel to a position between slightly above the top of the quench car to close to the grade on which the quench car is positioned.

5. An apparatus according to any one of the preceding claims, in which the air scoops consist of the sections obtained by cutting a cylinder diagonally, and the resulting scoops are affixed to the duct over openings therein so that the semi-circle end of the scoop points in a direction opposed to the direction of gas flow in the duct when the duct is under negative pressure.

6. Apparatus for collecting emissions substantially as hereinbefore described and as illustrated in the accompanying drawings.

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