Sept. 2, 1958 G. J. FAIRBANKS 2,850,004

HIGH CAPACITY COMBUSTION HEATER

Filed Dec. 21, 1954 3 Sheets-Sheet 1

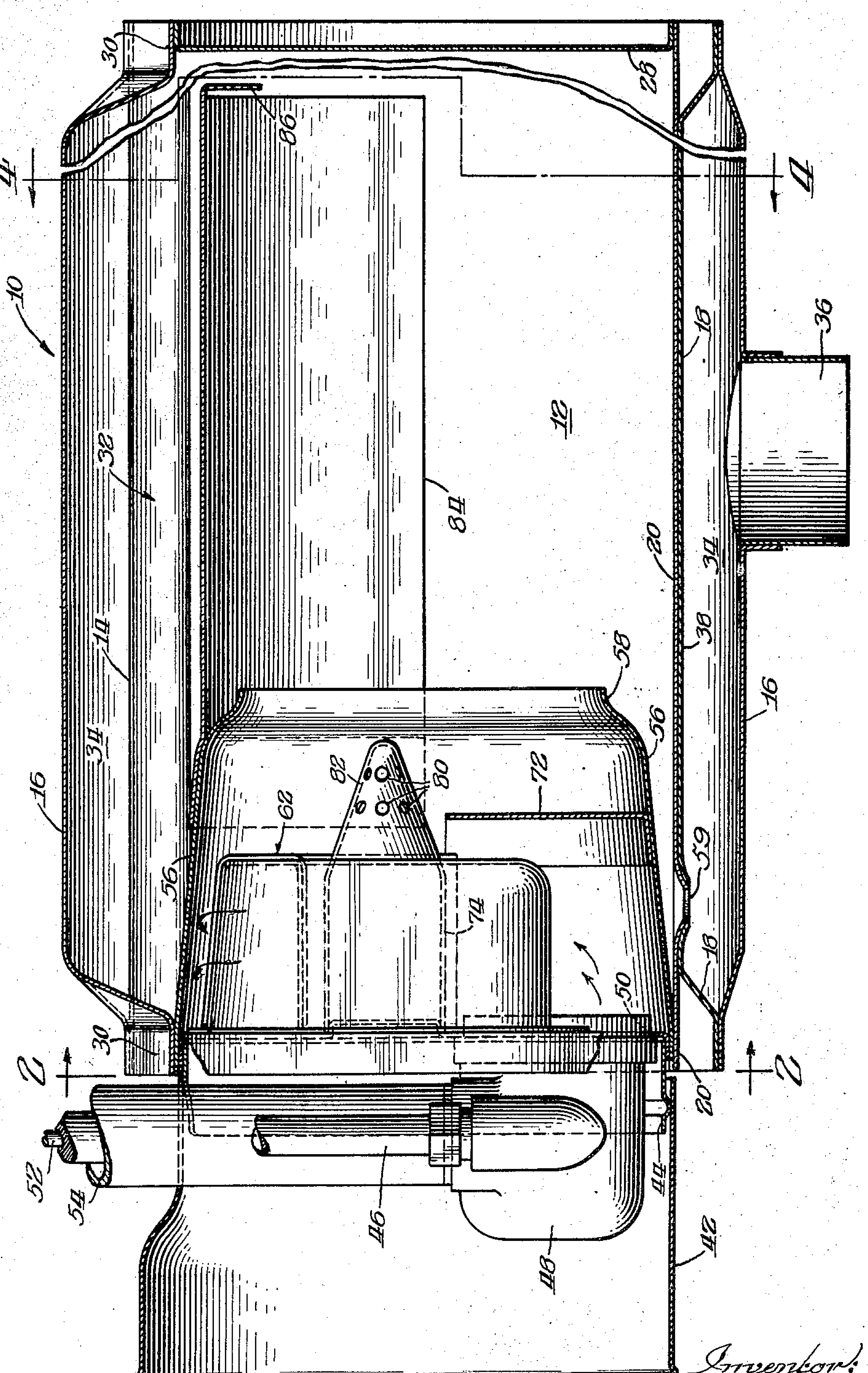

FIG. 1

Inventor:
Gordon J. Fairbanks
By Ahlberg, Wupper & Gradolph
Attorneys.

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Filed Dec. 21, 1954 3 Sheets-Sheet 2

Fig. 3

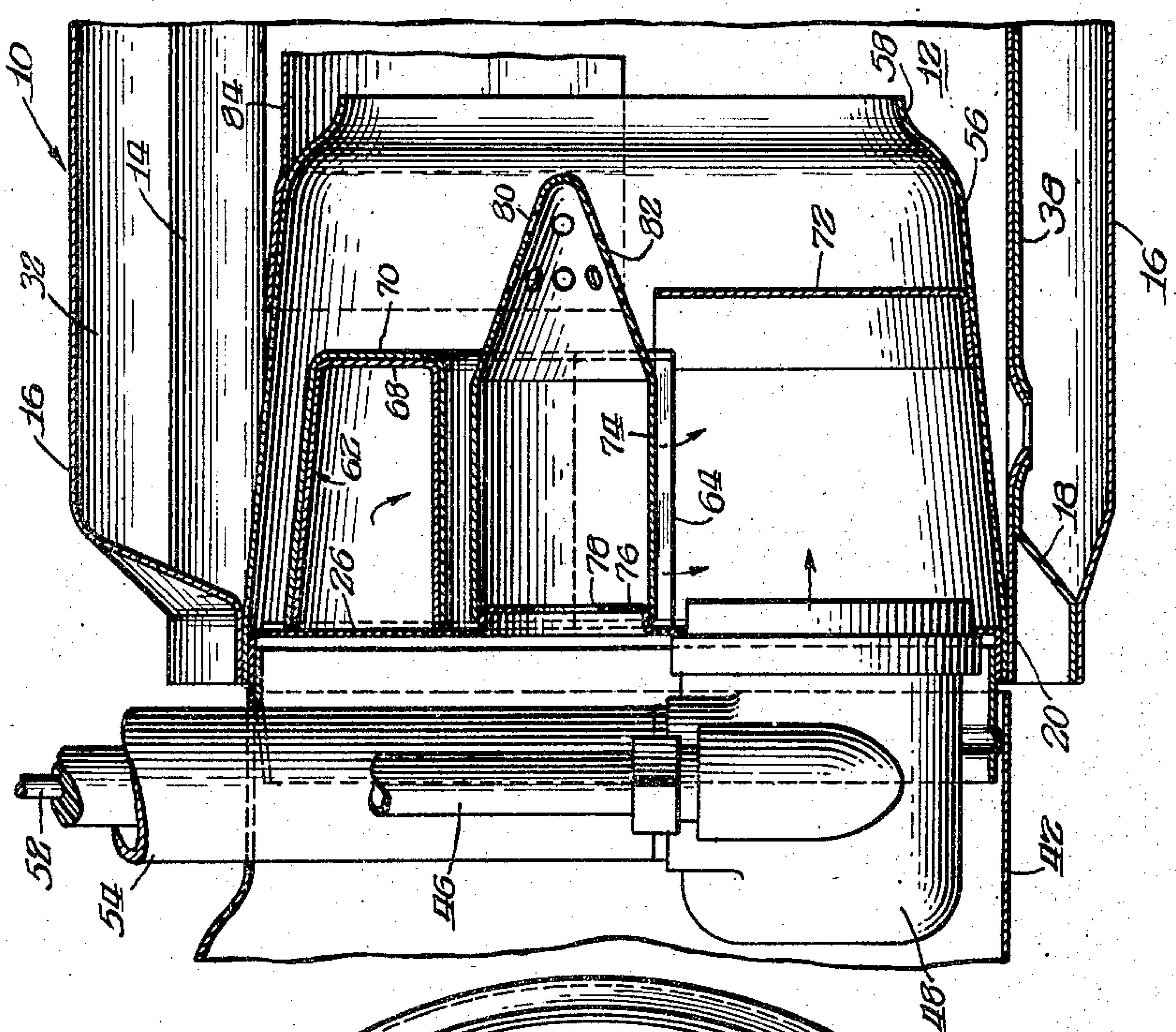
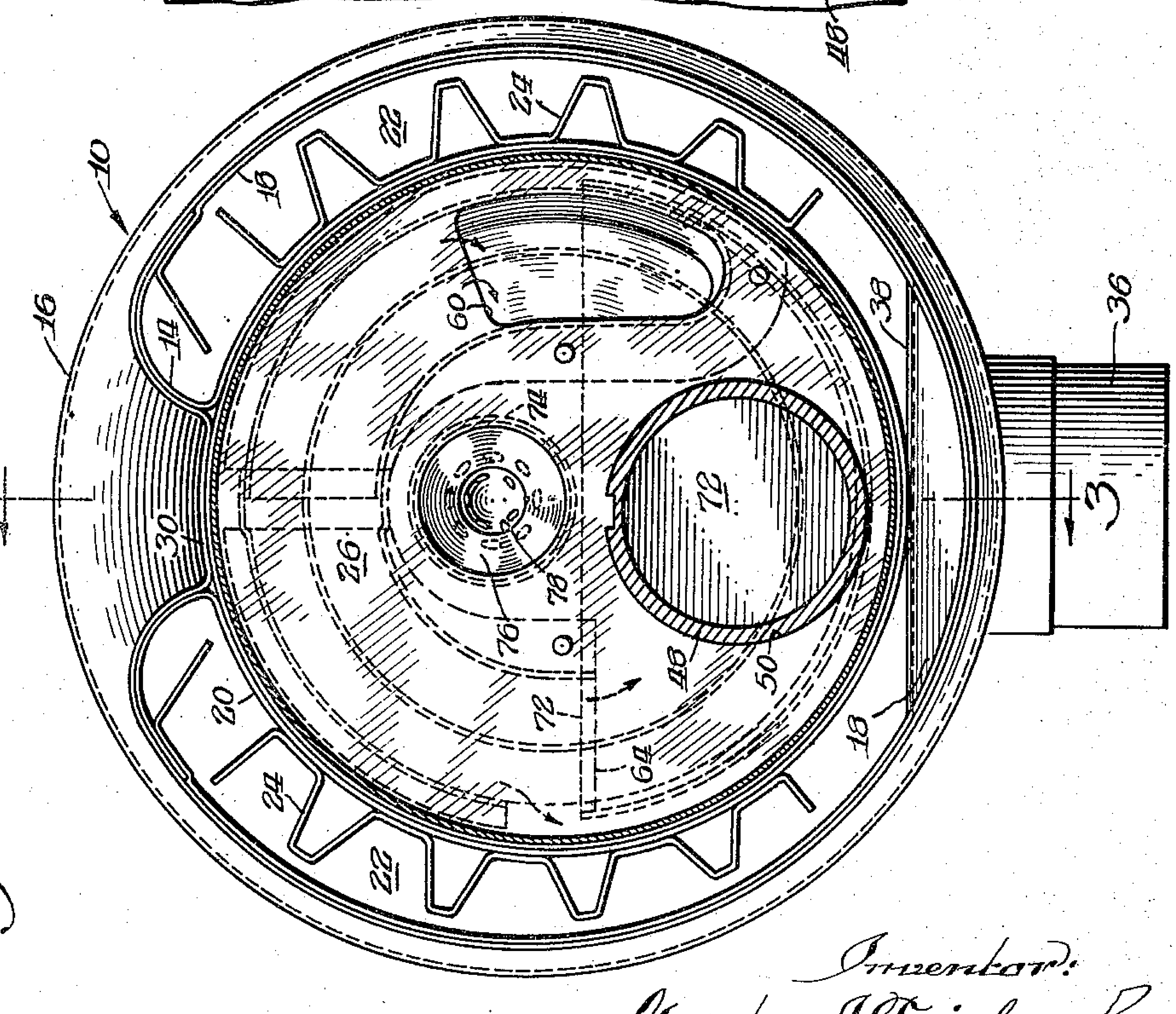


Fig. 2



Inventor:
Gordon J. Fairbanks
By Ahlberg, Wupper & Gradolph
Attorneys.

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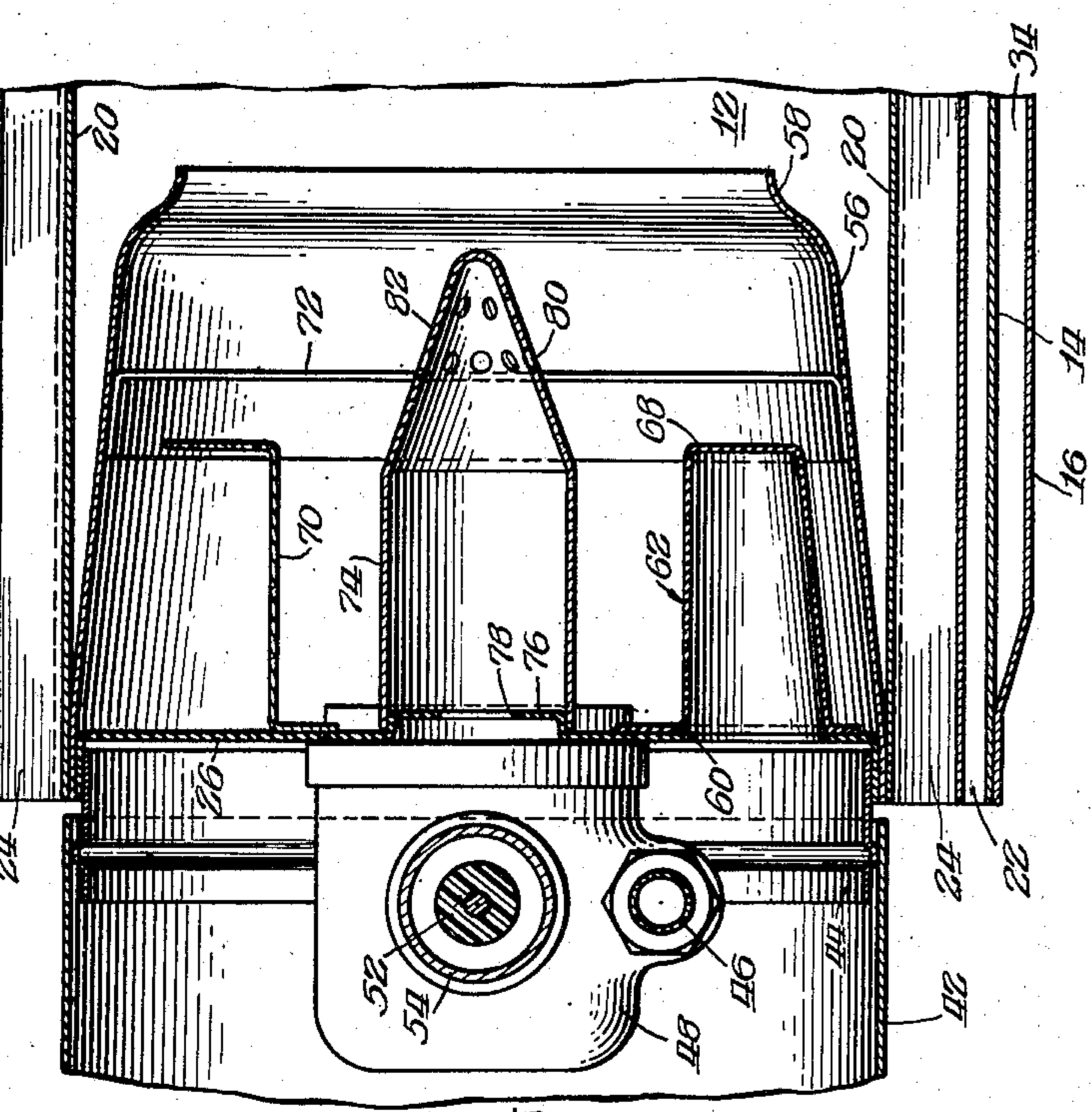

Fig. 5

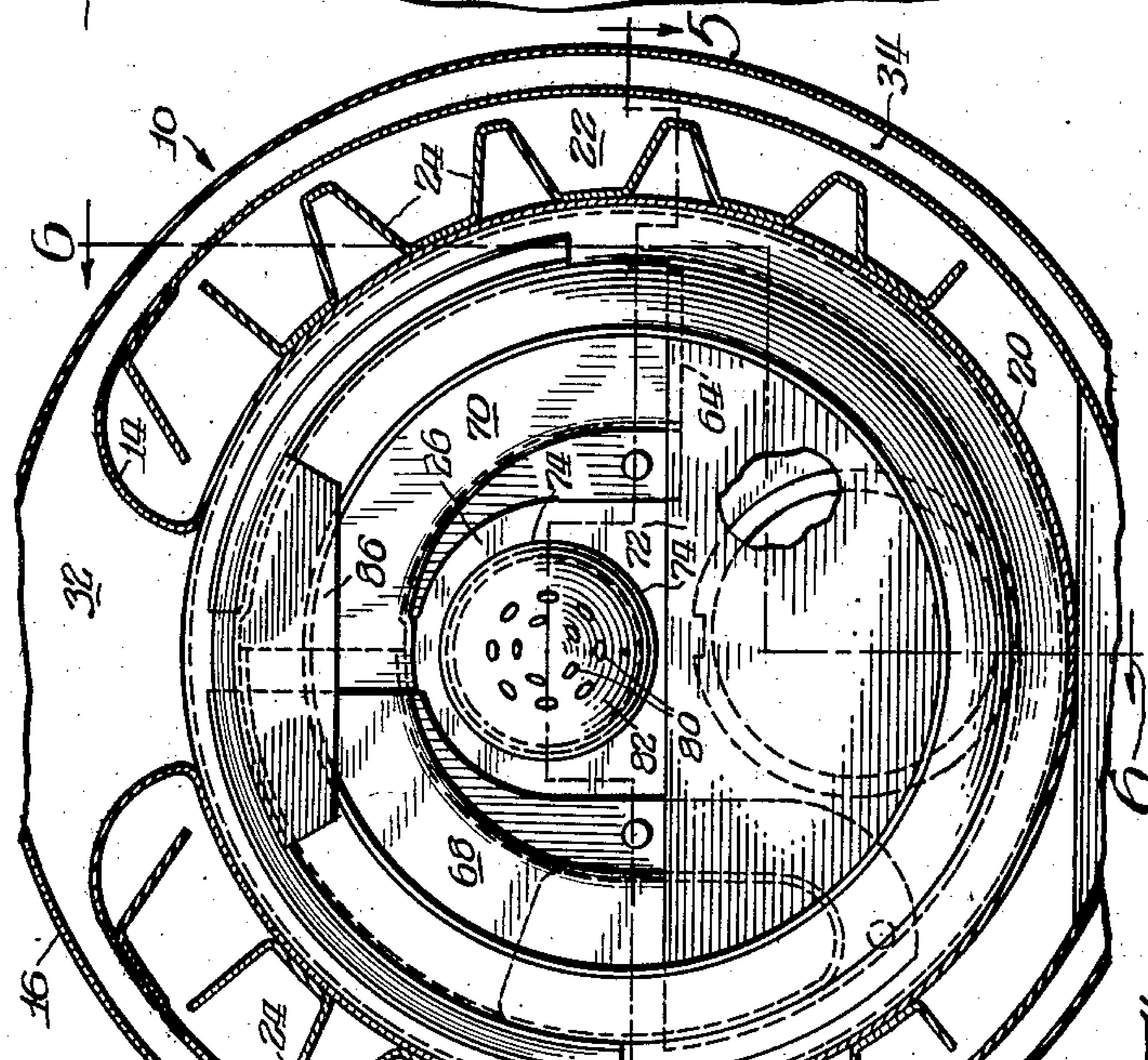

Fig. 4

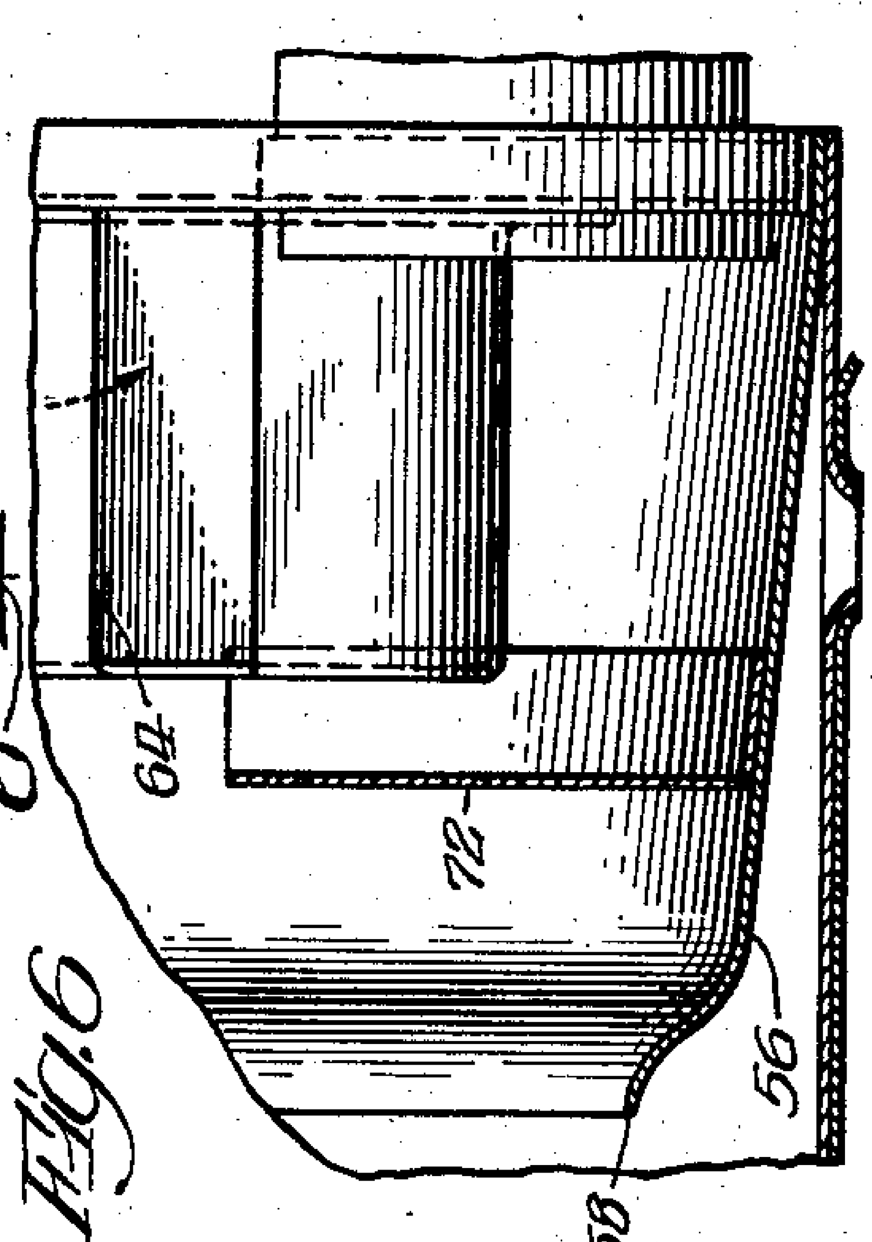

Fig. 6

Inventor:
Gordon J. Fairbanks
By Ahlberg, Wupper & Gradolph
Attorneys.

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HIGH CAPACITY COMBUSTION HEATER

Gordon J. Fairbanks, Indianapolis, Ind., assignor to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Application December 21, 1954, Serial No. 476,751

2 Claims. (Cl. 126—116)

The present invention relates to high capacity liquid fuel combustion heaters. It is highly desirable that heaters, such, for example, as are used for the heating of automotive vehicles, be of high capacity (e. g. 30,000 to 60,000 B. t. u. per hour) and that they be of minimum size and weight. To obtain these objectives in the heater of the present invention, the air which supports combustion is caused to flow at high velocity through a relatively small combustion space. Ordinarily this would tend to cause inefficiency due to poor mixing and incomplete or delayed burning of the liquid fuel in the high velocity stream of combustion air. However, in the heater of the present invention means are provided greatly to improve the efficiency of combustion and heat transfer, despite the high velocity at which the combustion air flows through the heater.

One object of the invention is to provide an improved heater in which the combustion efficiency is increased more completely to utilize the heating value of the fuel consumed and increase the heat output capacity of the heater, while at the same time preserving or decreasing the ratio of the size and weight of the heater to its heat output capacity.

A more specific object is to provide an improved heater of the above character in which the combustion efficiency is increased by improved preheating of the combustion air and a more thorough mixing of the fuel and air.

Another object is to provide a heater of the character recited in the previous object, in which premature exhausting of the burning fuel mixture from the combustion space is avoided and the hot combustion gases are evenly distributed to the heat transfer structure.

An additional object is to provide an improved heater of the character recited in the above objects which has a simple construction well adapted for economical manufacture.

Other objects and advantages will become apparent from the following description of the form of the invention illustrated in the drawings, in which:

Figure 1 is a longitudinal sectional view of the basic structure of a combustion heater embodying the invention;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical sectional view taken generally along the line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is a horizontal sectional view taken along the line 5—5 of Fig. 4; and

Fig. 6 is a fragmentary sectional view taken generally along the broken line 6—6 of Fig. 4.

The heater structure forming the illustrated embodiment of the invention comprises an elongated heat exchanger **10** surrounding a generally cylindrical combustion chamber **12**. For a more detailed description of

the specific heat exchanger shown reference may be made to the application of Frank A. Ryder, Combustion Heater Sheet Metal Heat Exchanger, Serial No. 388,096, filed October 26, 1953.

In general, the heat exchanger **10** shown comprises a folded sheet metal envelope **14** of generally C-shaped transverse configuration extending longitudinally through a cylindrical outer shell **16** in radially spaced relation to the shell. The circumferential end edges of the shell **16** are offset radially inward and welded or otherwise secured to the adjacent marginal edges of the outer fold **18** of the envelope **14**. The inner fold **20** of the envelope is radially spaced from the outer fold to form open ended longitudinal passages **22** through the heat exchanger for air to be heated. Heat transfer fin members **24** secured to the inner envelope fold **20** extend radially into the passages **22**.

Two vertical header plates **26** and **28** are fixed in opposite ends of the heat exchanger **10**, the peripheral edges of the headers being secured to the adjacent marginal edges of the inner envelope fold **20** and to end segments **30** of the shell **16**, Fig. 2, between the extremities of the upwardly open envelope. The headers **26**, **28** together with the envelope **14**, define the previously mentioned combustion chamber **12**, which opens upwardly through a longitudinal passageway **32**, formed by the horizontally spaced upper extremities of the envelope, Figs. 1 and 4. The passageway **32** connects with radially thin arcuate passages **34** extending circumferentially around the envelope **14** to an exhaust connection **36** in lower medial portion of the shell **16**.

To provide additional support to the envelope **14**, and to increase the effective size of the lower portion of the combustion gas passageway **34** which connects with the outlet **36**, the lower side of the outer envelope fold **18** is flattened upwardly at **38** to be contiguous with the inner fold **20**, Figs. 1 and 2.

Air to support combustion is supplied to the heater from conventional air scoop or blower structure (not shown) connected with a large conduit **42** extending to the left end of the heat exchanger **10**, Fig. 1, and connected by an annular coupling member **44** to the periphery of the header **26**. A fuel line **46** extends downwardly through the conduit **42** to a fuel supply fitting **48** of conventional construction which protrudes through an opening **50** in the lower central portion of the header **26**. An electric supply line **52** extends downwardly through a conduit **54** to the fitting **48** to energize a conventional electrical igniter (not shown) in the fitting.

The fuel supply fitting **48** discharges fuel through the header opening **50** into the lower portion of a truncated burner cone **56** having a small apex angle. The large end of the cone **56** is mounted for support between the periphery of the header **26** and the contiguous portions of the envelope **14** and the shell **16**. The shell **56** extends for a substantial distance into the combustion chamber **12** and is rolled inwardly at its free end **58** to a somewhat restricted diameter.

A small opening **59** formed through the bottom of the inner fold **20** and the outer fold **18** where they are brought together at **38** permits any liquid which might otherwise collect within the combustion chamber **12** to drain to the exhaust fitting at **36**. This opening is preferably located near the inlet end of the heater beneath the burner cone **56** so that the cone acts to baffle the opening to prevent an excessive gas flow therethrough. The two thicknesses of metal should be welded together around this opening to prevent leakage of combustion gases or liquid into the ventilating air stream.

Extremely efficient combustion is obtained through an improved mixing and burning of the fuel in a high velocity vortex of thoroughly preheated air, provision being made to avoid premature discharging of the burning gas by centrifugal force through the longitudinal combustion chamber outlet.

Combustion air supplied under pressure through the conduit **42** flows through an opening **60** in the central right hand portion of the header **26** (as viewed from the left in Fig. 1, see Fig. 2) into the closed end of a semicircular duct **62** attached to the inner face of the header **26**. From the opening **60**, the duct **62** extends circumferentially over and around the center of the header **26** in radially spaced relation to the burner cone **56** to a downwardly open end **64**, Figs. 3 to 6.

Structurally the duct 62 is formed from two arcuate sheet metal members 68, 70, U-shaped in transverse section, attached to the inner face of the header 26 in end to end overlapping relation to each other. The width of the duct **62** in transverse section preferably is somewhat greater along the axis of the burner cone **56** than in a radial direction from the center of cone, thus providing extensive heat transfer area to the air supplied through the duct.

After turning approximately 180° around the axis of the burner cone **56** in passing through the duct **62**, the air is directed downwardly from the outlet **64** of the duct with a high circular velocity which sweeps circumferentially over the lower inner surface of the cone **56** to pick up the fuel supplied from the fixture **48**. The flow of air along the axis of the cone **56** is blocked at this point by a semicircular baffle **72** spaced somewhat from the duct **62** toward the center of the combustion chamber **12** and extending vertically from the lower portion of the cone **56** to a horizontal upper edge slightly above the duct outlet opening **64**.

This structure sets up a high velocity vortex of burning fuel and air mixture which swirls around the air supply duct **62** to provide a high degree of preheating of the incoming air, which further improves volatilization and mixing of the fuel with the air. The swirling fuel and air mixture spills out of the burner cone **56** into the combustion chamber **12** as a high velocity vortex which continues the thorough mixing and burning of the fuel.

Additional or "secondary" air is supplied to the combustion chamber **12** through a cylindrical tube **74** substantially coaxial with the burner cone **56**. The outer end of the tube **74** embraces a circular support boss **76** swaged inwardly from the header **26**, Figs. 3 and 5. Air under pressure in the conduit **42** flows through a central opening **78** in the boss **76** into the tube **74** and through the tube to a series of outlet apertures **80** in a conical tip **82** on the tube, which extends somewhat beyond the vertical baffle **72** toward the center of the combustion chamber **12**.

The effective diameter of the swirling vortex of burning fuel mixture is reduced somewhat by the restricted inner end of the burner cone **56** as it passes by the conical secondary air supply cone **82**. Consequently, the streams of secondary air issuing from the apertures **80** are immediately caught in the swirling combustion gases. Although heated considerably in passing through the supply tube **74**, the secondary air introduced into the center of the swirling vortex of burning air and fuel is somewhat cooler and therefore heavier than the burning fuel mixture. Hence, as the secondary air picks up circular velocity it tends to move to the outer periphery of the vortex to be evenly distributed throughout the entire mixture for efficient combustion of the fuel.

The high circular velocity of the vortex of combustion gas discharged into the combustion chamber **12** creates centrifugal forces in the gas urging it radially toward the longitudinal combustion chamber outlet **32**. However, premature exhausting of the burning gas mixture from the combustion chamber is effectively suppressed by a sheet metal baffle **84** attached to the exterior surface of the inner end of the burner cone **56** opposite the passageway **32**. Semicircular in transverse section, the baffle **84** extends longitudinally through the major portion of the length of the combustion chamber **12** in radially spaced relation to the inner end of the passage **32** and to adjacent portions of the envelope **14** on opposite sides of the passageway. A projection **86** centrally located on the free end of the baffle **84** is turned radially inward.

Thus, despite the high circular velocity of the fuel mixture in the combustion chamber **12**, the hot gases are evenly distributed through the passageway **32** to the annular passages **34** by the pressure gradients created within the heat exchanger **10**.

The structure of the more efficient heater thus formed is well suited for economical fabrication largely from sheet metal.

While I have shown and described a preferred embodiment of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles and scope of the invention. I therefore desire, by the following claims, to include all such variations and modifications by which substantially the results of the invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A high capacity combustion air heater comprising, in combination, heat exchanger means defining a generally cylindrical horizontally elongated combustion chamber having an outlet opening extending longitudinally along one side thereof and a header at one end thereof, said heat exchanger means defining a combustion gas passageway communicating with the combustion chamber outlet opening and defining a passageway for air to be heated, an inwardly open burner cone extending into said combustion chamber from said header, the inner end of said cone being sharply necked inwardly, an arcuate duct attached to the inner face of said header in radially spaced substantially coaxial relation to the inner surface of said burner shell, said header defining an air inlet opening extending into one end of said duct, the opposite end of said duct opening downwardly toward the underlying portion of said burner shell, an upwardly extending baffle on the lower portion of said shell located forwardly of said duct outlet, means for supplying fuel into the lower portion of said burner shell between said header and said baffle, said header defining a second air inlet opening therethrough near the center of curvature of said duct, a tube on the inner face of said header communicating at one end with said second air inlet opening and extending forwardly substantially to the necked down end of said burner cone, the end of said tube opposite said header defining outlet openings for distributing secondary air to a vortex of a fuel air mixture formed by air admitted through said duct.

2. A high capacity combustion heater comprising, in combination, heat exchanger means defining a generally cylindrical horizontally disposed combustion chamber having an outlet opening along one side thereof and a header at one end thereof, said heat exchanger means defining a hot combustion gas passage communicating with said combustion chamber outlet opening, said heat exchanger means defining a passage for air to be heated, an annular burner shell opening into said combustion chamber from the inner face of said header, a semicircular duct attached to the inner face of said header and substantially coaxial therewith, said header defining a first air inlet communicating with one end of said duct, the opposite end of said duct opening downwardly into the underlying portion of said burner shell, a generally vertical baffle in the lower portion of said burner shell, means for supplying fuel into said burner shell between said header and said baffle, the medial portion of said

header defining a second air inlet therethrough, a tube connected with said second air inlet and extending beyond said duct toward the medial portion of said combustion chamber, the end of said tube remote from said header defining at least one air discharge opening for comingling secondary air with fuel in a vortex of air admitted through said duct, and a transversely curved baffle attached to said burner shell and extending longitudinally through the major portion of said combustion chamber in spaced covering relation to said outlet opening therefrom.

References Cited in the file of this patent

UNITED STATES PATENTS

858,285	Heuermann	June 25, 1907
1,455,076	Clymer	May 15, 1923
2,379,018	McCollum	June 26, 1945
2,507,081	Allen et al.	May 9, 1950
2,725,930	Hillery et al.	Dec. 6, 1955

FOREIGN PATENTS

616,007	Great Britain	Jan. 14, 1949