

Nov. 24, 1942.

A. H. DON HOWE
RADIANT CELL GAS BURNER

2,302,751

Filed July 5, 1940

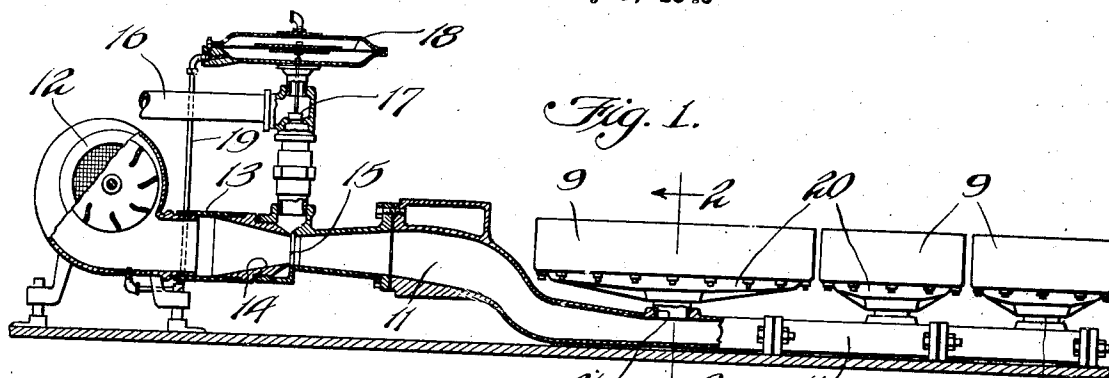


Fig. 1.

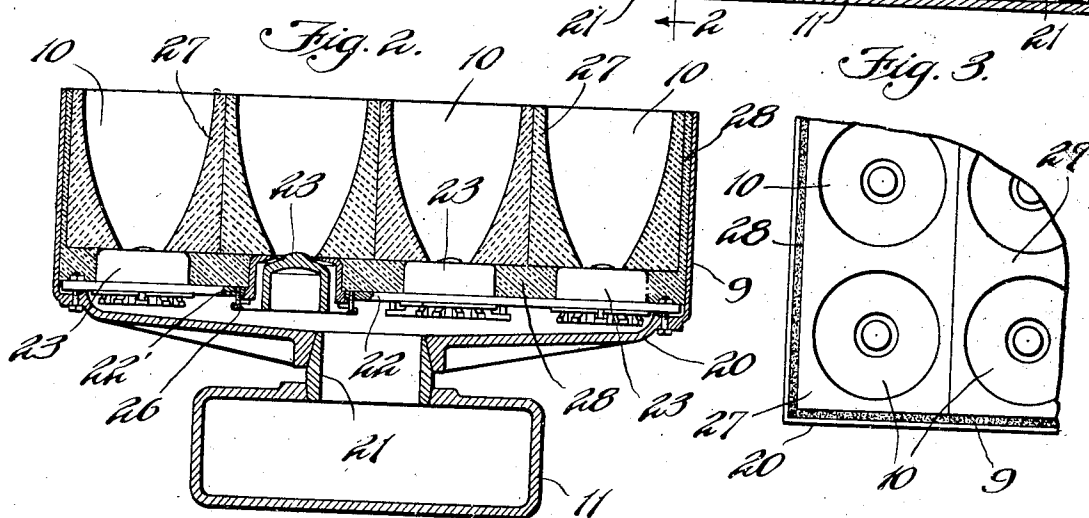


Fig. 2.

Fig. 3.

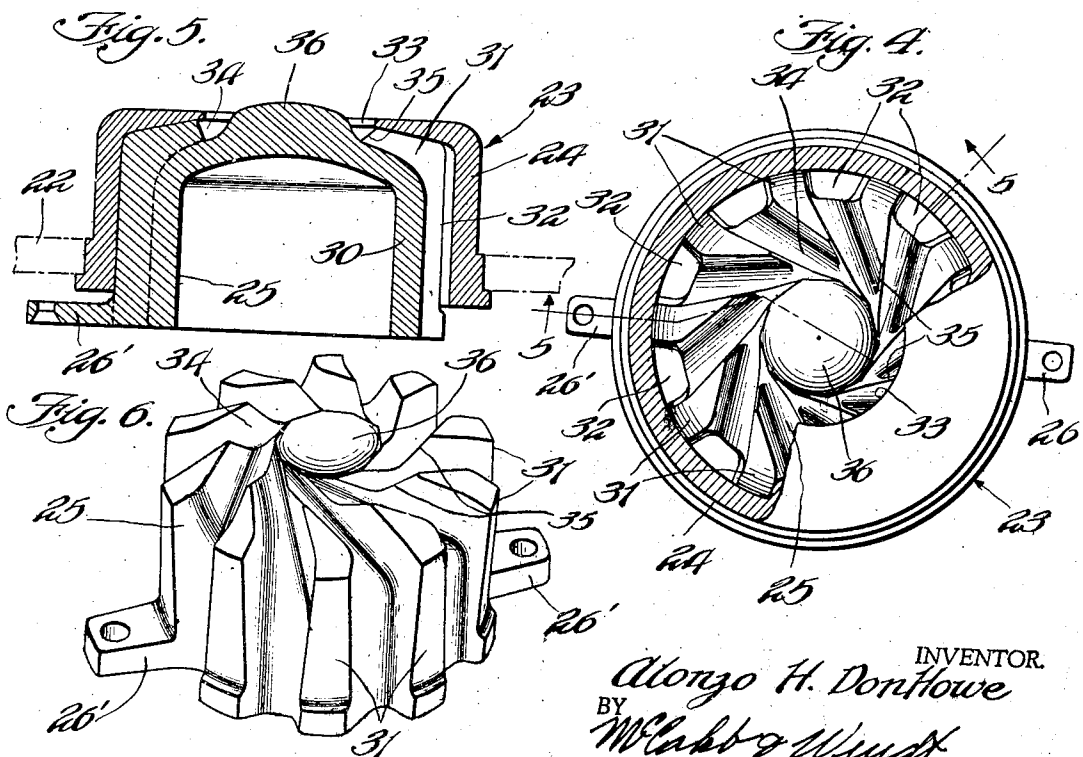


Fig. 4.

Fig. 5.

Fig. 6.

INVENTOR.
Alonso H. DonHowe
BY *McLabb & Wundt*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,302,751

RADIANT CELL GAS BURNER

Alonzo H. Don Howe, Chicago, Ill., assignor to
Radiant Heat, Inc., a corporation of Illinois

Application July 5, 1940, Serial No. 343,964

16 Claims. (Cl. 158—104)

My invention relates to radiant cell gas burners, and in many respects it constitutes an improvement upon the gas burner disclosed in my Patent No. 2,070,859 of February 16, 1937.

In that patent, I disclosed a plurality of cells, more or less cigar-stump shaped, formed in blocks of refractory material. A combustible mixture of gas and air was forced into the inner end of each cell through a burner tip. The function of that burner tip was to introduce the combustible mixture to the inner end of the cell in such a tangential manner as to give the combustible material a whirl whereby the mixture, as it burned, described a helical path in progressing from the inner end of the cell to the outer end. This brought the burning gases into scouring contact with the wall of the cell, rendering it incandescent. The velocity with which the gas was introduced through the burner tip and the swirling action given it by the burner tip combined to maintain a high centrifugal pressure against the wall of the cell and a high peripheral speed, but the relatively fine lead given the spiral path considerably delayed the axial travel of the burning gases through the cell.

In this manner an unusually large percentage of the heat of the burning gases was translated into radiant heat which was directed against the interior of the boiler with correspondingly less heat left to be abstracted by flue passages.

The principal object of my present invention is an improvement in the burner tip—especially for the larger sizes of burners—whereby a larger capacity of feed is afforded for the same size of cell while augmenting or at least retaining the desired whirling action.

In the design of burner tips shown in my patent, if the passages through the tip were curved to introduce the streams of combustible mixture at more nearly a tangent to a plane at a normal to the axis of the cell, the partitioning ribs between the passages had to come closer together at the outer end of the tip and hence constricted the passages and tended to lessen their capacity. By my present invention I am able to curve the passages more nearly into tangential relation with a plane at a normal to the axis of the burner and thereby produce helical paths with less lead so that the burning gases make more revolutions and stay within the cell longer in their travel from the tip to the open end of the cell,—and yet I am able to maintain, and in fact greatly increase, the capacity of the tip so that more gas may be burned in a given cell.

Another object is a burner tip and mounting

therefor, especially for the larger size burners, which is better calculated to avoid backfiring. This becomes important when the burner is being operated at the lower limit of a wide range of capacity and also just after the burner has been shut off and the velocity of the combustible mixture passing through the burner tip falls below the velocity necessary to offset the rate of flame propagation.

The foregoing, together with further objects, features and advantages of my invention, are set forth in the following description of a specific embodiment thereof and illustrated in the accompanying drawing wherein:

Fig. 1. is a somewhat diagrammatical side elevation, partly in longitudinal vertical section, of my gas burner unit;

Fig. 2 is a transverse section through one of the burner sections of the unit taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail plan view of one corner of a burner section showing a typical cell;

Fig. 4 is a plan view, on an enlarged scale, of one of my burner tips with part of the top of the shell piece broken away to show a major portion of the core piece;

Fig. 5 is a vertical axial section of the burner tip taken on the line 5—5 of Fig. 4; and

Fig. 6 is a perspective view of the core piece.

Referring to Fig. 1, which shows my complete gas burner unit, one or a plurality of burner sections 10 are arranged to be mounted in the ash pit beneath a boiler. Each burner section may have a set of, say, twelve to thirty-two cells 10 arranged in longitudinal and transverse rows and preferably giving the burner section a rectangular plan contour. If a plurality of rectangular sections is used, they may be placed end to end or side by side, either transversely or longitudinally of the ash pit. In Fig. 1 I have indicated a compound arrangement where the leftmost burner section would be one of a pair arranged longitudinally side-by-side in the ash pit, and with the intermediate section and the rightmost section side-by-side but extending transversely of the ash pit.

Combustible mixture is fed to the burner sections by a manifold 11 which passes beneath them.

Outside of the boiler, my burner unit includes an air blower 12 connected by a flexible hose 13 to the protruding end of the manifold 11, which end is formed to provide a venturi 14. At the neck of the Venturi passage, an annular gap or orifice 15 permits infeed of gas. The gas passes

from a supply line 16 through a gas valve 17 controlled by a diaphragm 18 and through the orifice 15 into the manifold 11, where it mixes with the air from the blower. An air line 19 leads from the discharge side of the blower to the underside of the diaphragm. It is not unless and until the blower is in operation that the diaphragm opens the gas valve to admit gas to the orifice 15 of the venturi, and even then the gas is fed more by aspiration than by positive pressure. This arrangement is calculated to lessen the danger of gas leakage wherever the blower is not in effective operation.

Each burner section 9 is jacketed by a casing or pan 20, the peripheral sides of which upstand to about the level of the upper ends of the cells and the bottom of which is dished and provided with a central hub. The casing 20 is connected to the manifold by a short connector tube 21. The connector tube 21 has a taper fit with the central hub on the bottom of the casing 20, as well as with an appropriate opening on the top side of the manifold 11. A horizontal plate 22 is mounted across the bottom or pan portion of the casing 20 and underlies the cells. Beneath each cell the plate 22 has a circular opening 22' for receiving the burner tip 23 for that cell.

Each burner tip 23, as shown in Figs. 4 and 5, consists of two interfitted parts, a shell 24 and a core 25. Near its lower periphery the shell 24 is machined to make a close fit with the hole 22' in the plate 22. The core 25 is held within its shell 24, and both pieces are fixed relative to the plate, by cap screws 26 passing through ears 26' on the core and threaded into the plate.

The burner tips protrude a considerable distance above the plate 22. The cell blocks 27, of refractory material, are set side-by-side within the casing 20 and with their bottoms resting on the top surfaces of the burner shells 24. The space around the burner tips 23 and between the cell blocks and the plate 22 is filled with a heat resisting insulating material 28, such as powdered magnesia. The upstanding walls of the casing 20 sufficiently fit the margin of the battery of cell blocks to position them with the axes of their cells 10 aligned with the axes of the respective burner tips 23.

Again referring to Figs. 4, 5 and 6, the core 25 of each burner tip 23 comprises a body 30, which is preferably of inverted cup shape, and a set of arcuately spaced fins 31 extending outwardly from the body. At their vertical edges the periphery of the fins 31 is machined to make a fit with the bore of the side wall of the inverted cup-shaped shell 24. The top edges of the fins 31 are machined to make a fit with the somewhat conically conformed under-surface of the top of the shell 24.

When the core is mounted within the shell, as shown in Figs. 1 and 4, the fins and body 30 of the core combine with the inner surface of the shell 24 to define passages 32. These passages 32 extend vertically upwardly and are then turned inwardly on to the top of the body 30 to communicate with the central discharge port 33 in the top of the shell 24. The discharge port 33 is preferably of the same diameter as the inner end of the cell formed in the cell block.

Although the upper reaches of the passages 32 are turned inwardly, they are not turned radially inwardly. Rather, they are turned inwardly in a direction which is tangential to a circle of somewhat lesser diameter than the discharge port 33. Viewed in plan, as in Fig. 4, the top reach of

each fin curves away from a radius to the axis of the tip. Also, the top reach of each fin is tapered; that is, the more or less vertical walls defining the top reaches of the fins converge. The fins are tapered, rather than the passages therebetween being tapered, to avoid restriction of the intervening passages 32. The passages 32 are directed into tangency with an annular channel 34 formed between the sloping sharp inner edges 35 of the fins and the lateral periphery of a central knob or dome 36, which knob protrudes into the discharge port 33.

It is this tangential discharge relationship which gives the combustible mixture admitted into the lower end of the cell its swirling motion. Even if the passages discharged the mixture into the port 33 in a plane at a normal to the axis, the swirling gases would be displaced upwardly as more mixture was forced in through the passages, and this would give an upward component to the swirl. But the slight upward inclination of the upper reaches of the passages 32 gives a more definite and formal upward component to the swirling motion. By my present invention, this upward inclination may be kept relatively slight and thereby the axial lead imparted to the swirl may be kept finer so that the mixture—in its several stages of unburned mixture, burning gases, and products of combustion—may be longer delayed in their travel up through the cell.

If, as in my prior patent, the passages curved from the vertical to reduce the axial lead of the swirling motion, while keeping each passage throughout its length at a uniform radius from the axis of the tip, the partitioning fins would, at the discharge ends of the passages, come closer together and constrict the passages. This constriction of the passages would be a limitation on the reduction of the angle to a normal to the axis with which the mixture could be discharged from the passages. By my present arrangement, with the upper ends of the passages turned inwardly to approach the axis, but still tangent to a sizable circle concentric with the axis, the set of passages may be intersted without substantially constricting them. Thereby I am enabled to increase the capacity of the burner tip and yet reduce the axial lead of the discharged swirling mixture to define a lead as desired.

I call attention to another aspect of my present invention. The passages are relatively long and they lead rather directly away from the heat of the cells and the combustion in the cells. The plate 22, which defines the top of the feed passage to the burner tips, is spaced some distance below and insulated from the bottom of the cell blocks. This spacing in insulation better prevents the plate 22 from becoming hot enough to ignite the combustible mixture anterior to the burner tips. Ordinarily, the burning of the gases is confined to the cells rather than taking place in the burner tip or in the feed passage anterior thereto, because the velocity with which the combustible mixture travels through the passages of the burner tip is in excess of the rate of flame propagation.

To vary the amount of gas burned per minute, the blower may be adjustably dampered or its speed may be varied. The air feed, partly by aspirating gas at the venturi and partly by the diaphragm control of the gas valve, draws in gas in proportion to the air flow, and thereby maintains the proper ratio of air to gas throughout

a range of feed. If the feed should be cut down too much, the velocity of the combustible mixture traveling through the passages in the tip might be less than the rate of flame propagation. The rate of flame propagation might at the same time be somewhat increased, because with a smaller flow of mixture through the tip, the tip would not be cooled so much by the passage of the mixture and the mixture in the tip passages might be at a higher temperature, which would increase the rate of flame propagation. As a result, under such circumstances, the flame might propagate down into the passages. But because the passages are relatively long and lead more or less directly away from the source of heat, the metal parts of the tip defining the passages would conduct away and dissipate the heat of the flame propagated down into the passages, so that the flame would die out or reach a position of balance of its propagation before it had traveled the entire length of the passages back to the supply chamber beneath the plate 22. In this way, backfiring under such condition is avoided. My improved tip would likewise function to prevent such backfiring in the period following shutting off of the burner (i. e., opening the switch of the blower motor), where the velocity of the mixture through the burner tip would likewise fall below the normal rate of flame propagation and while the cells are still incandescent.

It will be noted that my burner tips are so mounted in the plate 22 as to have considerable thermal conductivity therewith better to aid in the dissipation of the heat of any flame traveling down into the passages 32.

The design of my tip is one which readily adapts itself to casting the passage-forming fins integral with the core piece of the tip, with relatively little subsequent machining.

While I have described and illustrated this specific embodiment of my invention, I contemplate that many changes and substitutions may be made without departing from the scope or spirit thereof. The terms "upper" and "lower" are used in a relative sense; my burner, or its burner sections, might be turned so that the cells open horizontally or even downwardly.

I claim:

1. A burner tip for introducing a combustible mixture of gas and air with a swirling motion into the central lower end inlet of an outwardly opening annular cell of refractory material, comprising a shell member in the form of an inverted cup having a central opening in its web adapted to register with the inlet of the cell and a core member fitted into the shell member and having a central body of greater diameter than the opening, and a set of arcuately spaced fins carried by one of the members and disposed between the members, the fins together with the core and shell members defining arcuately spaced passages for the mixture open at their lower ends and extending upwardly from the bottom of the members and then inwardly on to the top of the body and to the central opening to discharge the mixture therethrough.

2. A burner tip according to claim 1, wherein the inwardly extending reaches of the passages are directed tangentially inwardly to discharge the mixture tangentially into the central opening.

3. A burner tip according to claim 1, wherein, whereas the upwardly extending reaches of the passages are arranged in side-by-side substan-

tially non-converging relation to each other and at more or less uniform radius from the axis of the tip, the inwardly extending reaches of the axis are convergingly directed inwardly and somewhat upwardly into tangency with the opening.

4. A burner tip according to claim 1, wherein the fins are integral with the core member and the sides of each fin, adjoining its upper inner end, converging to terminate in a thin edge exposed at the central opening of the shell with the median lines of the converging sides extending in a direction tangential to a circle of somewhat less diameter than the central opening.

5. A burner tip of the class described comprising a shell of inverted cup shape with a central circular opening in its top providing a port into the small end of a radiant cell, a core fitted into the shell, the core having a body of inverted cup shape, arcuately spaced peripheral fins co-operating with the body and shell to form passageways leading upwardly and then inwardly to the central opening of the shell and a central knob at the top of the body in the plane of the central opening of the top but of smaller diameter than the opening to leave an annular space therebetween, the passageways being open at their lower ends and extending upwardly between the sides of the shell and the core body, and then being directed inwardly and slightly upwardly between the top of the core body and the top of the shell into tangency with the annular space between the knob and the central opening.

6. A burner tip according to claim 5, wherein the upwardly extending reaches of the passageways are longer than their radius from the axis of the tip.

7. A burner tip for a radiant cell gas burner comprising a pair of internested inverted cup-shaped members—one constituting a shell for the other, and the other a core for the one—the shell member having a central opening in its top to lie in registering proximity to the central inlet at the bottom of a radiant cell and one of the members having a set of arcuately spaced ribs disposed between the body of the two members and extending up their sides and turned inwardly between the tops of the members in a direction which, viewed in plan, is substantially tangent to the central opening, the ribs co-operating with the shell member and the body of the core member to define passages for receiving a combustible mixture at their lower ends, and conducting it upwardly through a relatively large height, and then inwardly to the central opening to discharge the mixture therethrough in a swirling motion.

8. A burner tip according to claim 7, wherein the core member has a central dome in the plane of the discharge ends of the passages, the dome being separated from the passage ends and from the margins of the central opening by an annular space, into tangency with which the terminal ends of the passages are directed.

9. A gas burner section comprising a horizontal plate, a pan spaced therebeneath and supplied with a combustible mixture of gas and air under pressure, spaced holes in the plate, a burner tip mounted in each plate hole and protruding a substantial distance thereabove, a refractory mounted over the burner tips leaving a vertical space between the refractory and the plate about the protruding burner tips, a heat resisting insulation inset piece, upwardly opening annular

cells formed in the refractory with narrowing lower ends terminating in central inlet ports, the respective burner tips and cells being aligned whereby each tip supplies a cell, each burner tip having passages for conducting combustible mixture from beneath the plate to the inlet port of the cell to discharge the mixture into the cell with a tangential swirling motion.

10. A gas burner section according to claim 9, wherein each tip comprises a shell member of inverted cup shape with a central opening in its top to register with the cell port, a core member fitted into the cup, and arcuately spaced fins carried by one of the members, between the members, whereby the fins and members cooperate to define passages leading upwardly toward the top of the tip and then inwardly in a tangential direction toward the central opening for discharging the mixture tangentially there-through, the lower periphery of the shell member having a shouldered seat for mounting the shell member in the plate hole and limiting upward movement of the shell member there-through, and means for clamping the core member toward the plate and, by engagement of the core member with the shell member, in turn clamping the shell member to the plate.

11. A radiant cell gas burner section comprising a set of side-by-side cell blocks of refractory material formed with upwardly opening annular cells narrowing toward central ports in their lower ends, at the bottom of the blocks, a horizontal plate extending a spaced distance beneath the bottoms of the cell blocks, metal burner tips mounted in the plate, beneath and in registering alignment with the respective cells, a casing forming, with the plate, a space beneath the plate for supplying under pressure a combustible mixture of gas and air, and passages in the burner tip opening at their lower ends to the supply space and extending upwardly for a considerable distance toward the upper end of the burner tip and then directed inwardly to discharge the mixture into the cell through its port with a swirling motion.

12. A radiant cell gas burner of the type in which a combustible mixture is fed into the narrowed inner end of an annular cell with a swirling motion to follow a spiral path of sufficiently fine axial lead to permit the completion of combustion largely within the cell, comprising an annular cell of refractory material open at its discharge end and narrowing from an annular inlet port at its inner end, a source of combustible mixture, under pressure, of gas and air, and a burner tip of non-refractory material anteriorly adjoining the inlet port and having arcuately spaced passages for receiving mixture from the supply and conducting it in a direction toward the plane of the inlet port and then inwardly in a direction generally toward the axis of the cell and into the inlet port, each passage thus extending inwardly to the inlet port in a direc-

tion which, viewed axially of the cell, is tangential to a circle concentrically intermediate the margin of the inlet port and the axis of the cell.

13. A radiant cell gas burner according to claim 12, in which each inwardly directed passage is, in radial section, upwardly and inwardly directed at an angle to the axis in the order of eighty degrees.

14. A radiant cell gas burner of the type in which a combustible mixture is fed into the narrowed inner end of an annular cell with a swirling motion to follow a spiral path of sufficiently fine axial lead to permit the completion of combustion largely within the cell, comprising an annular cell of refractory material open at its discharge end and narrowing from an annular inlet port at its inner end, a source of combustible mixture, under pressure, of gas and air, and a burner tip of non-refractory material anteriorly adjoining the inlet port and having arcuately spaced passages for receiving mixture from the supply and conducting it in a direction toward the plane of the inlet port and then inwardly in a direction generally toward the axis of the cell and into the inlet port, the burner tip having a central knob at its inner end exposed by the inlet port, the passages extending inwardly to the inlet port in directions substantially tangential to the knob, whereby the knob forms a core about which the mixture swirls as it passes through the inlet port into the cell.

15. A radiant cell gas burner according to claim 14, wherein the passages in the tip are separated by partitions which, at the discharge ends of the passages, taper to knife edges slanted tangentially toward the axis and away from the plane of the inlet port and toward the base of the knob.

16. A radiant cell gas burner of the type in which a combustible mixture is fed into the narrowed inner end of an annular cell with a swirling motion to follow a spiral path of sufficiently fine axial lead to permit the completion of combustion largely within the cell, comprising an annular cell of refractory material open at its discharge end and narrowing from an inlet port at its inner end, a source of combustible mixture, under pressure, of gas and air, and a burner tip disposed to adjoin the inlet port and having arcuately spaced passages for receiving mixture from the supply and conducting it into the inlet port of the cell, the passages being arranged to extend in a direction generally parallel to the axis of the cell for a distance in the order of their radii from the axis and displaced from the axis radially beyond the inlet port, and then to turn inwardly to the inlet port in directions which, in plan, are tangential to a circle concentrically intermediate the margin of the inlet port and the axis of the cell and which, in radial section, are inwardly and somewhat cellwardly inclined.

ALONZO H. DON HOWE.