No. 787,941. PATENTED APR. 25, 1905.

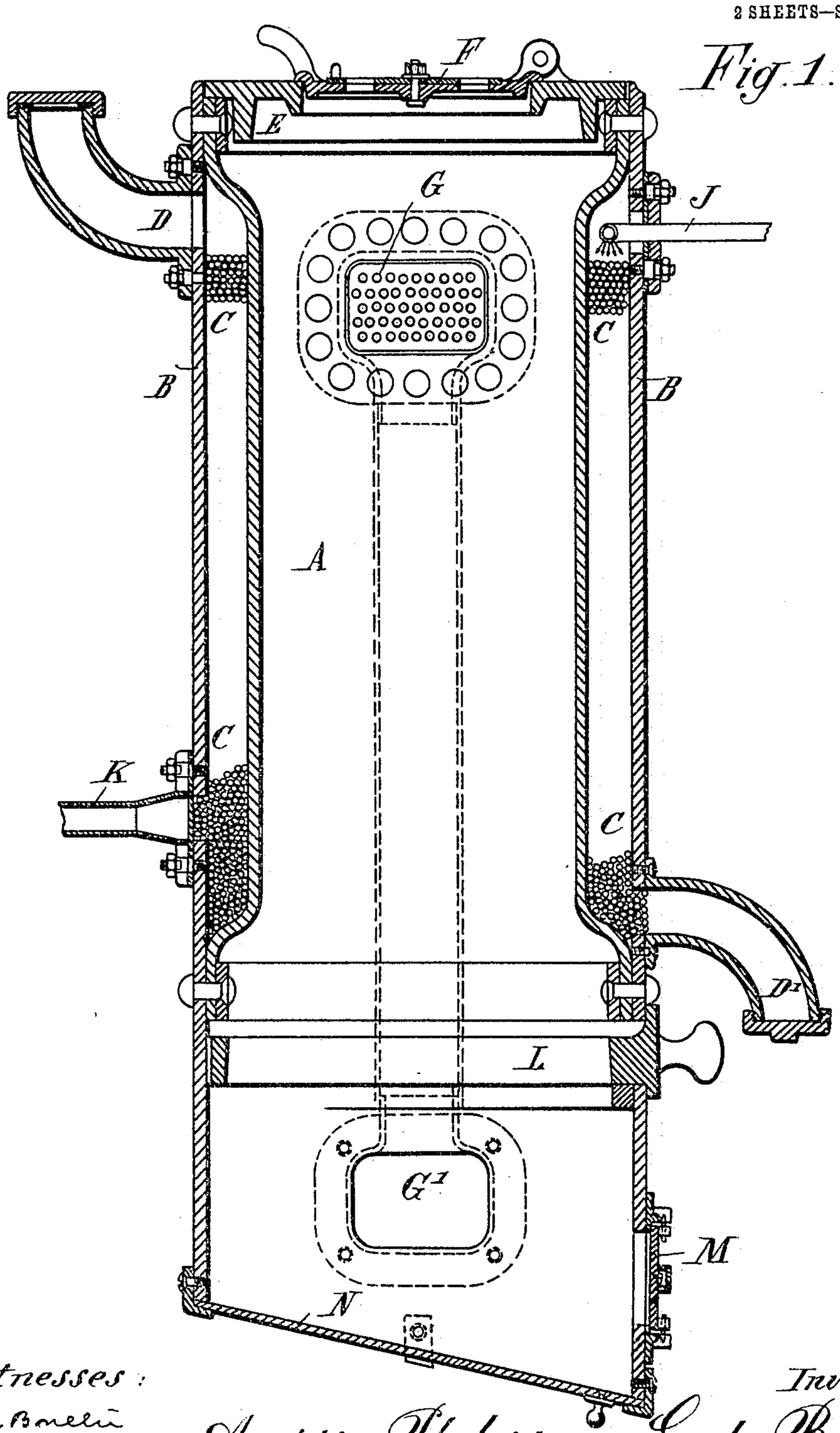
A. PHILLIPPE & E. BOIVIN.

STEAM GENERATOR.

APPLICATION FILED OCT. 6, 1902.

2 SHEETS—SHEET 1.

Fig. 1.



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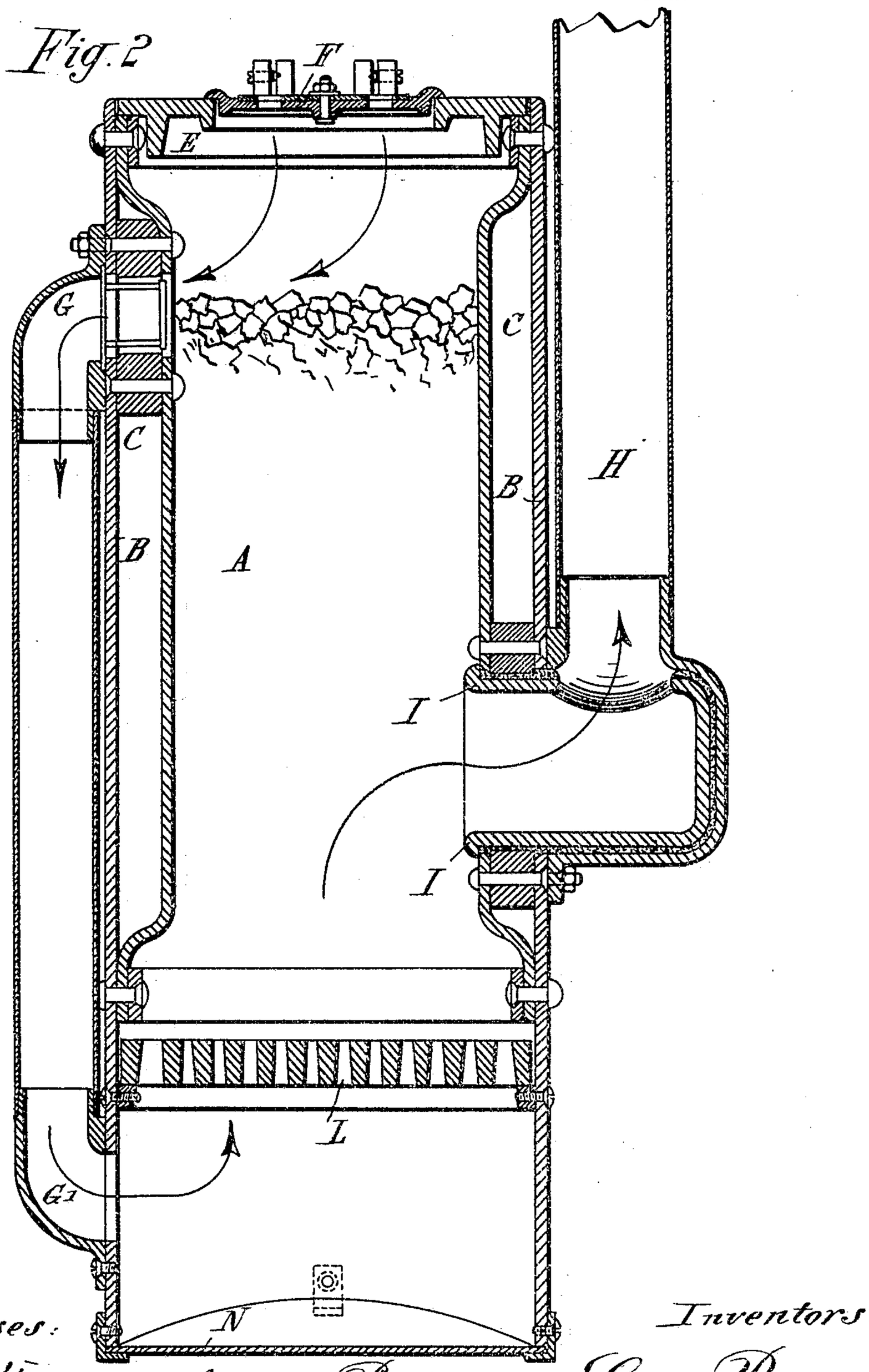
2 SHEETS—SHEET 2.

Fig. 2



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UNITED STATES PATENT OFFICE.

AMÉDÉE PHILIPPE AND EMILE BOIVIN, OF PARIS, FRANCE.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 787,941, dated April 25, 1905.

Application filed October 6, 1902. Serial No. 126,161.

To all whom it may concern:

Be it known that we, AMÉDÉE PHILIPPE and EMILE BOIVIN, citizens of the French Republic, and residents of Paris, France, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification.

In certain industries, particularly in automobile steam-traction for heavy loads, it is indispensable that the driver should be able to alter the power of the motor instantaneously, either for starting or for getting over a short declivity without changing speed or, finally, in order to avoid accidents on the road. For this purpose two means are at his disposition—driving through the slow-speed gearing while keeping the motor at the normal working or increasing the pressure of the steam, consequently the driving power, which may thus vary from the single to the double or the triple rate. This latter means is the more practical, provided that the generator is able to stand a very considerable pressure of the steam to produce instantaneously two or three times as much steam by its large heating-surface and has a body of metal sufficient for accumulating the quantity of heat units necessary for the formation of this steam without cooling, which would compel stoppages for the purpose of obtaining heat from the fireplace.

In order to facilitate the comprehension of this invention, we have annexed drawings to this description, and hereinafter will be given the calculations for a practical generator applicable to automobile-traction of heavy loads.

In the accompanying drawings, Figure 1 shows a side sectional elevation of the generator. Fig. 2 is a front sectional elevation, in which—

A is the inner shell of the boiler, forming fire-box, into which is charged the combustible.

B is the body of the outer shell, which will be covered or lined with a non-conductor of heat; C, the annular space or chamber between A B, which is filled with metal balls, such as worn cycle or badly-made balls or any other conductor of heat, the effect whereof being, first, to absorb and rapidly restore the heat generated in the fireplace A; second, to create within a limited cubical space a very large surface for heating by direct contact of the liquid and the saturated steam; third, to reduce considerably the space in which the liquid to be vaporized in placed.

D D′ are plugs whereby the balls may be introduced or withdrawn for cleaning when necessary; E, plate closing the upper part of the fire-box.

F is the door opened for charging the combustible. It is furnished with a circular damper pierced with holes corresponding to those of the door and by the opening whereof the required volume of air for combustion is easily regulated.

G G′ is a conduit by which the combustive air, the oxid of carbon, and the products of distillation flow and which mix among themselves in a proportion assuring their total reduction into carbonic acid before their introduction beneath the grate of the fire-box, from whence they pass through the burning combustible to be there reduced into carbonic acid with production of smoke.

H is the outlet-chimney for the carbonic acid. This chimney may be formed like an ordinary draft-chimney or one with a forced draft with the addition of a blower of any kind.

I is a lining of refractory earth protecting the base of the chimney from the action of the fire.

J is the inlet for water into the upper part of the generator, which is the least heated; K, outlet for the steam by the lower part of the generator, which is the most heated.

L is an ordinary cast iron or steel grate; M, a door for withdrawing the cinders; N, a movable plate closing the bottom of the cinder-box and for preventing cinders from falling upon the road and which is easily removable to permit the inside inspection of the fire-box A.

Heating-surface.—With a generator 0.500 meter in diameter and one meter in height above the fire-bars we obtain by the introduction of 47 d^3 of balls in the circular space a heating-surface of 53 m^2 plus the surface of

the fire-box—say a total of 54 m^2 of effective surface. As a fact one cubic decimeter contains about fourteen thousand five hundred and eighty balls of a mean diameter of 0.005 $X4\pi R^2 = 1$ $m^2 145$. This cubic decimeter minus the spaces between balls weighs seven kilos. Comparatively one M^2 of heating-surface of sheet metal resisting twenty kilos of steam-pressure would weigh ninety-three kilos. The same surface obtained by the pipes of a tubular boiler would weigh twenty-two kilos. Thus, the heating-surface being equal, we effect a great economy in weight.

Heat-accumulator.—The circular space in our generator containing 47 d^3 of balls weighing three hundred and thirty kilos and heated to 350°, the specific heat of iron being 0.125 unit of heat, we accumulate a reserve of heat of about ten thousand heat units, capable of instantaneously generating thirteen kilos of steam at a tension of twenty-five atmospheres.

No water-reservoir—No explosion.—One of the peculiarities of our form of generator is the absence of a water-reservoir in which steam is formed by convection. In fact, we introduce at each stroke of the feed-pump and according to the requirement of the hand-pump only the quantity of superheated water necessary for one cylinder of the motor-piston. The water introduced, which is quickly in contact with the first layers of balls, is converted into saturated steam, which flows away at the lower part of the generator after taking a rather long course through the balls, whereby it is superheated and thoroughly dried before acting on the motor-pistons. Thus even in the case of the sheet-iron of the body of the boiler being rent no disastrous consequences can arise.

No burning.—The body of our generator comprises two concentric cylinders with a circular space between them of 0.050 *m* which added to the thicknesses of the sheet-iron forms a total thickness of 0 *m* 0776, which is perfectly non-conductive of heat, which consequently cannot become red-hot through the intensity of our small fireplace, even when working with a forced draft.

Smoke-consumer.—The arrangement which we have considered in the construction of the fireplace has two principal advantages, the smaller of which is the power of putting on a large quantity of fuel without introducing cold air. For this purpose the upper part of the fire-box is formed by a fixed plate and a trap through which the fuel is introduced. This trap is furnished with a movable register placed near the stoker, who increases or reduces the force of this fire by opening or closing this register to a certain extent according to requirements for the purpose of consuming the smoke. This register being entirely closed, combustion ceases without the fire being extinguished, whereby economy of fuel is effected when the vehicle is stationary. Moreover, if we consider the operation of the fire we find the greatest degree of incandescence at and above the grate. Above this zone the less vigorous combustion produces oxid of carbon, which is recognizable by its blue flame. Above the heat distils the volatile products of the fuel that forms the smoke, which is a gaseous combustible. As the draft through the chimney takes effect at 0.300 *m* above the grate, these different gases, oxid of carbon, and products of distillation ascend freely toward the upper part of the fire-box, where in proportion as they are produced they mix with the cold combustive air, the introduction of which is regulated by their perfect combustion. This mixture is of course effected by the draft of the chimney. It passes into a special conduit which carries it under the grate, and then brings it into contact with the most incandescent fuel before its discharge through the carbonic-acid chimney, from which nothing issues but colorless carbonic acid. This arrangement insuring the complete comsumption of smoke is equally suitable for generators used in factories, where it affords the advantage of considerable economy and enables the tall brick chimneys to be dispensed with.

Having now fully described our invention, what we claim, and desire to secure by Letters Patent, is—

In a steam-generator, the combination with an inner shell A forming a fire-box, of an outer shell B, said shells being separated from each other to form a steam and water space surrounding the inner shell, heat-conducting bodies arranged within the steam and water space, a door closing the upper end of the shell A, and having air-inlet openings, a grate within said shell A at a point just below the lower end of the steam and water space, a conduit G, G′, arranged exteriorly of the outer shell B with its upper end leading from near the upper end of the shell A and its opposite or lower end discharging within the shell A at a point below the grate, an outlet H for products of combustion leading from the inner shell at a point above the grate, an outlet K for steam leading from the lower part of the water and steam space, and an inlet for water leading into the upper part of the steam-space, the outer shell being provided with charging and discharging openings for the heat-conducting bodies.

In testimony whereof we have hereunto set our hands in presence of two witnesses.

AMÉDÉE PHILIPPE.
EMILE BOIVIN.

Witnesses:
ADOLPHE STURM,
EDWARD P. MACLEAN.