E. ANDERSON.

EXHAUST GAS TURBINE AND SILENCER.

APPLICATION FILED MAR. 6, 1916.

1,304,928.

Patented May 27, 1919.

2 SHEETS—SHEET 1.

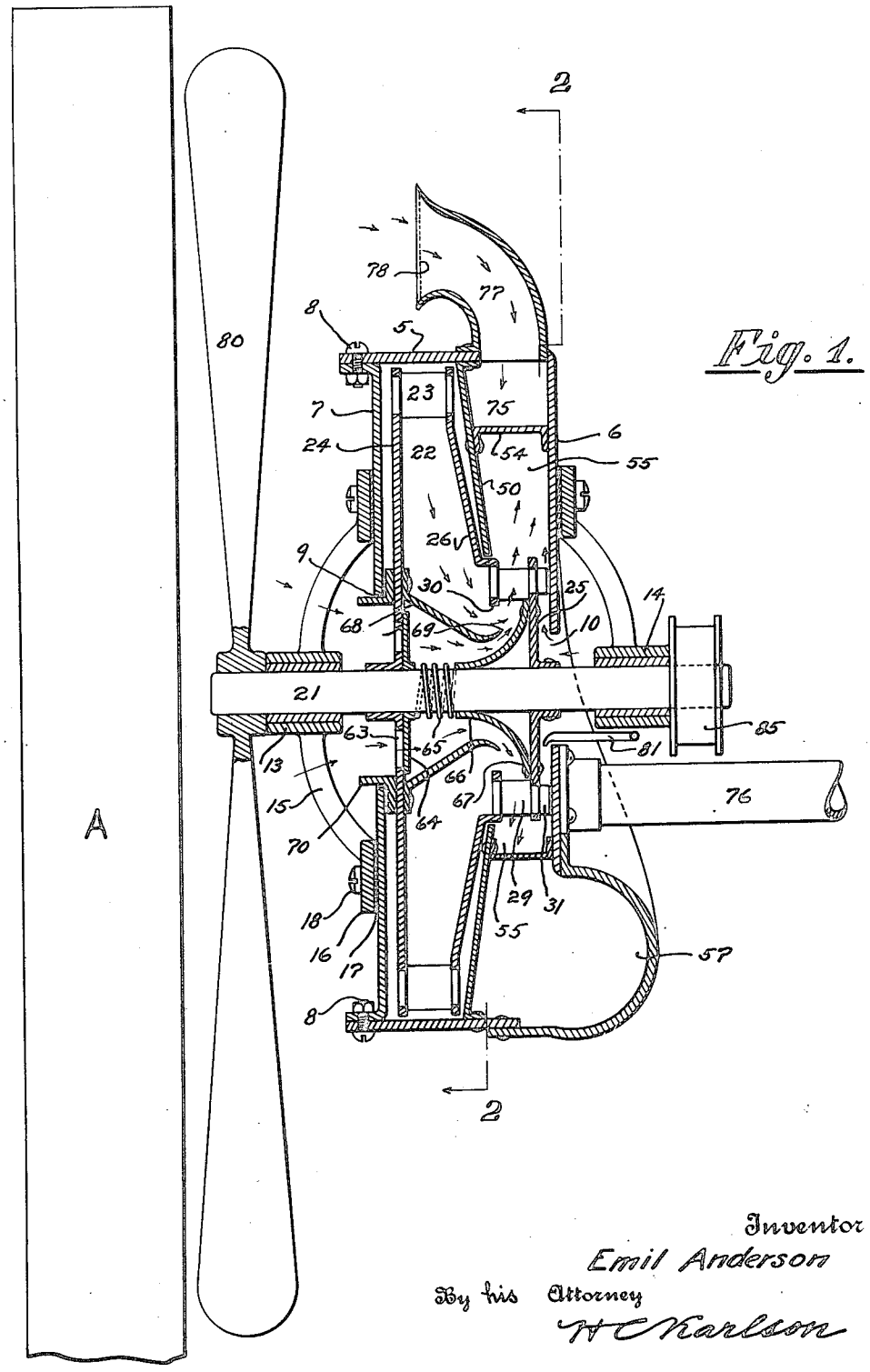


Fig. 1.

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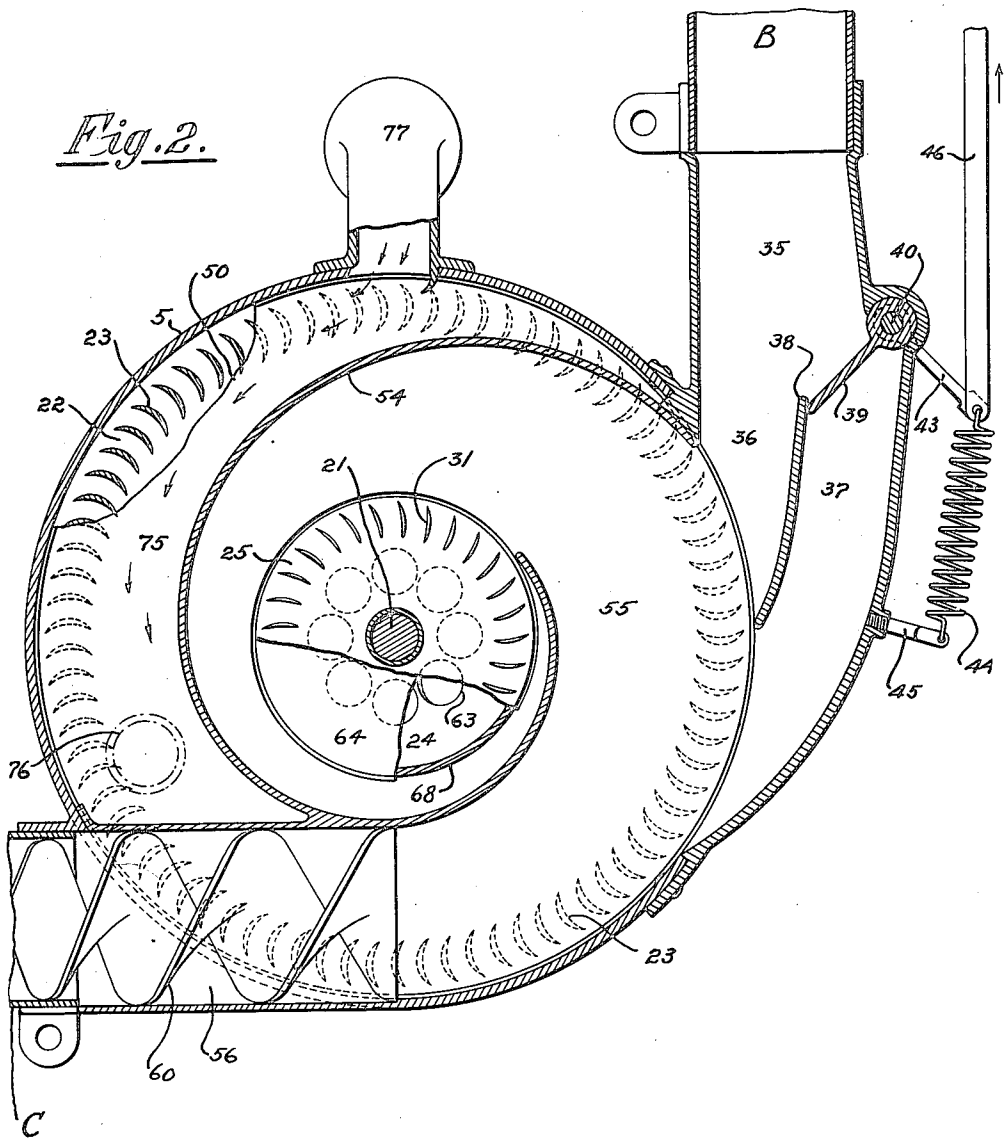
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2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

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EXHAUST-GAS TURBINE AND SILENCER.

1,304,928. Specification of Letters Patent. Patented May 27, 1919.

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To all whom it may concern:

Be it known that I, EMIL ANDERSON, a citizen of the United States, and resident of the city of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Exhaust-Gas Turbines and Silencers, of which the following is a specification.

This invention relates to an improved device adapted to be driven by the exhaust gases issuing from a thermo-dynamic motor, and more especially appertains to a turbine connected up with the outlet pipe of an internal combustion engine in such a manner as to utilize the available energy of expansion and impulse remaining in the burned gases, while reducing the latter to perfect quiescence and uniformity of flow.

The principal object of the present invention is to produce an improved self-contained device of the character described, which shall be capable of performing the following named functions, to wit:

Firstly, to utilize the maximum energy remaining in the otherwise wasted products of combustion from a gas or oil engine, without creating an appreciable back-pressure upon the latter by converting the inherent force of the burned gases into velocity through expansion of their volume, from the moment they leave the exhaust port.

Secondly, to maintain a constant velocity of the exhaust gases entering the turbine, irrespective of the power developed in the engine, by graduating the area for their admission to the turbine's buckets or vanes in conformity with the pressure of the gases supplied thereto, or in proportion to the amount of mixture introduced into the engine cylinders.

Thirdly, to chill to a lower degree the exhaust gases, already cooled by expansion and performance of useful work, through the medium of a current of external air forcibly mixed therewith, which will further serve to fill the interstices occurring between the pulsations from the different cylinders, so as to deaden the sound usually produced by the exhaust puffs following one another.

Fourthly, to preserve the speed of the mixed air and exhaust gases, so that they will be kept moving toward the exit end of the outlet pipe, notwithstanding incurred sluggishness due to their cooling off, which otherwise might cause a clogging effect at the outlet.

Fifthly, to take advantage of the heat existing in the exhaust gases by using it in drying and warming air needed for the carburation of the engine fuel,—this air being incidentally maintained under a slight pressure, for the twofold purpose of causing it to absorb the heat from surfaces that confine the same, and also aiding to effect a more complete delivery of the new charges to the cylinders during the suction period than is possible when the pistons alone are relied upon to draw in the required quantities of fresh mixture, when it mostly always incompletely fills the cylinders.

Sixthly, to afford inlets for the air to be mixed with the spent gases that first enable the former to pass over and keep cool the bearings for the turbine wheel, and subsequently permit portions of this air to join the used gases at such places where the latter would be apt to seek an escape, thereby sealing them up effectively.

Seventhly, to impart to the cooled, mixed air and exhaust gases a helical translatory movement in the final outlet pipe, so that when they issue together out in the atmosphere the acoustic waves set up by the exhaust discharges will be completely annihilated.

A further object is the production of an incomplex efficient secondary motor of the nature set forth, which shall be driven solely by the waste gases from an internal combustion prime mover, for example, an automobile engine, and have adequate power to operate the cooling fan for the radiator thereof, as well as to work the water circulating pump and storage-battery charging-dynamo, so that the energy consumed by the auxiliaries mentioned can be saved and added to that of the engine, making the latter less complicated, while running the accessories without cost through the economy effected, besides increasing the flexible relation between the main motor itself and its said appurtenances, for instance, in that the speed at which the fan and the pump run is made dependent upon the power generated, and not on the number of revolutions of the engine as is now the case.

Another object is to provide an exhaust

motor and silencer of the species named, which shall be of plain and compact design, as well as composed of few, durable parts, amenable to low cost of production, easy to install, and simple to operate.

Other objects and advantages will become apparent as the specification proceeds.

The advantages of the invention, as above outlined, are best realized when all of its features and instrumentalities are combined in one and the same structure, but useful devices may be produced embodying less than the whole. It will be obvious to those skilled in the art to which the invention appertains, upon becoming conversant with the details thereof, that the same may be incorporated in several different constructions. The accompanying drawings, therefore, are submitted herewith as showing merely the preferred exemplification of the invention.

In the said drawings:—

Figure 1 is a central longitudinal section of this improved exhaust gas turbine and silencer, showing also a portion of an automobile radiator in side elevation; and

Fig. 2 is a transverse section extending irregularly along the line 2—2 of Fig. 1, looking in the direction pointed out by the arrows.

In these views, the numeral 5 denotes a casing, which in the present instance is located in the rear of an automobile radiator A, that is, between the engine (not shown) and its radiator. This casing may be supported in any suitable manner from the chassis, or otherwise, under the engine hood. It is preferably made cylindrical, comprising a circular body 5, rear head 6, which may be formed integral therewith, and a front head 7, detachably held, as by bolts 8, for convenience of insertion, removal and inspection of internally disposed elements. The said heads 6 and 7, are provided with central openings 9 and 10 respectively, which may be of different sizes as shown. Concentrically arranged with relation to these openings and the casing are outboard bearings 13, 14, held at certain distances from the heads, both to avoid transference of heat from the latter and to give free access of air to the before mentioned central openings, which air also serves to keep the bearings cool in passing over them. As shown, the bearing 13 is carried from the head 7, by arms 15, having pads 16, at their outer ends, which are secured, with interposed layers of insulating material 17, such as asbestos, to the said head, as by means of screws 18. The other bearing 14 is held in a similar manner to the rear head 6.

A shaft 21 is journaled in the bearings 13 and 14, preferably extending beyond the same at both front and rear. Fixedly mounted on this shaft, within the casing 5, is a turbine wheel or rotor 22, carrying vanes or buckets 23. Although the latter are shown as being of radial impulse type, arranged for internal flow, it is understood that any other type and arrangement thereof may answer the same purpose.

In its preferred embodiment, the said turbine wheel is hollow, and in the main composed of three disks, 24, 25 and 26, of varying dimensions. Of these disks, the largest one (24) is adjacent to the front head 7, while the smallest (25) lies contiguous to the rear head 6, and the third (26) occurs intermediately of the two others. It will be noted that the middle disk 26 has the same external diameter as the front disk 24, but interiorly stops short of the center of the wheel.

The aforementioned vanes 23, as seen in Fig. 1, are formed with appropriate shoulders, secured in slots provided therefor in or near the outer margins of the said disks 24 and 26, so as to hold and space the latter at the proper interval apart. The rear disk 25 laps over the rim of the opening 10 in the rear head 6, for a predetermined distance all the way around, and is further provided with suitable apertures, adjacent to its periphery, for the reception of retaining shoulders pertaining to vanes, 29, at the outer ends thereof. Other shoulders on the inner ends of the latter named vanes serve to anchor them in a flange 30, which forms an internal rim for the intermediate disk 26. The vanes 29, which are arranged to one side of and around a less perimeter than the vanes 23, constitute an expeller for emptying the interior of the wheel of its contents. The shoulders of the said vanes 29 that are secured in the disk 25 project for a certain distance beyond the latter into the space between it and the rear head 6, as indicated at 31, thereby affording a supplementary suction means for urging an outside cooling medium into the casing 5, through the opening 10.

In Fig. 2 is represented a portion of a pipe B, leading from the exhaust manifold of the engine to which the invention is applied. The spent gases, as they leave the ports of the latter, can be expanded down to a pressure of one pound or less above or below that of the atmosphere, thus converting pressure into volume, and as a consequence into velocity. As shown, this pipe is attached by clamping it to one end of a nozzle or inlet 35, the other end whereof communicates directly with the casing 5 through one side thereof, and issues tangentially against the outer row of vanes 23. Preferably, the part of the nozzle where the gases issue is divided, the present exemplification showing two divisions 36, 37. It is obvious, however, that any other suitable number may be employed. The advantage of a sub-

divided nozzle or inlet resides in that it affords a means of keeping the flow of burnt gases constant against the vanes of the turbine, as the power of the engine varies with the speed of the car, or on account of additional work imposed upon it while climbing grades, and the exhausted products of combustion bear a certain relation to the power generated. Hence the desirability of a small port area when the engine is running light, and a larger one when a maximum of gases is being delivered. With this purpose in view, a partition 38 is made to separate the said inlet divisions 36, 37 and a closure 39, pivoted to one side within the nozzle, as at 40, in such a way as to offer the least obstruction when fully open, is arranged to coact with this partition in shutting off the gases from one division to the other, deviating the same, for instance, from 37, and directing them into 36.

Means are provided for regulating the said closure in accordance with the pressure of the exhaust gases in the nozzle, the adjustment being effected either automatically, or manually, or in both ways. To this end, a lever 43 is coupled up with the closure 39, on the outside of the nozzle 35, and a yielding medium, as a spring 44, is attached at one terminal to the outer end of the said lever and with its other terminal to an arm 45, projecting outwardly from one side of the nozzle. As the pressure increases with the load on the engine, the resiliency of the spring permits the closure 39 to open automatically and expose a greater number of vanes to the action of the gases, and the reverse condition obtains with a decrease of pressure. The manual operation, if resorted to, may be effected by a link 46. Either or both of these methods of adjusting the closure may thus be used, independently or combined. Although but one divided nozzle has been shown and described, it is within the realm of the invention to employ a plurality of similar nozzles, disposed around the circumference of the turbine wheel, depending upon the volume of exhaust gases supplied and to be liberated.

Within the outer casing 5, and to one side of the plane of rotation of the intermediate disk 26 pertaining to the turbine wheel, is a transverse wall 50, attached at its edges to the body of the casing and extending close to the internal rim 30 of the said disk. An interior partition 54 is placed between this wall 50 and the rear head 6, the same being set substantially perpendicular to the head, and commencing in approximately tangential alinement with the lower edge of the small disk 25, and thence extending outwardly according to an involute spiral, terminating at a point substantially opposite the intersection of one side of the nozzle 35 with the casing. The spent and mixed gases, as they are expelled by the vanes 29 from within the wheel 22, are collected in a gradually widening chamber 55, formed by the said partition 54 and adjacent inside portions of the wall 50 and head 6, and thence are led out through a duct 56, into the final exit pipe C. The said chamber and duct may be swelled out or widened exteriorly of the casing on one side, as shown at 57, so as to accommodate the continually increasing volume of the now mixed inert gases.

Extending a suitable distance from within the duct 56 into the outlet pipe C, is a helically twisted deflector 60, which serves as a means of destroying the acoustic waves that would redound from the external atmosphere by the forceful impingement of the spent gases thereagainst. The said reflector starts with a sharp pitch, which is gaged so as to impart a gradual twist or turning movement to the gases as they pass along within the pipe, and the pitch is made to diminish by degrees or become lower farther in the pipe, whereby the rotative motion of the gases is accelerated, as they flow outward.

The central portion of the front disk 24, exposed within the opening 9 of the head 7, is provided with ports 63, for the admission of air, which are kept normally closed by a single valvular means, presently to be described. The latter named means is shown as consisting of a discoidal plate 64, slidably engaging the shaft 21, and kept against the air admitting ports 63, by one end of a spring 65, coiled around the shaft. The other end of the said spring abuts on the vertex of a conoidal shell 66. This shell is also mounted upon the shaft and has its flaring base 67 fastened to the inner face of the near disk 25, adjacent to the inner periphery of the wheel's vanes 29, so as to rotate therewith, while forming one of the members of an internal air-guide. The coacting member for the latter consists of the interior of another conical shell 68, secured to the inner face of the front disk 24 of the wheel. This forward member of the air-guide projects for approximately one-half of its length over the rear member, and has its contracted end turned outwardly, from the latter, as at 69, to constitute an annular air-inlet to the interior of the turbine wheel. The said turned end 69 is given substantially the same curvature as that of the inner or rear guide cone to facilitate deflection of the air to be mixed with the spent gases, and the urging thereof by the expeller vanes 29 for progressive transition into the previously mentioned collecting chamber 55.

The space between the front disk 24 and the inner face of the inner head 7, around the opening 9, is occupied by a flanged ring 70, which seals this opening in two planes and prevents leakage of such gases as might

escape from between the impulse vanes 23, or the nozzle 35.

The compression spring 65 is sufficient under normal conditions to hold the valve disk 64 seated against the ports 63, but as the wheel rotates and the internal suction produced by the expulsion vanes 29 increases, the said valve will recede from the ports in proportion to the speed, thus admitting a correspondingly larger volume of cold air into the interior of the wheel in direct ratio to its velocity.

A compartment 75, complementary to the collecting chamber 55, is formed at one side of the latter within the body of the casing 5, between the rear head 6, part of the wall, 50, and the involute partition 54. The compartment 75 constitutes a pre-heater for the air used in the carburation of the fuel for the engine, and is connected up with the carbureter or vaporizer of the latter by means of a pipe 76, communicating with the lower part of the said compartment. The entrance of air into this pre-heating compartment takes place through a cowl 77, placed as shown outside the casing, on top thereof, and provided with a screen 78, to preclude admission of foreign matter with the air.

At the forward end of the shaft 21 is fixed a fan 80, for drawing air through the radiator A and promoting its circulation in the usual manner. The air thus set in motion by the fan is thrown rearward with a certain velocity or equivalent pressure, and a part thereof, filtered by the screened cowl 77, flows into the preheating compartment 75, maintaining a slight over-pressure in the pipe 76 and thereto connected carbureter, so that when the inlet valves of the engine open during the suction period, the pistons are relieved of considerable work in over-coming the inertia of the new charge while drawing the same into the cylinders.

The present drawings show only one preheating compartment and one collecting chamber, disposed at the rear end of the casing, but it is manifest that in exhaust turbines with larger wheels or having a plurality of inlet nozzles, two or more such chambers and compartments could be incorporated with the structure, for instance at the front as well as in the rear of the casing.

In cases where a liberal supply of water can be had, for example, in marine use, it is contemplated to employ a fine stream or spray thereof, which may be delivered, as indicated at 81, to the supplementary, seal-effectuating, extension vanes, 31. Due to the rapid rotation of the latter, the water admitted will be beaten into a very fine subdivided state, and then drawn into and mixed with the spent gases in the chamber 55, thereby assisting in further cooling them off.

At the rear end of the shaft 21 is indicated a drive connection 85, for the auxiliaries of the engine, such as the pump which maintains the circulation of water between the cylinder jackets and the radiator, and the dynamo that charges the secondary batteries employed for the lighting, ignition, and starting systems. The said connection may be a belt-pulley, as shown, or a gear, a sprocket, or other approved form of power transmitting element.

The several functions of the divers constituents of the improved self-contained exhaust gas turbine and silencer disclosed herein have been so fully brought out already as to make the *modus operandi* thereof quite clear, and for that reason, as well as to obviate an annoying superfluity, no attempt will be made to recapitulate the same at the end of the present specification.

Notwithstanding that this improved device has been described solely in conjunction with an automobile engine, it is understood that no limitation in that sense is at all intended, since the device can be used with equal benefit in marine, aeronautical, and stationary engine practice. Furthermore, the power realized by the same may be reverted, to wit, conveyed back to its original source, the prime mover, through any suitable instrumentality known in the arts.

Having described my invention, what I desire to secure by Letters Patent, and claim, is:—

1. The combination with the exhaust of a combustion engine, of a turbine adapted to receive the gases from said exhaust, an inlet to said turbine admitting air into the same to be mixed with the expended gases therefrom, and a valve for said inlet.

2. The combination with the exhaust of a combustion engine, of a turbine arranged to receive the gases from said exhaust so as to be rotated thereby, an inlet for admission of air to be mixed with the expended gases from said turbine, and a valve for said inlet automatically controlled by the speed of the turbine.

3. The combination with the exhaust of combustion engine, of a turbine positioned to receive the hot gases from said exhaust, means for preheating air for the engine through the agency of said gases, an air inlet to said preheating means, and an agitating element operated by the turbine delivering air under pressure to said inlet.

4. The combination with the exhaust of a combustion engine, of a turbine adapted to receive the gases from said exhaust so as to be impelled thereby, means for preheating air within said turbine through the action of the spent gases from the latter for delivery to the engine carbureter, and a fan actuated by the turbine operating to draw air and forcibly feed a portion thereof to said preheating means.

5. The combination with the exhaust of a

combustion engine, of a turbine wheel positioned to receive the gases from said exhaust, a casing inclosing said wheel, including a compartment for preheating air for the engine through the agency of the spent gases from the turbine, an air inlet to said compartment, and an element moved by the turbine operating to deliver air to said inlet.

6. A device for the development of power from the exhaust gases from the combustion engine, comprising an impulse turbine wheel driven by the expanded gases, a chamber in which the expended gases after passing the turbine wheel are collected for further transit toward the atmosphere, a compartment for utilizing the heat of the expended gases, and means for passing air through said compartment to preheat it for carburation of fuel used in the engine.

7. A device for utilizing the velocity of the expanded gases from a combustion engine, comprising a casing, a shaft therethrough, an inwardly open turbine wheel mounted on said shaft inside said casing and provided with radial flow impeller and expeller vanes, a nozzle for directing the expanded gases against said impeller vanes, the expended gases from the latter passing inside of the wheel, a port near the wheel's center for admitting air to be acted upon conjointly with the spent gases by the expeller vanes, and means for admitting other air to be intermingled with the previously mixed air and spent gases beyond said expeller vanes.

8. A device for utilizing the velocity of the expanded gases from a combustion engine, comprising a substantially cylindrical casing having a removable head, outboard bearings attached one to said head and the other to the rear of said casing, a shaft journaled in said bearings, a hollow turbine wheel mounted on said shaft inside the casing, vanes opening inwardly of said wheel arranged around the periphery thereof, a nozzle at one side of the casing directing the gases against said vanes, and means for forcibly drawing in air through said removable head for mixing with the spent gases within the wheel to silence the final exhaust thereof.

9. A device for utilizing the velocity of the exhaust gases from a combustion engine, comprising a casing, a shaft journaled therewith, an inwardly open turbine wheel, composed of disks spaced apart on said shaft inside said casing, impeller vanes held between a pair of said disks, expeller vanes held between another pair of the disks, a nozzle for directing the expanded gases against said impeller vanes, and means for admitting air to be acted upon by said expeller vanes contemporaneously with the passage of expended gases thereto from the first mentioned vanes.

10. A device for utilizing the velocity of the exhaust gases from a combustion engine, comprising an inwardly open turbine wheel having impulse vanes, a chamber formed around the center of the former and provided with an inlet for air, a nozzle directing the expanded gases against the vanes toward the inside of said wheel, means for exerting suction upon the contents of the wheel and said chamber, and a valve normally keeping said inlet closed but opening to let in air in proportion to the suction produced.

11. A device for utilizing the velocity of the exhaust gases from a combustion engine, comprising a hollow turbine wheel having sets of impeller and expeller vanes, a chamber formed centrally of said wheel including an air inlet and provided with an outlet directed toward said expeller vanes, a nozzle directing the expanded gases against said impeller vanes and into the inside of the wheel, and a spring actuated valve normally closing the air inlet to said chamber, said valve opening against its spring by the rarefaction produced by the expeller vanes in proportion to the speed of the wheel.

Signed at the borough of Manhattan in the county of New York and State of New York this 23rd day of February A. D. 1916.

EMIL ANDERSON.

Witnesses:
H. C. KARLSON,
W. H. GEE.