June 22, 1948. C. C. SPANGENBERGER 2,443,875

LUBRICATING SYSTEM FOR ENGINES

Filed March 13, 1943. 2 Sheets-Sheet 1

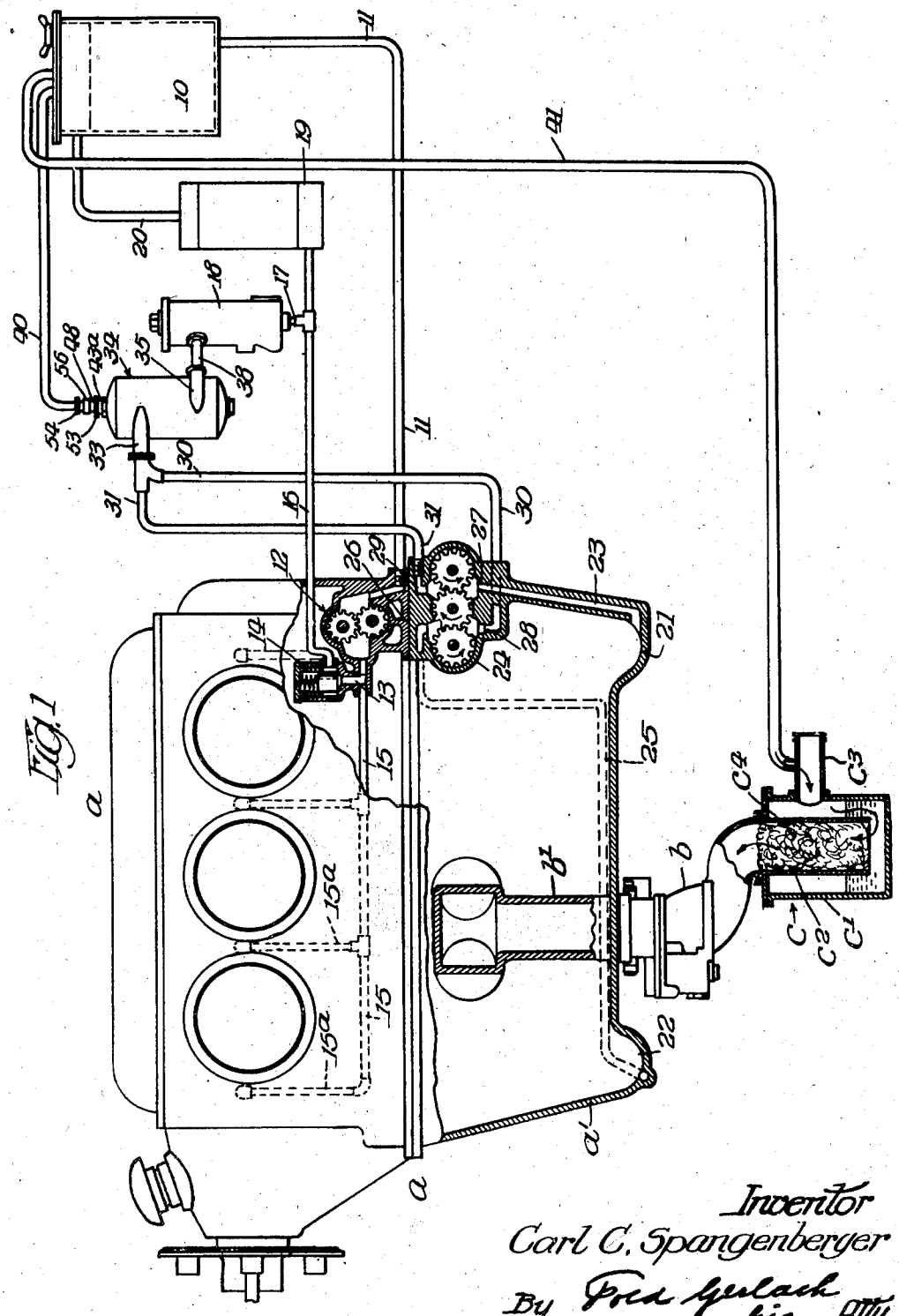

FIG. 1

Inventor
Carl C. Spangenberger
By Ford Gerlach his Atty.

June 22, 1948. C. C. SPANGENBERGER 2,443,875

LUBRICATING SYSTEM FOR ENGINES

Filed March 13, 1943 2 Sheets-Sheet 2

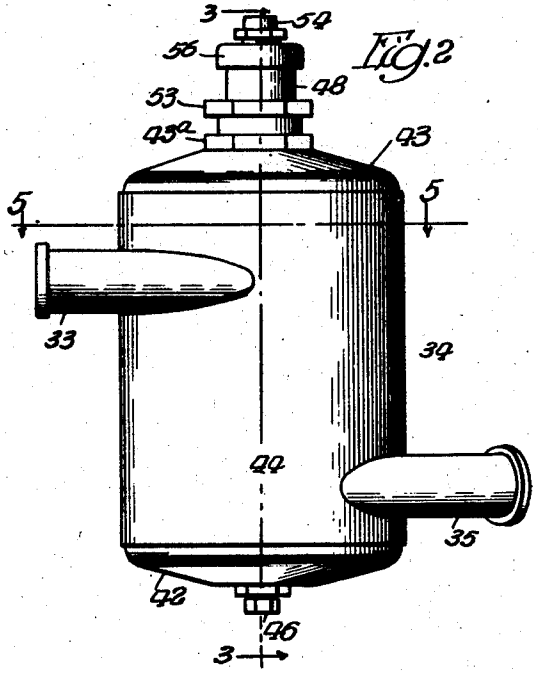

Fig. 2

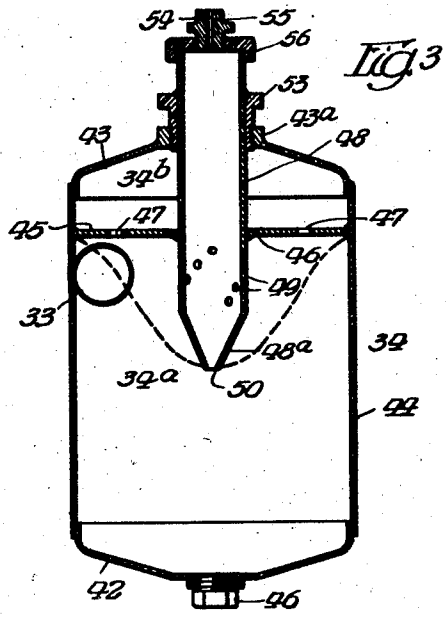

Fig. 3

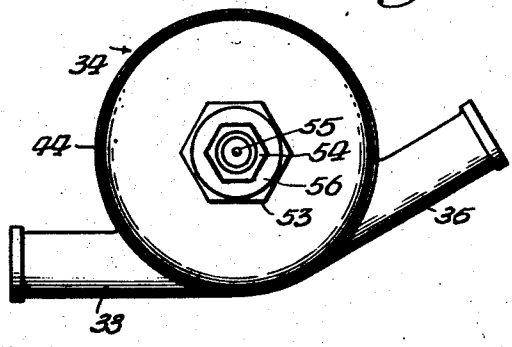

Fig. 4

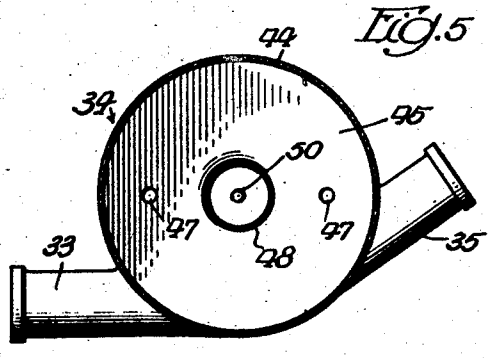

Fig. 5

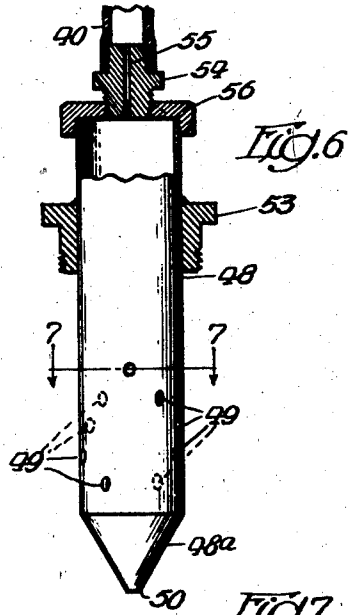

Fig. 6

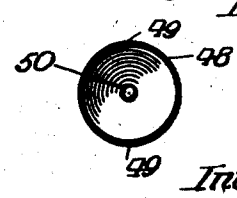

Fig. 7

Inventor
Carl C. Spangenberger
By Joseph Gerlach
his Atty.

Patented June 22, 1948 2,443,875

UNITED STATES PATENT OFFICE

2,443,875

LUBRICATING SYSTEM FOR ENGINES

Carl C. Spangenberger, Williamsport, Pa., assignor to Avco Manufacturing Corporation, a corporation of Delaware

Application March 13, 1943, Serial No. 479,033

4 Claims. (Cl. 123—196)

1

The invention relates to apparatus or systems for engine lubrication.

The several objects of the invention are to provide lubricating apparatus of this type: with means for separating entrapped gases or air which may be drawn by the oil scavenging pump from the engine prior to its return to the supply tank for recirculation; with means for arresting surge pressures which may occur in the system to prevent objectionable transitory or pulsating pressures in the conduits; with combined means for separating the oil from the air, or gas in the fluid and arresting surging in the fluid before the liquid oil is returned from the crankcase to the supply tank for recirculation; with means for separating the liquid oil from the air and gas in the fluid drawn by the oil-scavenging pump from a plurality of sumps in the crankcase of the engine, either of which may run dry when the engine is used on aircraft or military tanks which in their maneuvering are tilted at severe angles so that the oil in the crankcase will flow by gravity to one end thereof while the other becomes dry; with means for delivering the gas or vapor separated from liquid oil to an air filter provided with an oil bath; with separator means which is efficient in separating the oil from the air and gas and in arresting the surge caused by the drawing of fluid from the wet and dry sumps; and which is reliable in its operation.

Other objects will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings:

Fig. 1 is a diagrammatic view of lubricating apparatus embodying the invention, and an engine for which the apparatus is used.

Fig. 2 is a side elevation of the separator.

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2.

Fig. 4 is a plan of the separator.

Fig. 5 is a section taken on the line 5—5 of Fig. 2.

Fig. 6 is a view partly in elevation and partly in section of the air or vapor discharge tube separator.

Fig. 7 is a section taken on the line 7—7 of Fig. 6.

The invention is exemplified with an internal combustion engine a of the opposed cylinder type which comprises a crankcase a^1 provided with a depression at one of its ends forming an oil-sump

2

21 and with a similar oil-sump 22 at the opposite end. A carburetor b is connected to deliver a combustible mixture to an uptake b^1 which extends upwardly through the crankcase and conducts the mixture to the intake manifold. An air filter c is connected to the air intake of the carburetor and comprises an outer casing c^1, the lower end of which contains a column of oil, a central tubular member c^2 which contains a filtering medium c^4 such as steel wool, and has its lower end extended into the oil column and has its upper end communicatively connected to the air intake of the carburetor. An air inlet c^3 is connected to the casing c^1 above the oil column. Air is drawn by the suction in the carburetor, into the inlet c^3, through the oil-column in casing c^1, member c^2 and filtering medium c^4.

The lubricating system is of that type in which oil under pressure is drawn from a reservoir, forced under pressure through or around the bearings and parts to be lubricated, is then collected in the crankcase, and returned, by a scavenging pump from the sump to the reservoir for recirculation.

The lubricating apparatus comprises a tank or container 10 for a supply of oil for lubrication; an engine-driven oil pump 12, usually of the gear-type, for drawing oil through a conduit 11, from the tank 10, and which has a sufficient capacity to discharge oil in excess of that required for pressure lubrication at all engine speeds; a conduit 15 having the necessary number of branches for delivering oil to all bearings and parts to be lubricated, and connected to the discharge side of pump 12; a by-pass valve 14 which is spring-loaded so it is responsive to a predetermined pressure in the conduit 15, and will by-pass the oil in excess of that desired for lubrication, to a conduit 16, an oil cooler or radiator 19, to which the oil flows from conduit 16; and a conduit 20 for delivering the oil from the radiator 19 to the tank 10. The oil from the bearings and parts lubricated drains into and collects in the crankcase a^1 of the engine, as well understood in the art.

The fluid which collects in the crankcase a^1 is drawn from sumps 21, 22 through conduits 23, 25 by a duplex, engine-driven scavenging pump 24 of the gear type. This fluid may include liquid, air or gas, or a mixture of liquid and air or gas. Engines used on vehicles, such as aircraft or military tanks, are often tilted longitudinally at severe angles during maneuvering. The sumps 21, 22 are provided at opposite ends of the crankcase so that the pump 24 will draw oil from

one or the other of the sumps. The pump 24 will, at times, draw air, gas or vapor either alone or mixed with oil, from one of the sumps. Since the scavenged fluid consists of oil and air or gas, which may vary in proportions, it is necessary to separate the liquid from the air or gas, for recirculation, and furthermore, surge-pressures or pulsations and foaming result in the scavenged fluid discharged by the pump, and may cause slugs to be produced in the discharge from said pump. Such surge-pressures, unless arrested, and such slugs, unless prevented, produce dangerous transitory pressures or impulses, which are likely to cause breaks in the conduits. The presence of substantial amounts of air and gas in the recirculated oil may also result in inefficient lubrication of the bearings. The pumps 12 and 24 are constantly driven from the engine, as well understood in the art, so they will always operate proportionately to engine-speed.

The apparatus of the invention includes a combined centrifugal separator and surge arrestor, generally designated 34 to which the mixed fluid scavenged from the sumps is delivered under pressure by the duplex pump 24.

The body of separator 34 comprises a convex bottom 42, a cylindrical side 44, and a convex top 43. The tubular inlet 33, which receives fluid drawn from both sumps in the crankcase by the scavenging pump 24, is connected to the side wall 44 below the top 43, and to deliver fluid tangentially into the upper portion of the chamber 34ª in the separator body. The tubular outlet 35 is communicatively connected to the wall 44 of the separator body adjacent the bottom 42 to discharge liquid tangentially from said wall. The tangential discharge of fluid under pressure into the separator body causes the oil, which is the heavier constituent of the fluid, to circulate around the inner side of the chamber 34ª and to be subjected to centrifugal force, produces a vortex in the central portion of the body, somewhat as indicated by dotted lines in Fig. 3, and causes the air and gas to be separated from the liquid in the space above the liquid column and in the vortex. The liquid-oil is discharged tangentially from the lower portion of chamber 34ª in the separator and flows under pressure through the oil filter 18, conduit 17, radiator or cooler 19, and conduit 20 to the tank 10 for recirculation by the pump 12.

A tube 48 in the top 43 of the separator body functions as an outlet for the air and gas separated from the liquid oil in the central and upper portions of chamber 34ª. This tube 48 is fixed in a nipple 53 which is screw-threaded into a ring 43ª which is welded to the top 43. A cap 56 is screw-threaded to the upper end of tube 48. A coupling-nipple 54 is screw-threaded into the cap 56 and is provided with a restricted orifice 55 for limiting the outflow of air and gas from the separator body. The lower end 48ª of tube 48 is conoidal and has a small opening 50 in the apex of the conoidal portion. Two helical rows of apertures 49 are provided in the tube 48 above the conoidal portion 48ª and below a transverse wall 45 which is fixed, for example by welding, to the cylindrical wall 44 of the separator body. Wall 45 forms the top of chamber 34ª around the tube 48 and forms, below the top 43, a cushioning chamber 34ᵇ in the upper portion of the separator body and above the chamber 34ª. A pair of diametrically opposite apertures 47 extend through wall 45 to permit air to pass between chambers 34ª and 34ᵇ. The tube 48 extends through the wall 45. A drain plug 46 is connected to the bottom 43 of the separator body. The coupling-nipple 54, which is provided with an outlet orifice 55, is connected, by a conduit 40, to deliver the air or gas separated from the liquid to the top of tank 10.

Due to the restriction of the flow of oil by the filter 18 and the cooler or radiator 19, the pressure in the separator-chamber 34*a* must be greater than that in the tank 10 to cause the oil to flow to said tank. To maintain this differential of pressure, the restriction of the air or gas flow from the separator 34 to the tank 10 must be sufficient so that when the normal amount of air or gas from the scavenging pump 24 is flowing through conduit 40 to tank 10, the pressure drop necessary to force the amount of oil being delivered by pump 24 is at least equivalent to that necessary to force the liquid oil discharged from separator 34 through the oil-filter 18 and radiator 18 with the oil by-passed by the valve 14, to conduit 16. The pressure maintained in the separator 34 may be between 20 and 40 lbs. per square inch gauge pressure, varying with the engine speed, the pumps 12 and 24 being constantly driven in proportion to the engine speed. The ratio of the air or gas and the oil in the mixed fluid delivered by the scavenging pump 24 may also vary as the result of one of the sumps in the crankcase being temporarily dry. The tube 48 has a relatively large diameter, in practice substantially from 1¼'' to 1½'', with an inside volume of approximately 32 cubic inches, so that it will form a chamber of substantial area which will be filled with liquid before the latter can reach the discharge orifice 55. Since the flow restriction ratio of air to oil through the orifice 55, for example $\frac{3}{32}$'' in diameter, is approximately 1 to 1000, the pressure in tube 48 will be greatly reduced due to the flow of oil instead of air through the perforations 49 in the tube 48. This lowering of the pressure in the tube 48 decreases the airflow and increases the time required before the liquid will rise or flow through orifice 55. If the liquid level in the separator continues to rise, it will compress the air or gas in the upper portion of tube 48, together with any other air from pump 24, to increase the pressure of the liquid in chamber 34*a*. This causes an increased flow of liquid through outlet 35. Normally, this high-percentage oil-condition is transitory and the percentage of gas in the fluid delivered by pump 24 is sufficient to prevent the level of liquid oil in the tube 48 from rising to the orifice 55. The gas or air released from the oil tends to push the oil downwardly and according to its percentage, will progressively open the perforations 49 from uppermost downward, and the gas will bubble upwardly through the upper portion of the tube and the restricted orifice 55 while the oil in the tube 48 will gradually flow downward through the apex aperture 50 into chamber 34*a* for discharge through the outlet 35.

The correct areas of apertures 49 and orifice 55 may be best determined from a trial run for a 15 minute period. The size of apertures 49 and orifice 55 can be varied until only a slight quantity of liquid oil occasionally flows through conduit 40. This condition will indicate that only liquid is flowing through the outlet 35 and that no foaming is present in tank 10. It has been found that with an orifice 55 $\frac{3}{32}$'' in diameter only a slight amount of liquid oil will flow through said orifice in a system flowing approx-

imately 44 gallons per minute. Any liquid oil which flows through orifice 55 will be collected and recovered in tank 10.

Any surging which occurs in the fluid which is pumped into the separator will be arrested by the cushioning effect of the confined air or gas in chamber 34b, so that liquid and air will be discharged from the separator in substantially even streams. This will also tend to break up any slugs in fluid discharged by the pump 24. Dangerous transitory pressures are thus prevented in the conduits between the separator and the tank 10 and the filter and cooler.

The space above the oil column in the supply tank 10 is connected by a conduit 41 to the air intake c^3 of an air filter c. This air filter comprises a closed casing c^1 containing an oil bath on its bottom, a tubular member c^2 containing suitable filter material such as steel wool c^4. The lower end of member c^2 terminates in the oil bath and its upper end is communicatively connected to the air intake of, and subject to suction from, the carburetor b. The gas or vapor in the upper end of the supply tank 10 is drawn by the suction of the carburetor through the conduit 41, mixed with the air entering the air inlet c^3, passes through the oil bath where the oil in the vapor or gas is separated from the air and retained to replenish the oil in the bath. The cleaned air passes through the material c^4 to the intake of the carburetor. This draws the fumes or vapor from the supply tank 10 to the oil bath of the air filter so that the vapor and fumes will not contact with or condense upon the outside of the surrounding parts. This also prevents the collection of dust by the condensate on the parts of the vehicle around the engine.

The operation of the apparatus will be as follows: The pump 12 draws oil from the tank 10 through the conduit 11 and delivers it via the conduit 13, valve-casing 14a, and conduit 15 and its branches 15a to the bearings and parts of the engine which require lubrication. The oil from the parts lubricated flows to the crankcase a^1 and into the sumps 21, 22. The pump 12 has a sufficient capacity to discharge oil in excess of the volume required for lubrication of the parts. The spring-loaded valve 14 maintains the desired pressure in conduits to the lubricated parts at varying engine speeds, and by-passes the excess oil from the conduit 15 through conduit 16, the radiator 19 where this oil is cooled. The cooled oil flows through conduit 20 to the tank 10. The scavenging pump 24 draws the fluid, which may consist of oil and air or gas, from the sumps 21, 22 through pipes 23, 25 and forces it through conduits 30, 31 to the tangential inlet 33 of the separator 34. On account of the tilting of the engine when used on a vehicle or aircraft, one branch of the pump 24 may draw mostly oil from one of the sumps and mostly air or vapor from the other sump. The fluid discharged by the duplex scavenging pump 24 may consist of intermingled oil, foam, air and vapor or slugs which will be delivered through the tangential inlet 33 into the chamber 34a of the separator. This tangential delivery under pressure to the cylindrical side wall 44, will cause the liquid to swirl around, and be subjected to centrifugal force in the chamber 34a, and form a vortex in chamber 34a. The oil constituent of the fluid, being of greater specific gravity than the air or gas, will be thrown against the side wall 44 and the air or gas will be separated from the liquid in the central and upper portion of the chamber 34a. The oil is forced under sufficient pressure through tangential outlet 35 to flow through conduit 38, oil filter 18, conduit 17, radiator 19, and conduit 20 to the upper portion of the oil tank 10. The restriction of the air and gas by the orifice 55 results in a pressure drop to the tank 10 which is sufficient to permit the flow of oil from the separator through the oil filter 18 and cooler 19 with the by-passed oil from valve 14, to the tank 10.

Normally, at least the upper apertures 49 are open so that no liquid will flow therethrough to the upper portion of the tube 48. The liquid level in the separator and tube 48 may fluctuate. As the percentage of air and gas increases, the liquid level will drop and expose additional apertures 49, which are preferably helically arranged, for the flow of air or gas from the chamber 34a into the tube 48. As the liquid level rises, the compression of the air or gas will tend to increase the pressure upon the liquid and its discharge from the separator. This results in separation of the liquid from the gas and maintaining a sufficient drop in pressure between the tube 48 and the upper portion of the tank 10 for the delivery of the liquid-oil through the filter and cooler to the supply tank for recirculation.

The scavenging pump, particularly while discharging a high percentage of air or gas from one sump and a high percentage of oil from the other sump, may produce slugs or surging in the fluid entering and in the separator body. The chamber 34b into which the air and gas can flow through perforations 47, acts as a cushioning or expansion chamber for the air or gas which arrests the surging and breaks up the slugs of the liquid before it is discharged from the separator. This eliminates dangerous transitory pressures and impulses in the conduits, oil filter and cooler between the separator and the supply tank 10.

The vapor or gas, or fumes therefrom, which are delivered to the supply tank 10, are drawn by the suction of the carburetor b through the conduit 41 and the air filter c so that no condensate will form on the conduits and on the parts of the vehicle surrounding the engine. The oil in the vapor drawn into the filter c will be trapped by the oil bath in said filter and replenish the oil drawn from the bath by the carburetor.

The merging of the flow of the by-passed excess oil from valve 14 retards the flow of oil from the separator and filter to the cooler.

It will be understood that the apparatus functions to continuously recirculate the oil from the supply tank 10 under pressure to the parts to be lubricated.

The invention exemplifies a lubricating apparatus for an internal combustion engine in which the lubricating oil is continuously recirculated from one or more sumps in the crankcase, the mixed air or gas and vapor from the crankcase are separated by centrifugal force, the separated oil is filtered and cooled before it is returned to the supply tank, the air, gas or vapor separated from the scavenged fluid is separately returned to the supply tank, and is separately removed therefrom by suction from the carburetor to replenish the oil bath maintained in the air filter. The invention also exemplifies a combined separating and surge arresting apparatus for the fluid scavenged from the crankcase which effects efficient separation of the constituents of the fluid and prevents dangerous transitory impulse pressures in the system.

The invention is not to be understood as re-

stricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A system for circulating oil for lubricating an internal combustion engine which is provided with an oil sump to which oil flows from the parts lubricated and includes a container for a supply of oil and a carburetor, comprising a scavenging pump for drawing fluid containing liquid and gas or air from the sump, a centrifugal separator for separating the air or gas from the liquid in said fluid, provided with a body connected for receiving the fluid under pressure from the scavenging pump, means for conducting the separated oil from the separator to the container for recirculation, restricted flow means for delivering the air or gas from the separator to the container, and means for applying suction from the carburetor to the gas or vapor in the container for its removal therefrom.

2. A system for circulating oil for lubricating an internal combustion engine which is provided with an oil sump to which oil flows from the parts lubricated and includes a container for a supply of oil and a carburetor, comprising a scavenging pump for drawing fluid containing liquid and gas or air from the sump, a centrifugal separator for separating the air or gas from the liquid in said fluid, and provided with a body connected for receiving the fluid under pressure from the scavenging pump, means for conducting the separated oil from the separator to the container for recirculation, restricted flow means for delivering the air or gas from the separator to the container, an air filter of the oil-bath type, connected to the carburetor, and means for sucking the gas or vapor from the container to the air filter.

3. A system for circulating oil for lubricating an internal combustion engine which is provided with an oil sump to which the oil flows from the parts lubricated and includes a container for a supply of oil and a pressure pump having a capacity for delivering oil in excess of that required for lubricating the parts, and with means for by-passing said excess oil, comprising: a scavenging pump for drawing fluid containing liquid and air or gas from the sump, a centrifugal separator for separating air or gas from the liquid and provided with a chamber connected to receive fluid under pressure from the scavenging pump, an outlet for the separated liquid and a restricted outlet orifice for the separated air or gas, a filter connected to receive oil from the separator, an oil cooler connected to receive oil from the filter, means for conducting oil from the filter to the container, means for merging the by-passed excess oil with the oil flowing from the filter to the cooler and retarding the flow of oil from the filter to the cooler, means for delivering the oil from the cooler to the container for recirculation, and means for conducting air or gas from the separator to the container.

4. A system for circulating oil for lubricating an internal combustion engine which is provided with an oil sump to which the oil flows from the parts lubricated and includes a container for a supply of oil and a pressure pump having a capacity for delivering oil in excess of that required for lubricating the parts, and with means for by-passing said excess oil, comprising: a scavenging pump for drawing fluid containing liquid and air or gas from the sump, a centrifugal separator for separating air or gas from the liquid and provided with a chamber connected to receive fluid under pressure from the scavenging pump, an outlet for the separated liquid and a restricted outlet orifice for the separated air or gas, a filter connected to receive oil from the separator, an oil cooler, means for conducting oil from the filter to the cooler, means for conducting the by-passed excess oil to the means for conducting oil from the filter to the cooler and retarding the flow of oil from the filter to the cooler, means for delivering the oil from the cooler to the container for recirculation, and means for conducting air or gas from the separator to the container.

CARL C. SPANGENBERGER.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,329,038	Curtiss	Jan. 27, 1920
1,440,808	Wineman	Jan. 2, 1923
1,790,372	Good	Jan. 27, 1931
1,857,652	McKinley	May 10, 1932
1,864,095	Rodman	June 21, 1932
1,903,412	Woolson	Apr. 4, 1933
1,907,706	Atwell	May 9, 1933
2,024,336	Cavanaugh	Dec. 17, 1935
2,073,096	Church	Mar. 9, 1937
2,140,735	Clark	Dec. 20, 1938
2,316,729	Tryon	Apr. 3, 1943
2,323,525	Ebel	July 16, 1943
2,335,420	Jones	Nov. 30, 1943
2,379,579	Hunter	July 3, 1945

FOREIGN PATENTS

Number	Country	Date
359,401	Great Britain	Oct. 12, 1931
501,998	Great Britain	Mar. 9, 1939
692,505	Germany	June 21, 1940
709,671	France	May 20, 1931