April 12, 1927. 1,624,689

E. J. SWEETLAND

LUBRICATING SYSTEM OF INTERNAL COMBUSTION ENGINES

Filed Nov. 19, 1920 2 Sheets-Sheet 1

Fig. 2.

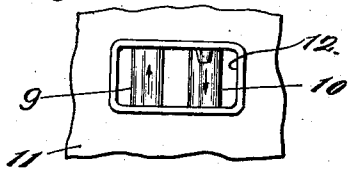


Fig. 1.

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April 12, 1927. E. J. SWEETLAND 1,624,689

LUBRICATING SYSTEM OF INTERNAL COMBUSTION ENGINES

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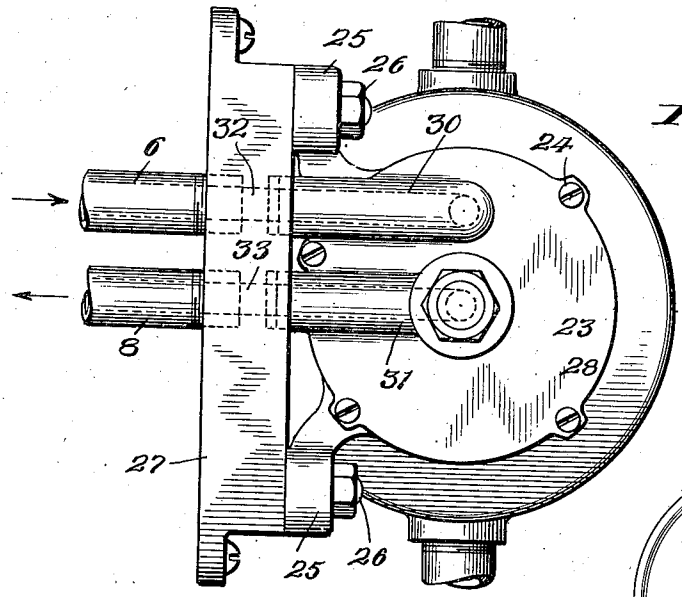


Fig. 3.

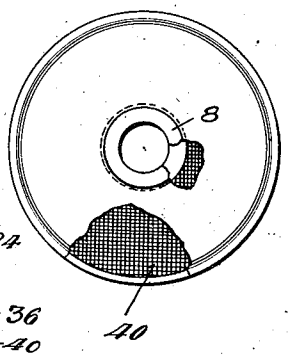


Fig. 5.

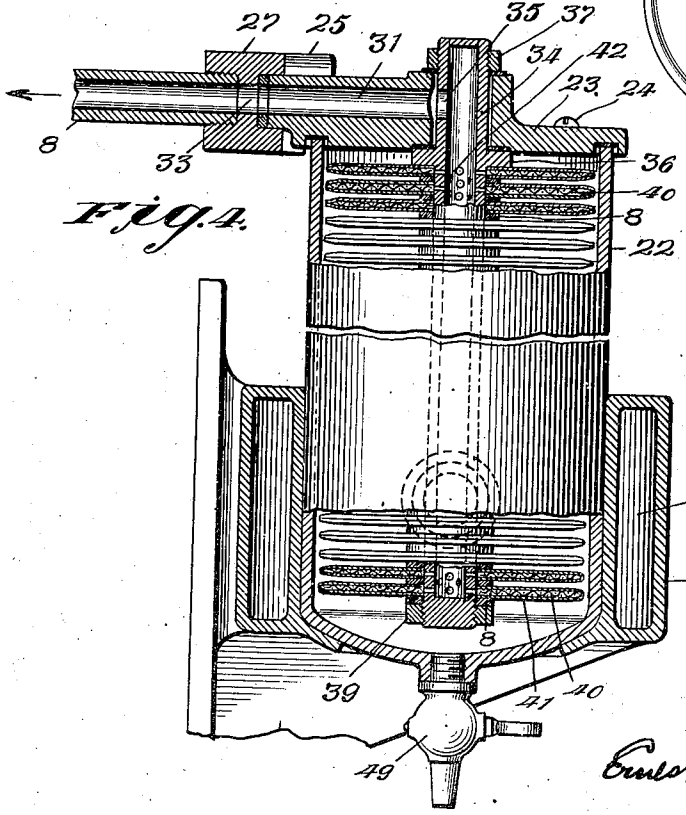


Fig. 4.

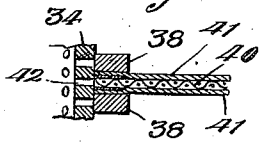


Fig. 6.

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UNITED STATES PATENT OFFICE.

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LUBRICATING SYSTEM OF INTERNAL-COMBUSTION ENGINES.

Application filed November 19, 1920. Serial No. 425,042.

This invention relates to improvements in lubricating systems of internal combustion engines and is especially adapted for use in connection with the internal combustion engines of motor vehicles, such as automobiles, aeroplanes, motor-boats and the like, and has for its object to provide for the removal of all of the foreign deleterious matter which may be suspended in the oil with which the moving parts of the engine are lubricated, thereby insuring that the oil supplied to such parts will be freed of all such deleterious matter and be substantially restored to its initial clear condition. The removal of all of such deleterious matter is of the utmost importance in order to insure against undue wear of the engine parts, as the presence of such matter in the oil will cause an inefficient operation of the engine and will eventually wear the parts to such an extent as to render it necessary to repair or renew the same. The impurities usually found suspended in the lubricating oil after the engine has been operated for some time, are dust, dirt, metallic particles and carbon.

According to present practice, the larger particles are removed from the oil by passing the oil through wire screening, but such screening does not remove the fine particles as they pass readily through the screening now commonly employed. It is, therefore, only a matter of time before the crank case oil is contaminated to such an extent as to render it necessary to remove it and replace it with a supply of clean oil.

According to my invention, the crank case oil is so thoroughly cleaned that it is practically restored to and maintained in its initial condition, as a consequence of which it may be used over and over again, and the replacing thereof by a fresh supply of clean oil is rendered unnecessary. By avoiding the necessity of renewing the oil at frequent intervals, as is now the case, the expense incident to the operating of the engine is materially decreased, and the danger of any of the co-acting moving parts of the engine being damaged, due to foreign matter suspended in the oil, is removed. The restoring of the oil to and maintaining it in a clean state is effected by passing it through a filter adapted to remove all foreign matter from the oil and so arranged and connected that whatever may be the resistance of the filter circuit to the flow therethrough, the presence of the filter in the system will in no way interfere with the proper lubrication of the co-acting moving parts of the engine in the usual manner.

In the accompanying drawings forming part of this specification, wherein I have shown a preferred embodiment of my invention, for the purpose of illustrating the principle thereof,

Figure 1 is a side elevation of an internal combustion engine embodying my invention, parts being shown in section;

Figure 2 is a detail view on an enlarged scale of a portion of the vehicle instrument board and the sight glasses through which the oil flows to and from the filter;

Figure 3 is a plan view of the filter;

Figure 4 is a view thereof partly in side elevation and partly in section;

Figure 5 is a plan view of one of the filter elements, parts being broken away, and

Figure 6 is a detail sectional view, on an enlarged scale, of a portion of the filter.

Referring to the drawings, 1 represents an internal combustion engine of any suitable type having a crank case 2 which contains the oil for lubricating the co-acting moving parts of the engine. Mounted upon the engine casing, or upon the frame of the vehicle, is a pump 3 of any approved type, which may be the pump usually employed in connection with forced feed lubricating systems. The pump 3 is provided with an intake pipe 4, extending within the crank case 2 and having its open, inner end positioned adjacent the bottom of the crank case, and an outflow pipe 5 which serves to conduct oil from the pump to the bearings of the engine, or to any other parts thereof the lubrication of which is desired. This portion of the drawing is purely diagrammatic, the dotted connections 5^a representing the tubes which lead to bearings or other parts requiring forced feed lubrication, or they may represent ducts leading to a level pan where splash lubrication is employed. Communicating with the pipe 5 is a pipe 6 leading to a filter 7, hereinafter described, from which the filtered oil is conducted through pipe 8 to the crank case 2. Interposed in the pipes 6 and 8 are sight glasses 9 and 10 mounted in any suitable manner upon the instrument board 11 of the vehicle and visible to the driver through a window 12 formed in the board 11, whereby he may observe the flow of oil to and from the filter in order to ascertain if oil is flowing in a proper manner and if

the filter is operating efficiently. Test cocks 13 and 14 are provided adjacent the lower ends of the sight glasses in order to permit of the withdrawal of some of the unfiltered or filtered oil for testing or other purposes, if desired. A pressure gauge 15 mounted upon the instrument board 11, to indicate the pressure in the filter circuit, is connected by a pipe 16 to the pipe 6 through which pipe the oil is conducted to the filter 7.

Communicating with the pipe 6 at any desired point is a relief valve 17 of any suitable type provided with an outlet pipe 18 communicating with the crank case 2. As shown, the relief valve is provided with a valve member 19 in the form of a ball normally held upon its seat, to prevent oil from flowing from the pipe 6 to the pipe 18, by a spring 20, the tension of which may be varied by varying the position of the spring engaging member 21 adjustably mounted within the casing of the relief valve 17. By adjusting the member 21 within the valve casing the spring 20 which normally holds the ball valve 19 upon its seat, is placed under such tension as will insure that the oil flowing through the pipes 5 and 6 will be under a working pressure sufficient to lubricate properly the engine parts and to overcome the back pressure offered to the flow of oil through the filter, as herinafter described. Should the pressure of the oil rise above this working pressure, due to any clogging in the oil circulating system or to the fact that the pump delivers more oil than can flow through the filter and circulating system, the ball valve will be forced from its seat thus permitting some of the oil to pass through the relief valve into the pipe 18 through which it is returned to the crank case. When the pressure of the oil within the circulating system returns to its normal working value, the spring 20 forces the ball valve upon its seat, thus preventing any of the oil being returned to the crank case through the valve, and pipe 18. It will thus be seen that the relief valve serves to prevent the oil pressure from rising above a predetermined value as a result of which there is no danger of its increasing to such an extent that the operation of the pump will be affected.

The filter 7, which may be of any suitable construction, is shown for purposes of illustration as comprising a shell or body portion 22 having an open upper end closed by a cover 23 removably held in position by bolts or screws 24. The filter construction employed, however, must be efficient as a filter to accomplish the purpose of thoroughly cleaning the oil as stated. The structure herein shown and described is a preferred form thereof, though many modifications in form and design are permissible. The cover is provided with lugs 25 adapted to receive bolts 26 serving to secure the cover to a supporting block 27 mounted upon the vehicle dash 28. Carried by the cover 23, and preferably formed integral therewith, are inlet and outlet ducts 30 and 31, respectively, communicating at their inner ends with the interior of the filter shell. The outer ends of the ducts 30 and 31 are seated within recesses in one side of the block 27 and communicate with passages 32 and 33 formed therein and which, in turn, communicate with the pipes 6 and 8, the ends of which are seated in corresponding recesses in the other side of the block 27. Positioned within the shell 22, with its upper end extending through an opening in the cover 23, is an axially positioned tubular member 34 having a closed lower end and provided with an opening 35 in its wall adjacent its upper end communicating with the bore of the tubular member and registering with the inner end of the outlet duct 31 on the cover 23. The tubular member 34 is provided with a shoulder 36 engaging the inner surface of the cover 23 and with a nut 37 threaded upon the threaded upper end of the tubular member and engaging the upper surface of the cover.

Mounted upon the tubular member 34 are a plurality of annular filter elements spaced from one another by annular spacing members 38, formed of any suitable material, the filter elements and spacing members being removably maintained in assembled position upon the tubular member by a nut 39 threaded upon the lower end thereof. Each filter element consists of an annular member 40, formed of coarse wire screening, reticulated metal, or other suitable material, enclosed within a casing or envelope 41 formed of a suitable filtering material, the member 40 serving to hold the sheets of filter cloth or other filtering material spaced from one another, to form drainage areas communicating with perforations 42 formed in the wall of the tubular member and communicating with the bore thereof. The filter elements, as shown in Fig. 4, do not abut or fit close against the walls of the shell 22, but leave a narrow clearance between their peripheries and said walls to provide a flow passage for the incoming oil along the walls of the shell throughout its length. This flow passage is in communication with the numerous spaces between the filter elements, which together provide numerous restricted flow passages for the oil to the filter areas. Thus, the structure of the filter is such as to provide a very large filtering area and a maximum of filtering efficiency in a minimum space—a compactness of filter structure that has great advantage in an automotive filtering system.

The casings or envelopes 41 are formed of a material of such fine texture that any fine particles of foreign matter, such as carbon,

which may be suspended in the oil, cannot pass therethrough but will be deposited upon the surfaces thereof in the form of a slime bed. Furthermore, the material of which the casings are formed must be of such fine texture as to offer an appreciable resistance to the passage of the oil therethrough, thus requiring the oil to be supplied to the filter under pressure sufficient to overcome the back pressure due to the resistance offered to the passage of oil by the casings. The casings or filter cloths should be of such fine texture that they will permit the passage therethrough of not more than one gallon of clear oil per square foot of filter area per hour when the oil is under a pressure of one pound per square inch under normal working conditions. In fact the resistance is usually so great that the rate of flow is often below one quart per square foot of filter area per hour even at ten or fifteen pounds pressure per square inch. Owing to the fact that the casings are formed of a material having an extremely fine texture the foreign matter deposited upon the surface thereof during the filtering operation will be deposited over the entire surfaces of the casings in layers of substantially uniform thickness throughout. Although the passage of the filtered oil through the casing of each filter element is retarded by reason of the fine texture thereof and by the slime bed formed on the surface thereof, the required flow of filtered oil through the filter is obtained by reason of the extensive filter area provided by the combined filtering surfaces of the several filter elements, and by reason of the fact that the oil to be filtered is under pressure. The filter area should be not less than the total piston area of the engine, and for the best results I employ six to ten square feet of filter surface for the average automobile. The casings 41 of the filter elements are preferably formed of a close woven cloth fabric such as duck, canvas, chain cloth or the like, or they may be formed of wire screening having a fine mesh, or they may be made of felt or asbestos cloth. If desired, the casings may be formed of wire screening of a comparatively coarse mesh having fibrous asbestos, or the like, woven through the meshes thereof or applied to the screening in such a manner as to form, in effect, a sort of felt surface which is of such fine texture that it will prevent the passage therethrough of carbon particles and the like. I may even employ filter elements of porous stone or earthenware or unglazed porcelain (such as is used in a Pasteur filter) without departing from the spirit of my invention.

It will, of course, be understood that the invention is not limited to casings formed of the filtering material specified, nor to the particular construction of the filter elements shown and described, it being merely necessary to provide an extensive filter area of such fine texture as to offer appreciable resistance to the passage of clear oil therethrough and to prevent the passage of the finest particles of carbon or other foreign matter that may be suspended in the oil to be filtered.

Although the density of the filter elements permits only slow seepage therethrough of oil freed from deleterious solids, their arrangement and total area is such as to permit in the aggregate a rate of filtration at least equal to the normal rate of contamination of the oil under operating conditions.

The lower end of the filter shell 22 is supported within an annular casing 43 secured to the dash 28 of the vehicle or any other suitable part thereof and provided with a chamber 44 having an inlet pipe 45 connected to the exhaust manifold of the engine, and an outlet pipe 46 communicating with the atmosphere. In operation, a portion of the hot exhaust gases from the engine will pass through the pipe 45 into and through the chamber 44, from which the gases exhaust into the atmosphere through the outlet pipe 46. The flow of the hot exhaust gases through the chamber 44 serves to heat the oil within the filter, thereby preventing it from becoming so viscous and sluggish in cold weather that it cannot pass through the filtering surface in an efficient manner. The flow of the gases to the chamber 44 may be controlled by a suitable valve 47 positioned within the pipe 45 and operatively connected to the end of an actuating rod 48, the other end of which may extend through the instrument board 11 and be provided with a suitable handle to permit the rod to be actuated by the driver to open and close the valve.

During the running of the engine it frequently happens that water finds its way into the crank case owing to condensation or other causes, and this water may become emulsified with the oil, due to the rapid movement of the mechanical parts of the engine through the mixture of oil and water within the crank case, as a result of which the lubricating qualities of the oil are greatly reduced. If no impurities are suspended within the oil the water will separate from the oil after the mixture has been allowed to stand for some time, but if any impurities are held in suspension within the oil, the water remains emulsified with the oil for a much longer period of time, and there is practically no tendency for the water to separate from the oil. I have found by tests that when the slime bed is formed upon the filtering medium of fine texture, as above described, the ready passage therethrough of water which may be mixed with the oil is prevented, and consequently the water will be separated from the oil and will remain

within the filter shell. The thus separated water will collect within the space at the bottom of the filter shell, which serves as a collecting chamber, and may be withdrawn therefrom by a suitable drain-cock 49. As the filter medium also serves to remove all of the suspended impurities from the oil, thereby keeping the oil clean, there is less likelihood of the water emulsifying with the oil than is the case when the oil contains impurities in suspension.

Under normal conditions during the operation of the engine, the pump 3 will withdraw oil from the crank case 2 and force it to flow continuously through the oil circulating system, a portion of the withdrawn oil being forced through the pipe 5 to the parts of the engine requiring lubrication, while the remaining portion or a part of it is forced through the pipe 6 to and through the inlet duct 30 into the filter shell. After entering the filter shell the clear oil is forced through the filter area formed by the casings 41 of the several filter elements into the drainage areas thereof from which it passes through the perforations 42 in the tubular member 34 into the bore thereof. The filtered oil is forced upwardly through the bore of the tubular member until it reaches the opening 35 in the wall thereof whereupon it flows through the outlet duct 31 to the pipe 8 which conducts it back to the crank case 2. The necessary pressure upon the oil to insure an efficient operation of the system is maintained by the relief valves 17 as above explained. After a layer of slime has been collected upon the filtering medium, the back pressure of the filter of its resistance to the flow of oil is effective to limit the flow of oil through the filtering circuit so that sufficient oil for proper lubrication is continuously supplied to the working parts of the engine. Should the filter become clogged from unduly long use to such an extent as to prevent it from functioning in a proper manner, the increase in the back pressure merely results in an increase in the amount of oil which returns to the crank case through the relief valve and no harm results. Therefore, the operation of the pump will not be affected by any increase in the resistance offered to the flow of oil through the filter, and consequently there can be no interruption to the flow of oil through the pipe 5 to the parts of the engine requiring lubrication. By observing the flow of oil through the sight glasses 9 and 10, the driver can ascertain at a glance if the oil is circulating properly, and by observing the difference in color between the oil flowing through the sight glass 9 into the filter and the oil flowing through the sight glass 10 after having passed through the filter, the driver can tell if the filter is functioning properly. When the filter unit is new and until a bed of slime has been deposited thereon, its resistance to the flow of oil may be insufficient to ensure a proper supply of oil to the parts to be lubricated. A valve 50 or other appropriate means for resisting or controlling the flow of oil in the filter circuit is located in one of the conduits of the filter circuit, as for example, in pipe 8, so that when the filter is of low resistance, the resistance of the filtering circuit may be made enough to ensure sufficient flow of oil in the lubricating circuit for proper lubrication of the engine parts. Also, should the filter become ruptured during use, the resistance in the filter circuit may be regulated by the valve 50 to prevent a free flow of oil through the filtering circuit, which, if not so prevented, would result in an insufficient supply of oil to the bearings for proper lubrication.

Any fine carbon particles or other foreign matter will be deposited upon the filter surfaces of the several filter elements in an even layer, as above set forth, to form a slime bed which assists in the filtering action. At the start, some of the finest particles may pass through the filtering material but the larger particles cannot pass therethrough, and these together with other impurities, will in a short time form or build up a slime bed which will effectually prevent the passage of even the finest particles.

As the flow of oil through the filter is continuous during the running of the engine, the oil will, within a short time, be freed from foreign matter which may be suspended therein, and any foreign matter that may become mixed with the oil during the operation of the engine will also gradually be removed. It will thus be seen that the oil within the crank case will be maintained in practically a clear state, freed from impurities and foreign matter, and may be used over and over again and need not be withdrawn and replaced by a new supply of oil. It has been found in practice that an engine embodying my invention may be operated for months and that the vehicle may be run for thousands of miles without draining the crank case to get rid of accumulated impurities, and that at the end of that time the oil in the crank case will be almost, if not perfectly, clear. It is merely necessary to add oil from time to time to compensate for any loss of oil due to wear, evaporation, leakage or the like.

It should be understood that in this system of employing a pressure filter of exceedingly fine texture I obtain a clear bright filtrate resembling new oil, and although the rate of flow through the filter is exceedingly slow, the purifying process is going on steadily while the engine is running, and in effect the result is practically the same as withdrawing several quarts of used oil from

the crank case per hour and replacing same at an equal rate with a like volume of perfectly clear oil.

While I have illustrated and described my invention in connection with a preferred embodiment thereof, it will be understood that I do not intend to limit myself to the specific embodiment shown, but that I intend to cover my invention broadly in whatever form its principles may be employed. Obviously the type of filter employed may be greatly diversified without departing from the spirit of the invention.

Having thus described my invention, I claim:

1. The combination with an automobile internal combustion engine having a crank case, of a single pump means for withdrawing oil therefrom and delivering a portion of the oil directly to the engine and another portion of the oil to a purifying device from which the oil freed from deleterious matter, is returned to said crank case.

2. The combination of an automobile internal combustion engine having a crank case, a filter, and single pump means for withdrawing oil from said crank case and delivering a portion of the withdrawn oil to said filter and another portion of the oil to the engine, and means whereby the oil passing through said filter is returned to the crank case.

3. The combination of an internal combustion engine having a crank case, a filter having its outlet communicating with said crank case, and means for withdrawing oil from said crank case and delivering a portion of the withdrawn oil to said filter and another portion of the oil to the engine parts.

4. The combination of an internal combustion engine having a crank case, a filter adapted to offer resistance to the flow of oil therethrough and having its outlet communicating with said crank case, and means for withdrawing oil from said crank case and delivering a portion of the withdrawn oil to said filter and another portion of the oil to the engine parts.

5. The combination of an internal combustion engine having a crank case, a filter adapted to offer resistance to the flow of oil therethrough and having its outlet communicating with said crank case, a pump for withdrawing oil from said crank case, and means for delivering the withdrawn oil from said pump in part to said filter and in part to the engine parts.

6. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, a pump for withdrawing oil from said crank case, and means for delivering a portion of the withdrawn oil to said filter and another portion of the oil to the engine parts.

7. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, and means for withdrawing oil from said crank case and delivering it under pressure in part to said filter and in part to the engine parts.

8. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, and means for withdrawing oil from said crank case and delivering it under pressure in part to said filter and in part to the engine parts, said means being constructed and arranged to maintain the thus delivered oil at a pressure above predetermined value at normal engine speeds.

9. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, means for withdrawing oil from said crank case and delivering it under pressure in part to said filter and in part to the engine parts, said means being constructed and arranged to maintain the thus delivered oil at a pressure above predetermined value at normal engine speeds and means operative to prevent such pressure from exceeding a predetermined value.

10. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, means for withdrawing oil from said crank case and delivering it under pressure in part to said filter and in part to the engine parts, a normally closed by-pass operatively associated with said first-named means and communicating with said crank case, and means adapted to open said by-pass when the pressure of the delivered oil exceeds a predetermined value.

11. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, a pump for withdrawing oil from said crank case, a pipe leading from said pump to the engine parts, and a pipe leading from said first-named pipe to said filter.

12. The combination of an internal combustion engine having a crank case, a pressure filter having its outlet communicating with said crank case, a pump for withdrawing oil from said crank case, a pipe leading from said pump to the engine parts, a pipe leading from said first-named pipe to said filter, a valve operatively associated with said second-mentioned pipe and adapted to be opened when the pressure within said pipe exceeds a predetermined value, and a pipe leading from said valve to said crank case.

13. The combination of an internal combustion engine having a crank case and a forced-feed lubricating system, a pressure filter adapted to receive oil under pressure from said system and having its outlet communicating with said crank case, and means for supplying oil to the filter, said means maintaining a constant flow of oil through said lubricating system irrespective of the passage of oil to said filter.

14. The combination of an internal combustion engine having a crank case and a forced-feed lubricating system including a pump, a filter circuit including a pressure filter adapted to receive oil under pressure from said pump, said filter being capable of simultaneously removing from the oil suspended impurities and water that may be mixed therewith, and means in said filter circuit for observing the condition of the oil.

15. The combination of an internal combustion engine having a crank case and a forced-feed lubricating system including a pump, a pressure filter adapted to receive oil under pressure from said pump, said filter being capable of simultaneously removing from the oil suspended impurities and water that may be mixed therewith, and means for observing the clarified oil as it flows from said filter.

16. The combination of an internal combustion engine having a crank case, a filter, means for withdrawing oil from said crank case and delivering a portion of the withdrawn oil to said filter and another portion of the oil to the engine parts, and means located adjacent to the filter whereby samples of filtered and unfiltered oil may be withdrawn.

17. The combination of an internal combustion engine having a crank case, a pressure filter, means for withdrawing oil from said crank case and delivering it under pressure in part to said filter and in part to the engine parts, and means associated with the filter for heating the oil before its passage thru the filtering medium.

18. The combination of an internal combustion engine having a crank case, a filter capable of simultaneously removing from oil suspended impurities and water, and one pump means for withdrawing impure and water-contaminated oil from said crank case and delivering a portion of the withdrawn mixture to said filter and another portion of the mixture to the engine.

19. The combination of an internal combustion engine having a crank case, a filter capable of separating water from oil having its outlet communicating with said crank case, and one pump means for withdrawing oil from said crank case and delivering it to said filter, said filter being provided with a collecting chamber to receive water separating from the oil passing through said filter.

20. In a purifying system for lubricating oil of internal combustion engines, a pump, a filter, a main oil reservoir, a suction pipe for the pump extending into said main oil reservoir, a discharge pipe for the pump extending to said filter, a pipe connecting to said discharge pipe and leading to the parts of the engine to be lubricated, a pressure controlled valve connected and arranged to relieve the pump from excessive back pressure from the filter, and a discharge pipe leading from the filter to the main oil reservoir.

21. In a purifying system for lubricating oil of internal combustion engines, a pump, a filter, a main oil reservoir, a suction pipe for the pump extending into said main oil reservoir, a discharge pipe for the pump extending to said filter, a pipe connecting to said discharge pipe and leading to the parts of the engine to be lubricated, a pressure controlled valve connected and arranged to relieve the pump from excessive back pressure from the filter, a discharge pipe leading from the filter to the main oil reservoir, and means to regulate the flow of oil through the filter.

22. In combination with an internal combustion engine having parts to be lubricated, an oil pump, a device for separating an impurity from the oil, and means normally operative to convey part of the oil delivered by said pump to the separating device and another part to the parts to be lubricated, whereby said parts and said device are each supplied with oil independently of the other at all engine speeds.

23. The combination of an internal combustion engine having a crank case and a forced feed lubricating system including a pump, a pressure filter adapted to receive oil under pressure from said pump, said filter being capable of simultaneously removing from the oil suspended impurities and water that may be mixed therewith.

24. The combination with an internal combustion engine of a lubricating system including an oil reservoir, a pressure filter communicating with the reservoir, single means for forcing oil from the reservoir through the filter and for supplying the normal amount of oil to the working parts of the engine at all times without passing through said filter.

25. The combination with an internal combustion engine of a lubricating system including an oil reservoir, a pressure filter communicating with the reservoir, single means for forcing oil from the reservoir through the filter and for supplying the normal amount of oil to the working parts of the engine at all times without passing through said filter, and a pressure relief valve

for relieving excess pressure in said system.

26. The combination with an internal combustion engine of a lubricating system including an oil reservoir, a pressure filter communicating with the reservoir, means to regulate the flow of oil through the filter, single means for forcing oil from the reservoir through the filter, said reservoir having provision for supplying oil therefrom to the engine without passing through the filter, and a pressure relief valve for relieving excess pressure in said system.

27. The combination with an internal combustion engine of a lubricating system including an oil reservoir, a pressure filter communicating with the reservoir, said filter having filter surfaces of dense material arranged in compact form and having an aggregate filter area notably in excess of the piston area of the engine, and single means for forcing oil from the reservoir through the filter, and for supplying the normal amount of oil to the working parts of the engine at all times without passing through said filter.

28. In combination with an internal combustion engine, an oil reservoir, a lubricating circuit, a filter circuit, pump means for forcing oil from said reservoir through said lubricating circuit, a filter, conduits leading from said pump means to said filter and from said filter to said reservoir, one of said conduits having provision for presenting such resistance to the flow of oil therethrough that the desired flow of oil through said lubricating circuit is continuously maintained.

29. In combination with an internal combustion engine, an oil reservoir, a lubricating circuit, a filter circuit, pump means for forcing oil from said reservoir through said lubricating circuit, a filter, conduits leading from said pump means to said filter and from said filter to said reservoir, one of said conduits having a valve for presenting such resistance to the flow of oil therethrough that the desired flow of oil through said lubricating circuit is continuously maintained.

30. In combination with an internal combustion engine, an oil reservoir, a lubricating circuit, pump means for forcing oil from said reservoir through said lubricating circuit, and a branch circuit including a filter receiving oil from said pump means, said filter containing a dense filter surface so arranged as to permit only slow seepage therethrough of oil freed from deleterious solids and being of sufficient area to permit in the aggregate a rate of filtration equal to the normal rate of contamination of the oil under operating conditions, the normal back pressure of said filter tending to resist flow of oil therethrough and to prevent diversion through said filtering circuit of oil required in said lubricating circuit for proper lubrication of the working parts of the engine.

31. In combination with an internal combustion engine, an oil reservoir, a lubricating circuit, pump means for forcing oil from said reservoir through said lubricating circuit, a branch circuit including a filter receiving oil from said pump means, said filter containing a dense filter surface permitting only slow seepage of oil freed from deleterious solids and being of sufficient area to permit in the aggregate a rate of filtration equal to the normal rate of contamination of the oil under operating conditions, the normal back pressure of said filter tending to resist flow of oil therethrough and adjustable means in said branch circuit to regulate the oil flow therethrough whereby when the resistance of the filter is sub-normal the flow in the lubricating circuit may be adjusted to properly lubricate the working parts.

In testimony whereof I have affixed my signature to this specification.

ERNEST J. SWEETLAND.