

Sept. 14, 1948.

P. W. EELLS

2,449,110

COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Filed Nov. 4, 1946

2 Sheets-Sheet 1

Fig. 1.

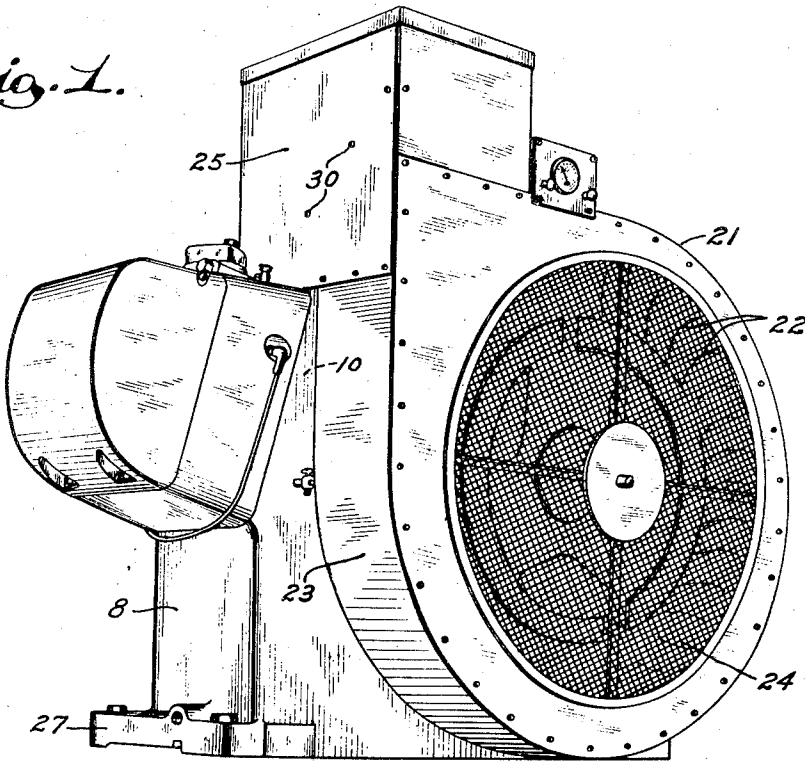


Fig. 2.

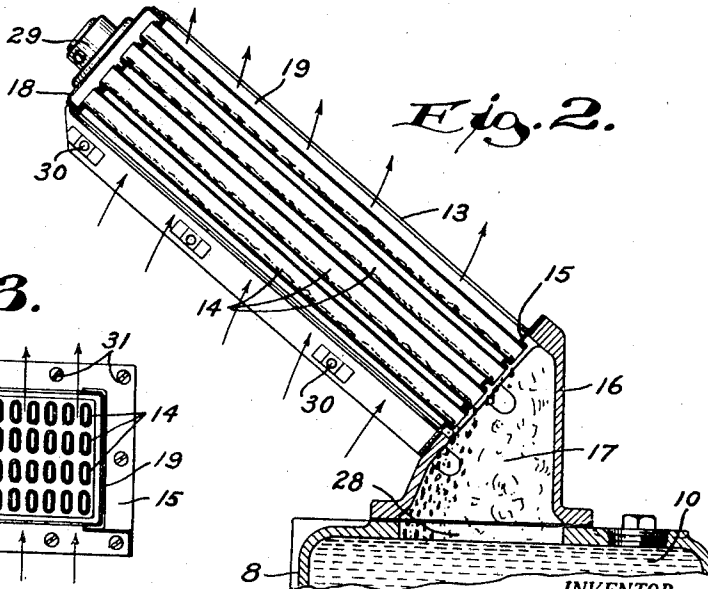
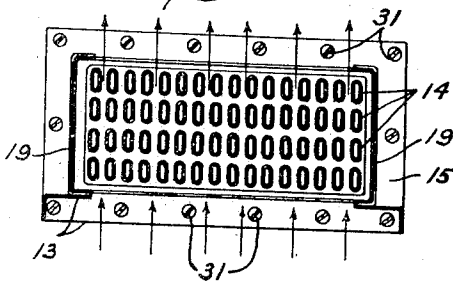


Fig. 3.



INVENTOR.
Paul W. Eells
BY
Lieber & Lieber
ATTORNEYS.

Sept. 14, 1948.

P. W. EELLS

2,449,110

COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Filed Nov. 4, 1946

2 Sheets-Sheet 2

Fig. 4.

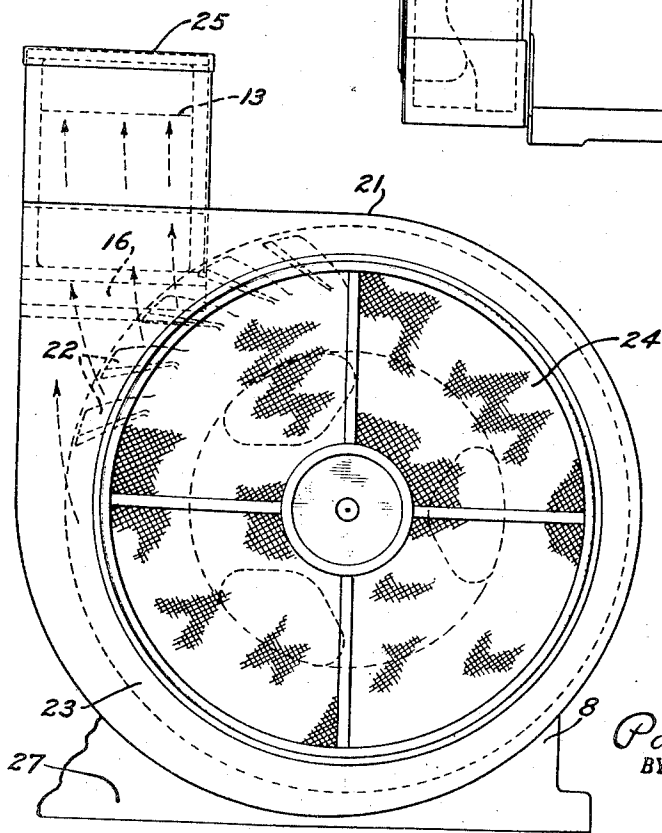
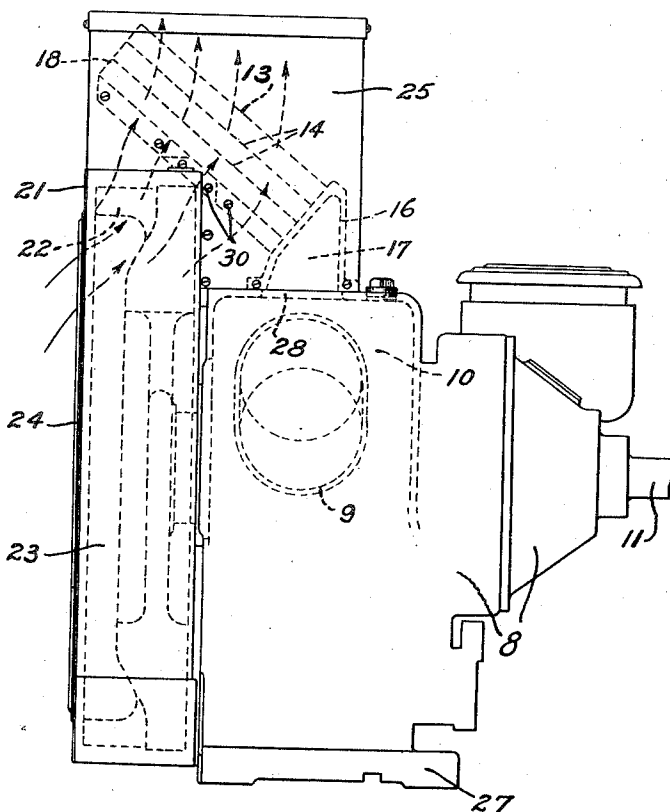


Fig. 5.

INVENTOR.
Paul W. Eells
BY
Lieber & Lieber
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,449,110

COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Paul W. Eells, West Allis, Wis., assignor to Le Roi Company, West Allis, Wis., a corporation of Wisconsin

Application November 4, 1946, Serial No. 707,655

9 Claims. (Cl. 123-174)

1

This invention relates generally to improvements in the art of heat exchange, and relates more specifically to improvements in the construction and operation of cooling systems for internal combustion engines or the like.

The primary object of my invention is to provide an improved cooling system for internal combustion engines or the like, which is simple in construction and highly efficient in operation.

Ordinarily, internal combustion engines employing vaporizing and condensing systems, have their cylinders surrounded by a water jacket in open communication at the top with a vapor condenser embodying either vertical or horizontal heat radiating tubes through which the vapor may flow internally and past which cooling air may be circulated or propelled externally by a fan or blower. When vertical radiation tubes are utilized in such condensers, the condensate must return to the water jacket in direct opposition to the rising vapor, thus causing both the condensate and the vapor to impede each other's progress and also permitting the condensate to form an insulating layer or coating on the interiors of the tubes. When the radiation tubes are disposed horizontally or nearly so, the condensate accumulates in large quantities upon the lower internal tube surfaces and does not gravitate quickly toward the cooling water jacket, thus likewise providing relatively deep insulating basins of liquid in the tubes which prevent most effective heat transfer. Then too, in both of these prior vertical and horizontal tube condensers, it is very difficult to properly direct the cooling air along and between the nests of tubes in a manner whereby most efficient condensation of the vapor is accomplished, thus making them relatively objectionable for various reasons.

It is therefore a more specific object of the present invention to provide an improved cooling system of the vaporizing and condensing type, wherein the condenser tubes are disposed so as to most effectively condense the vapor and to permit free return of the condensate to the heat absorbing jacket of an engine with minimum obstruction to the vapor and condensate flows.

Another specific object of this invention is to provide an improved cooling system for internal combustion engines of the water cooled type and having a cooling air blower for the water driven by the engine so as to deliver the air laterally of the engine shaft, wherein the air is most effectively applied for water cooling and vapor

2

condensing purposes without necessitating the use of complicated deflectors for the air flow.

A further specific object of the invention is to provide a cooling system for internal combustion engines or the like, having an improved vapor condenser disposed and associated therewith in a manner whereby most efficient radiation of excess heat is constantly effected during normal operation of the engine.

Still another specific object of my invention is to provide an improved vapor condenser of the tubular type, wherein the tubes are so formed and positioned at an oblique angle to the direction of flow of the rising vapor and of the returning condensate produced in the condensing unit, that most effective cooling is assured at all times.

An additional specific object of the invention is to provide an improved water cooled internal combustion engine and cooling system therefor, wherein the engine, tubular vapor condenser, and cooling air circulating fan or blower, are compactly associated with each other to produce a single relatively small power generating unit of maximum capacity and efficiency.

These and other objects and advantages of the invention will be apparent from the following detailed description.

A clear conception of the features constituting my present improvement, and of the construction and operation of a typical internal combustion engine and cooling unit embodying such features, may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a perspective view of a typical commercial internal combustion engine embodying my improved vaporizing and condensing cooling system;

Fig. 2 is an enlarged longitudinal section through the improved inclined tubular vapor condenser of the cooling system, also showing a fragment of the cooling water jacket;

Fig. 3 is a similarly enlarged transverse section through the improved condenser, showing the tube formation and arrangement;

Fig. 4 is a somewhat diagrammatic side view of the combined engine, condenser, and blower unit; and

Fig. 5 is a similarly diagrammatic end view of the same unit, looking directly toward the blower inlet.

While the invention has been shown and described herein as being advantageously applicable to a particular type of internal combustion engine

direct connected to a particular type of air circulating blower, it is not my desire or intention to unnecessarily limit the scope or to restrict the utility of the improvements by virtue of this specific embodiment.

Referring to the drawing, the typical power generating unit disclosed therein, comprises in general an internal combustion engine 8 having one or more cylinders 9 surrounded by a cooling liquid or water jacket 10, and also having a horizontal main shaft 11 operable by the engine pistons to deliver power to any desired point of utilization; a vapor condenser 13 having a group of parallel inclined laterally spaced tubes 14 secured at their lower ends to a tube sheet or plate 15 which is mounted upon a base casing 16 forming a chamber 17 in open communication with the cylinder jacket 10, the tubes 14 also being in open communication with each other at their upper ends through an upper end head 18, and the group being confined between opposite side plates 19 forming an air duct between the spaced tubes; and a blower 21 having a bladed rotor 22 direct connected to the engine shaft 11, and being provided with a casing 23 secured to the engine 8 and having an axial horizontally directed screened inlet opening 24 and a tangential upwardly directed discharge duct 25 within which the inclined condenser 13 is bodily confined.

The engine 8 is mounted upon a base 27 which supports the entire unit, and the water confining jacket 10 is normally filled with liquid and in constant communication with the chamber 17 through a large opening 28 as clearly shown in Fig. 2. The inclined tubes 14 of the improved condenser 13, are preferably of approximately elliptical transverse cross-section with the major axes of the ellipses disposed in vertical planes as depicted in Fig. 3; and the lower ends of these tubes 14 extend slightly beyond the tube sheet 15 and are firmly secured thereto, while the upper extremities thereof are likewise firmly secured to the end head 18. The upper end head 18 is also provided with a suitable excess pressure relief valve 29, and the side plates 19 firmly unite the upper head 18 with the lower plate 15 and are secured to the adjacent walls of the air duct 25 by means of screws 30, or otherwise. The condenser unit is additionally supported from the base casing 16 by means of screws 31 connecting the lower plate 15 with the top of the casing 16. The inlet opening 24 of the blower 21 may be provided with a screen as illustrated in Figs. 4 and 5, but the interior of the air discharge duct is preferably devoid of deflectors and obstructions to the air flow, other than the condenser tubes 14 in order that free and direct contact of practically all cooling air with the radiator tubes will be assured.

During normal operation of the typical improved cooling system shown in the drawings, the internal combustion engine 8 is functioning to deliver power to the main shaft 11, and to simultaneously revolve the annular bladed rotor 22 of the blower 21, and the rotor blades are then drawing cooling air in abundant quantities through the inlet opening 24 and are constantly delivering this air from within the casing 23 into the discharge duct 25 and past the inclined radiation tubes 14. Continued operation of the engine 8 causes the liquid within the jacket 10 to become heated to such an extent that vapor is generated and rises through the opening 28 and through the chamber 17 into the inclined radia-

tion tubes 14, and the rising vapor constantly tends to fill these tubes. The vapor thus delivered into the tubes 14 will however be promptly condensed by the cooling air flowing between and along the tube exteriors, and the condensate will collect at the lowermost inclined bottom portions of the several tubes and will drain by gravity along the valleys formed by these tube bottoms, eventually being returned to the jacket 10 through the chamber 17 in the form of liquid drops, as indicated in Fig. 2. This cooling cycle involving continuous vaporization of liquid and condensation of the vapor, will continue as long as the internal combustion engine remains in operation; and if for any reason, the pressure within the jacket 10, chamber 17 or condenser 13 becomes excessive, the relief valve 29 will promptly and automatically release such pressure into the duct 25 and from thence into the ambient atmosphere.

The improved cooling system has several important advantages over prior systems involving vaporizing and condensing cycles, and which are attained by the use of the inclined condenser or radiation tubes 14. One of these advantages is that the condensate produced in the inclined tubes 14 and which returns by gravity to the engine jacket 10, flows downwardly along the lower inclined bottoms or valleys of the several tubes, leaving the major upper interior tube surfaces free of liquid films and available for direct contact and most effective condensation of the vapor rising through the tube interiors. With the inclined disposition of the tubes the liquid droplets produced by condensation, flow at an angle relative to the direction of flow of the rising vapor, and quickly collect only in the bottoms or lowermost tube portions, thus preventing insulating liquid coatings from gathering upon the greater internal surface areas of the tubes, especially when tubes of elliptical cross-section are utilized.

Then too, the angular or inclined disposition of the radiation tubes permits freer and more uniform flow of the cooling air over and along the external surfaces of tubes 14 of various types. In practice, the tubes 14 are frequently provided with external fins or projections in order to increase their exterior radiating surfaces, and these fins are ordinarily disposed approximately perpendicular to the tube axes so as to direct the air flow across the tube assemblages. Either finned or plain tubes 14 may be utilized in the improved inclined condenser 13, and when such a condenser is used in connection with a blower 21 of the type shown in the drawing wherein the rotor 22 is revolved directly by the engine 8 and delivers the air tangentially and upwardly, the air flow will be delivered uniformly and directly through the external passages between the tubes 14, without resorting to the use of obstructive baffles and other complicated air flow deflectors. The inclined condenser unit 13 may obviously be readily mounted within the blower discharge duct 25 with the aid of the screws 30 shown in Figs. 1 and 2 so that the air flow need not be sharply or excessively diverted before it contacts the heat transfer surfaces, thus not only simplifying the assemblage, but also increasing the quantity of air available for cooling.

From the foregoing detailed description it will be apparent that my present invention provides an improved cooling system for internal combustion engines or the like, which besides being simple and compact in construction, is also highly effi-

cient in operation. The inclined disposition of the condenser tubes 14 when utilized in a system involving the vaporizing and condensing cycle, insures most effective condensation of the vapor and return of the condensate to the cooling jacket 10, by virtue of the fact that the major internal surfaces of the tubes are maintained free of insulating liquid films or coatings, while the tube inclination permits rapid flow of the condensate by gravity to the source of vaporization of the liquid. This inclined tube assemblage when employed in such cooling systems also eliminates undesirable obstruction to the flow of the heat transfer fluid, and may be advantageously utilized in cooling units utilizing either air, water or other liquids as heat transfer media. The improved system is especially adaptable to cooling units for internal combustion engines direct connected to blowers or pumps for circulating the heat transfer media by virtue of the fact that it permits direct and most effective application of the cooling fluid to the condensing tubes with minimum obstruction and change of direction; and the entire system may obviously be embodied in a single compact unit capable of being readily transported and installed in limited quarters. The invention has proven highly satisfactory and successful in actual use, especially as applied to a power generating unit such as illustrated, but may also be advantageously utilized in other types of internal combustion engines.

It should be understood that it is not desired to limit this invention to the exact details of construction or to the precise mode of operation of the system herein specifically shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art. It is also intended that specific descriptive terms used herein, be given the broadest possible interpretation and meaning possible and consistent with the advantageous application of the improvements.

I claim:

1. In a liquid vaporizing and condensing system for cooling a heat engine, a condenser having radiation tubes abruptly inclined and directed toward the engine heat generating zone to cause condensate to gravitate rapidly along the lowermost internal tube surfaces toward said zone, said tubes having elliptical transverse cross-sections with the major axes of the ellipses lying in vertical planes, and means operable by the engine for delivering cooling medium externally across said tubes without abrupt change in the direction of flow of the medium.

2. In a liquid vaporizing and condensing system for cooling a heat engine, a condenser having radiation tubes abruptly inclined and directed toward the engine heat generating zone to cause condensate to gravitate rapidly along the lowermost internal tube surfaces toward said zone, said tubes having elliptical transverse cross-section with the major axes of the ellipses lying in vertical planes, and means operable by the engine for delivering cooling medium externally across said tubes in a direction parallel to said planes and without obstruction to the flow of the medium after leaving said delivery means.

3. In a liquid vaporizing and condensing system for cooling an internal combustion engine, a condenser having a group of radiation tubes abruptly inclined and directed toward and in open communication with the engine cooling jacket, said tubes having vertically elongated elliptical transverse cross-sections so as to cause conden-

sate to gravitate freely along the lowermost internal tube surfaces toward said jacket, and means operable directly by the engine for delivering cooling medium externally across said tubes while avoiding abrupt change in the direction of flow of the medium.

4. In a liquid vaporizing and condensing system for cooling an internal combustion engine, a condenser having a group of radiation tubes abruptly inclined and directed toward and in open communication with the engine cooling jacket, said tubes having vertically elongated elliptical transverse cross-sections so as to cause condensate to gravitate freely along the lowermost internal tube surfaces toward said jacket, and an impeller rotatable directly by the engine for delivering cooling medium externally across said tubes along vertical planes and without obstruction to the flow of the medium after it leaves the impeller.

5. In a liquid vaporizing and condensing system for cooling an internal combustion engine, an air blower operable directly by the engine and having an air delivery duct extending away from the engine shaft, and a condenser having a group of spaced tubes spanning said duct adjacent to said blower, said tubes being abruptly inclined relatively to said shaft and directed toward and in open communication with the engine cooling jacket to cause condensate to gravitate freely along the lowermost internal tube surfaces toward said jacket.

6. In a cooling system for an internal combustion engine having an approximately horizontal shaft, an air blower directly operable by the engine shaft and having an upwardly directed air delivery duct, and a condenser having a group of spaced tubes spanning said duct directly above said blower, said tubes being inclined toward and in open communication with the upper portion of the engine cooling jacket.

7. In a cooling system for an internal combustion engine having an approximately horizontal shaft, a condenser having a group of parallel spaced tubes inclined downwardly toward the engine cooling jacket and in open communication therewith, and an air blower having a rotor driven directly by the engine shaft and being provided with an upwardly directed air delivery duct formed to deliver air without abrupt change in direction to the spaces between the tubes of said group, said condenser being detachably confined entirely within said duct.

8. In a cooling system for an internal combustion engine having an approximately horizontal shaft, a condenser having a group of parallel spaced tubes inclined downwardly toward the engine cooling jacket and in open communication therewith, and an air blower having a rotor driven directly by the engine shaft and being provided with an upwardly directed air delivery duct formed to deliver air without abrupt change in direction to the spaces between the tubes of said group, the tubes of said condenser having elliptical transverse cross-section with the major axes of the ellipses lying parallel to the direction of flow of the air through said spaces.

9. In a liquid vaporizing and condensing system for cooling a heat engine, a condenser having radiation tubes abruptly inclined and directed toward the engine heat generating zone to cause condensate to gravitate rapidly along the lowermost internal tube surfaces toward said zone, said tubes having elliptical transverse cross-section with the major axes of the ellipses lying in vertical

2,449,110

7

planes, and means for delivering cooling medium
externally across said tubes in a vertical direction.
PAUL W. EELLS.

REFERENCES CITED

The following references are of record in the
file of this patent:

UNITED STATES PATENTS

Number	Name	Date	
714,445	Bridson et al.	Nov. 25, 1902	10

Number
1,182,825
1,431,965
1,432,518
5 1,553,808

8

Name	Date
Wedderburn	May 9, 1916
Livingston	Oct. 17, 1922
Armstrong	Oct. 17, 1922
Eriksson	Sept. 15, 1925

FOREIGN PATENTS

Country	Date
England	1934