Dec. 23, 1941. W. W. LOWTHER 2,266,882

AIR CLEANER

Filed Sept. 14, 1939

Fig. 1

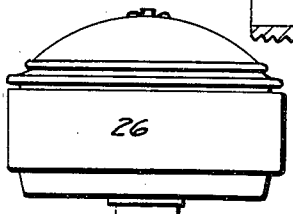


Fig. 3

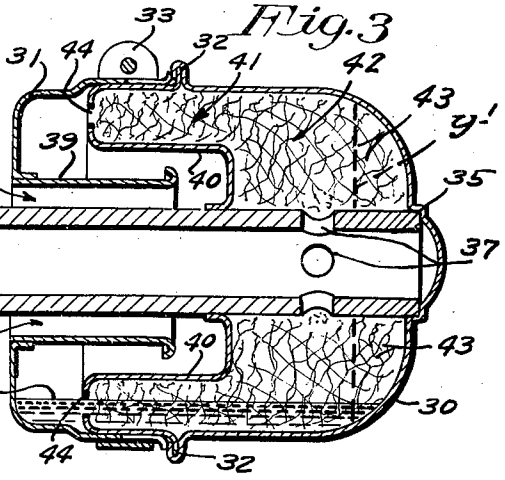
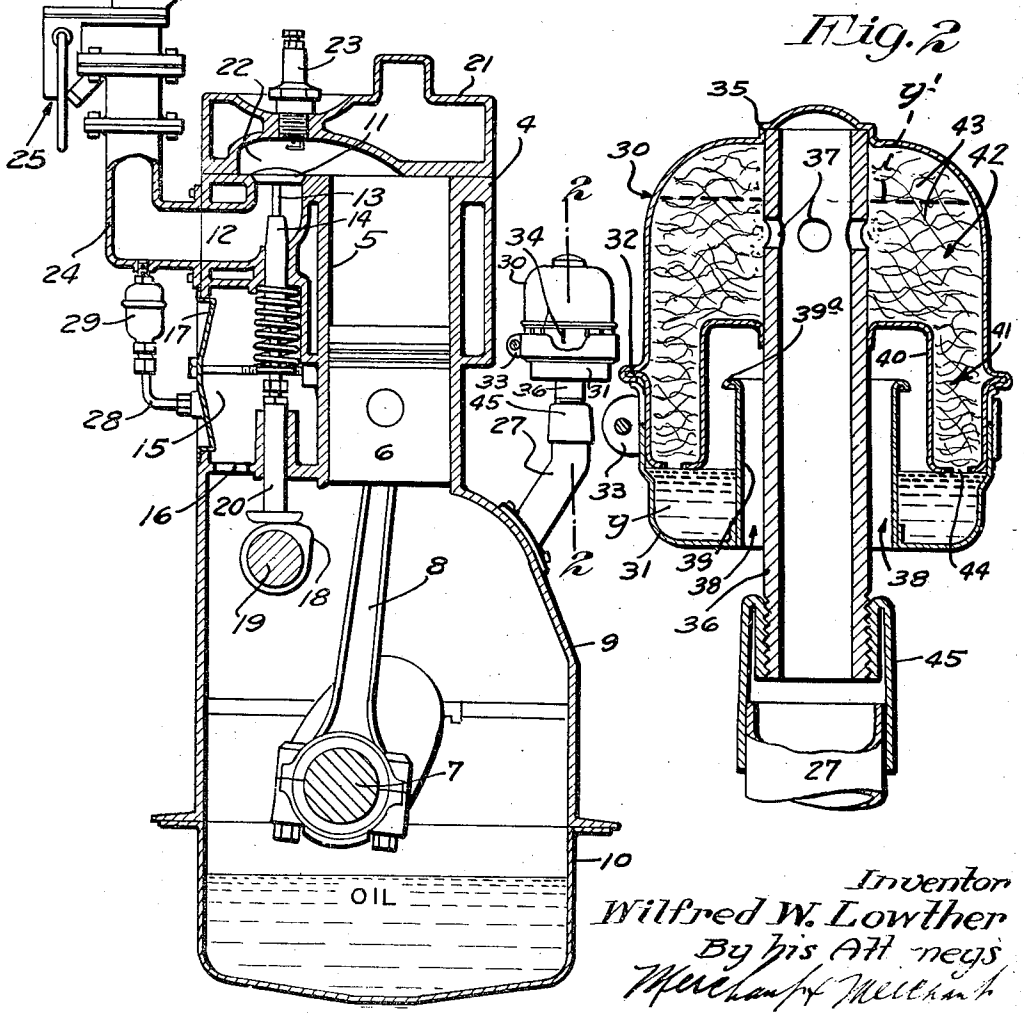


Fig. 2



Inventor
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By his Attnegs
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2,266,882

UNITED STATES PATENT OFFICE

2,266,882

AIR CLEANER

Wilfred W. Lowther, Minneapolis, Minn., assignor, by direct and mesne assignments, of twenty-five per cent to Ruth C. Donaldson, twenty per cent to Robert H. Donaldson, twelve and one-half per cent to A. Donaldson Olin, six and one-fourth per cent to Mae D. Buckeye, six and one-fourth per cent to Ralph A. Buckeye, twenty-five per cent to Ruth C. Donaldson as trustee, and five per cent to Margaret M. Donaldson

Application September 14, 1939, Serial No. 294,886

5 Claims. (Cl. 183—15)

My present invention relates to improvements in air cleaners for use in connection with internal combustion engines, and more particularly the invention relates to that type of air cleaner wherein the dust laden air is washed or cleansed by means including a body of fluid, usually oil, within the cleaner.

In a more specific sense, the present invention is in the nature of an improvement on the particular air cleaner structure disclosed in my prior Patent No. 1,991,759, of February 19, 1935, entitled "Air cleaner," but whereas the air cleaner of my above identified prior patent is particularly adapted for use in connection with the engine's main air intake, the air cleaner of the present invention, while suitable also for this purpose, is particularly adapted and has, as will hereinafter appear, certain inherent advantages which render it particularly suitable for use in cleaning air that is drawn into and through an engine's crank case for the purpose of ventilating the same.

Among the important objects of the invention is the provision of an air cleaner of the character described wherein the overall dimensions may be reduced to minimum for any given capacity, while at the same time maintaining a very high degree of efficiency.

Another important object of the invention is the provision of an improvement in air cleaners of the general character described in which the overall diameter may be reduced over that of previous cleaners of the design, for example, disclosed in my above identified prior patent, for any given capacity without producing any reduction of the cleaning efficiency.

Another object is the provision of an air cleaner of the so-called "oil washed" or fluid containing type that can be handled roughly when removed from the engine and disposed at various abnormal angles such as on its side or even upside-down without loss of fluid through either the open inlet or outlet.

Another important object of the invention is the provision of an air cleaner structure of the general character described which is so shaped and weight balanced that it will not remain disposed on any flat surface in any position wherein the fluid body therein can find its way to the inlet or outlet ducts. In this connection it may be specifically stated that the cleaner is preferably so shaped and balanced that even if placed on a relatively flat support in an upside-down condition, in which position fluid would eventually reach the interior of the cleaner's outlet in the specific construction illustrated, the cleaner will fall on to its side, in which position, due to its construction, the fluid level will be maintained well below the level of the inlet or outlet ducts.

In the automotive and tractor industries it has become practice in recent years to provide the crank cases of internal combustion engines with ventilating systems which maintain a constant flow of fresh air therethrough, and, of course, in connection with such systems it has been found necessary to provide the air inlets to the crank cases with a suitable air cleaner. For this purpose so-called filter type of cleaners have hitherto been employed in preference to the so-called "oil washed" or fluid containing type of air cleaner and this notwithstanding the fact that the tractor and automotive industries have long recognized the superiority of the oil washed or fluid containing type for the following reason, to wit: The oil washed type of cleaner requires relatively infrequent servicing and will maintain a consistently high degree of efficiency between long spaced service periods without building up any materially increased restriction to air flow; whereas, filter type air cleaners, while capable of relatively high degree of cleaning efficiency without producing objectionable restriction to air flow immediately following a servicing period, builds up air flow restriction rapidly under accumulation of dust between service periods and often become almost entirely plugged. Hence, this type of cleaner requires such frequent servicing as to render it undesirable.

While the tractor and automotive industries recognize the superiority of the oil washed type of air cleaner and have almost universally adopted the same in preference to the filter type for use in connection with the engine's main air intake and have also recognized the advantages of the oil washed type of air cleaner over the filter type for use in connection with crank case ventilating systems, they have been forced to use the filter type of air cleaner in connection with crank case breathing systems by reason of the fact that hitherto available cleaners of the oil wash type would not meet the following noted requirements for a commercially practical crank case ventilating system air cleaner, to wit: (*a*) because the only convenient place for attachment of an air cleaner to the inlet of a crank cast ventilating system is usually at the side of an engine where available space is very limited, the overall dimension of the air cleaner, particularly the overall diameter thereof, must usually be very small and, in fact, smaller than most prior fluid containing air cleaners of sufficient capacity, (*b*) because engine crank cases are usually filled with oil through the breather pipe to which the crank case air cleaner is usually

attached, such crank case air cleaners must usually be removed each time the crank case is oil serviced, and since most air cleaners of the oil washed or fluid body containing type must be maintained right side up or approximately so to prevent spilling or losing of oil through either the inlet or outlet openings of the cleaner, it has been found that hitherto available cleaners of this type are impractical for the reason that service men would usually mishandle such cleaners and thereby lose the body of fluid or sufficient thereof to materially seriously reduce the efficiency of the cleaner. In this respect it will be understood that the usual practice in taking off the old type cleaners from the breather when servicing the crank case is to lay the cleaner down without regard to its normal right side up position and, of course, this practice if followed by uninformed service station attendants on hitherto available oil washed cleaners of the usual construction, fluid will be spilled with the result that the efficiency of the cleaner will be impaired.

In the accompanying drawing like characters indicate like parts throughout the several views.

Referring to the drawing:

Fig. 1 is a transverse sectional view through an internal combustion engine incorporating one of the air cleaners of the present invention applied to the air inlet of the crank case;

Fig. 2 is an enlarged approximately full size sectional view of the crank case air cleaner sectioned on the line 2—2 of Fig. 1; and

Fig. 3 is a sectional view corresponding to Fig. 2 but illustrating the cleaner disposed on its side.

The engine herein shown for the purpose of example is of the conventional character such as employed in connection with automobiles, tractors and the like, and includes cylinder block 4 formed with one or more cylinders 5. The cylinder 5 is provided with a piston 6 which connects to the engine's crank shaft 7 through the medium of the usual connecting rod 8. In accordance with the customary practice, the cylinder block 4 is formed to afford the upper portion of a crank case 9, the lower portion of which is normally closed by a removable bottom pan 10. The particular engine illustrated is of the "L-headed" type employing conventional poppet valves. The section of Fig. 1 is through the axis of the cylinder and intake valve 11 and intake port 12. The stem 13 of the valve 11 works axially through a guide 14 and terminates within a valve chamber 15 that is in open communication with the interior of the crank case 9 through an opening or openings 16, and which chamber is normally closed by a removable cover plate 17. The poppet valve 11 is operated in the conventional manner from a cam 18 on the engine's cam shaft through the medium of reciprocable tappet 20 that engages the lower end of the valve stem 13 within the valve chamber 15. The cylinder head of the engine is indicated as an entirety by 21 and this cylinder head is formed to afford a combustion chamber 22 projecting into which is the electrode end of a spark plug 23. The intake port 12 connects to and forms a condition of the engine's main air and fuel intake duct 24 that is equipped with a conventional carburetor indicated as an entirety by 25. The intake of the carburetor 25 is illustrated as being equipped with an air cleaner 26 which may be assumed to be of the kind disclosed in my prior Patent 2,130,142, of February 13, 1938, entitled "Air cleaner."

What has been hitherto referred to as the engine's main intake duct may hereinafter also be referred to as the engine's intake manifold, since in multiple cylinder engines the lower portion of this duct is branched out to distribute to the several cylinders. The crank case ventilating system of which the air cleaner of this invention is illustrated as forming part, comprises the crank case breather or oil filler pipe 27 which forms the air intake to the crank case and which is illustrated as being equipped with its outer end with one of the air cleaners of the instant invention, and an air outlet conduit 28 extending from the valve chamber 15, which in reality constitutes the upper extremity of the crank case, to the engine's main air intake duct or manifold 24. Connection of the duct 28 to the valve chamber 15 is shown as being made through the removable cover plate 17. Preferably and as illustrated, this outlet duct 28 is shown as being equipped with an enlarged portion indicated by 29 which may be assumed to be the casing of a metering valve of the kind disclosed and claimed in my copending application S. N. 294,391, entitled "Crank case breathing system." However, an understanding of this valve is not necessary to satisfactorily understand the instant invention and therefore insofar as the instant invention is concerned, this device 29 can be ignored and the conduit 28 simply considered as providing suitably restricted communication between the engine's main intake duct and the crank case.

Of course, the purpose of a crank case ventilating system is to provide for withdrawing blow-by gases leaking past the piston as fast as they accumulate in the crank case and before condensation takes place, and in addition to this to maintain a steady flow of fresh air into and through the crank case.

In accordance with the present example this is accomplished by virtue of the low pressure or partial vacuum condition existing in the engine's intake duct under engine operating conditions, which causes a constant flow of gases from the crank case through conduit 28 to the engine's intake duct 24. As previously indicated, this flow through the duct 28 will cause, in addition to such gases as leak into the crank case by the piston 6, a steady stream of fresh air entering the crank case through the breather pipe 27 and the air cleaners provided at the projected end thereof.

The air cleaner of the invention includes a shell or casing made up of an inverted cup-shaped upper section 30 having telescopically applied to the upper end portion thereof a cup-like oil well 31. The upper shell section 30 preferably and as illustrated is formed of two parts rolled or otherwise secured together and forming at their point of jointure a radially projecting annular rib or flange 32, which forms a stop for telescopic application of the oil well acting lower section 31. The upper and lower section 30 and 31 may be secured against accidental separation in any suitable manner, but this is illustrated as being accomplished by means of a suitable clamping band 33. In order to permit radial compression of the upper edge of the oil well forming bottom section 31 against the telescopically engaged lower portion of section 30, the upper edge of said section 31 is provided with a series of circumferentially spaced slits 34, which, however, extend only partially through the portion of telescopic engagement between the sec-

tions 30 and 31 so that they will not interfere with the oil seal between the said sections.

Extending axially through the shell sections 30 and 31 and rigidly anchored to the upper end of section 30 at 35 is an air outlet tube or conduit 36 that is provided in spaced relation to the extreme upper end of section 30 with a plurality of circumferentially spaced ports or apertures 37 that provide nearly complete communication between the interior of the conduit 36 and the interior of the upper shell section.

The bottom of the cup-like section 31 which forms the oil well or fluid receptacle of the device is provided with an air inlet opening of considerably larger diameter than the external diameter of the outlet duct 36, so as to provide an annular air intake pipe 38 immediately surrounding the duct 36, and which air intake duct 36 is extended to the intermediate portion of the interior of the cleaner shell by means of an upstanding annular flange or sleeve 39 which forms also one of the annular walls of an annular oil receptacle, the outer and bottom walls of which are formed by the cup-like section 31.

Mounted on the axial air outlet duct 36 above the upper end of the annular flange 39 is a radially projecting and axially depending annular skirt-like sleeve 40 that serves several important functions, to wit: (*a*) The annular skirt-like sleeve 40 forms a reversely and downwardly directed continuation of the annular air intake 38 which terminates approximately at the normal static level of oil *y* in the annular oil receptacle. (*b*) The annular skirt-like flange 40 serves to divide the interior portion of the cleaner shell above the annular oil receptacle, which portion constitutes an expansion chamber, into a high velocity lower expansion chamber section 41 radially outward of the vertical wall of the skirt-like flange 40, and a lower velocity expansion chamber section 42 above the skirt-like flange 40. (*c*) Under operating conditions the radially projecting portion of the skirt-like flange 40 serves to form within the lower velocity upper section of the expansion chamber a quiet zone immediately thereabove where oil will be collected and returned to the high velocity lower section of the expansion chamber where it will be again picked up by the air and thoroughly commingled therewith. (*d*) Both under operating conditions and when in tipping the cleaner about in the course of handling the same skirt-like flange 40 serves as an oil directing baffle and directs all oil reutrned from the expansion chamber to the oil well at a point materially below the upper end of the upwardly directed primary section of the annular intake passage 38. In other words, under all conditions the skirt-acting flange 40 prevents oil from entering the upper opened end of the sleeve 39.

Preferably and as illustrated, the entire expansion chamber is packed with a suitable filter material such, for example, as hair or mineral wool, such filter material being indicated by 43. For performing the dual function of retaining the filter material in position and materially increasing the velocity of the air at the point where it passes from the oil well proper into the lower section of the expansion chamber, the lower end of the shell and the lower end of the skirt-like flange 40 are respectively turned radially inwardly and radially outwardly to form a constricted annular passage 44.

The cleaner may be detachably applied to the breather pipe 27 or to its equivalent in any suitable manner, but as illustrated, this is accomplished by means of a tapered coupling sleeve 45 that is screw threaded on to the projected lower end of the axial air outlet duct 36. With this coupling an air tight joint is made merely by wedging action between the sleeve 45 and the upper end of the breather pipe 27 by virtue of wedging action resulting from the taper.

Operation

When the cleaner described is in operative position with the engine at rest, the fluid level will be substantially as indicated in Fig. 2. However, when the engine is set in operation there will be a continuous but variable flow of air from atmosphere through the cleaner described through the breather pipe 27 to and through the crank case and valve chamber 15 to the engine's air to the fuel intake duct 24 through the medium conduit 28 and metering valve housing 29, if such be provided.

It is, of course, assumed that the crank case is sealed from atmosphere except through the air cleaner described. The air thus passed through the crank case air cleaner by virtue of the difference between atmospheric pressure and the pressure in the intake duct 24 will impinge upon oil in the oil receptacle immediately below the downwardly directed section of the air intake passage 38 and will cause a large portion of the oil to be displaced from the annular oil well into the expansion chamber and the air will reverse its direction of travel over such oil as remains in the annular oil receptacle and will pass through the constricted annular passage 44 into the high velocity lower section 41 of the expansion chamber. The air will, of course, rapidly expand as it leaves the constricted passage 44 and will become very thoroughly commingled with oil carried therewith into the lower portion of the expansion chamber. While the air will lose considerable velocity after leaving the constricted passage 44 it will, nevertheless, maintain a relatively high velocity through the lower high velocity section of the expansion chamber and will further expand over the upper edge of the skirt-like flange 40 as it enters the lower velocity section. A large amount of oil will be carried with the air entirely through the high velocity lower section of the expansion chamber, but as the air expands above the high velocity lower section, the velocity will be materially decreased and oil carried with the air will find its way into the relatively dead air annular conical space surrounding the upper portion of the outlet duct 36 intermediate the radial portion of the flange 40 and the ports 37. The thoroughly cleaned air will pass through ports 37 into the axial outlet tube 36 to the engine's crank case. Of course, a large portion of the dust and all the heavier particles will be removed from the dust laden air entering the cleaner by the process of impingement as it reverses its direction of travel over the oil in the well, but such light particles of dust as remain in the air after leaving the oil well will be intercepted by oil in the filter containing expansion chamber and will be thereafter returned to the oil well with the oil. The filter material, which may hereinafter be referred to as oil and dust intercepting means, serves not only as an oil soaked self-cleaning filter but further serves together with the oil to subject the dust to what is referred to as a scrubbing process and still further serves the important function of intercepting and returning

oil to the oil well. As stated before, oil will be collected in this quiet zone above the skirt-like flange **40** and, of course, this hydraulic head of oil will continuously drain back into the air as it passes through the high velocity lower section of expansion under operating conditions.

Not only does the skirt-like flange **40** obviously serve to direct oil away from the upper end of the intake tube or sleeve **39** under operating conditions, but it will also be evident that this skirt-like flange will serve this same purpose under any abnormal condition such, for example, as when it is laid on its side as when oil servicing the engine. The static level of the body of oil *y* when the cleaner is disposed on its side is illustrated in Fig. 3

The preferred practice in carrying out the invention is to space the holes **37** sufficiently far from the normal top of the cleaner that the said holes will be above the oil level in the top of the cleaner when the cleaner is held upside down, even for a prolonged period. In fact, with the arrangement illustrated, the fluid body will be spaced from the holes **37** and prevented from entering the tube **36** in any rotated position of the cleaner. In Figs. 2 and 3 the approximate fluid level in an upside down position of the cleaner is shown by dotted lines Y'.

As previously indicated, the cleaner is so shaped and balanced that it will not remain upside down on any relatively flat support even if inadvertently placed on the support in that position, but will roll over on to its side where the fluid will be well spaced from both the inlet and outlet. This is accomplished largely by virtue of rounding the head and of the shell section **30** and so distributing the weight of the device that it will always roll on to its side under the action of gravity.

Preferably the open upper end of the intake tube or sleeve **39** is rolled outwardly and downwardly at **39***a* to provide an oil trap flange which will serve when the cleaner is turned upside down, for example, to trap and prevent oil on the outside surface of the sleeve **39** from running off of the end thereof and on to the radially projecting portion of the skirt-acting flange **40**. This is desirable since in the absence of the flange **39***a*, fluid once deposited on the skirt-like element **40** would be apt to drip into the primary vertical portion of the outlet passage **38**, which would not only result in loss of oil but would also result in collection of dust on the inner surface of the sleeve **39** and consequent, at least, partial plugging of that portion of the intake passage **38** formed thereby.

What I claim is:

1. An air cleaner including a cylindrical shell-like casing formed by an inverted cup-like main upper section and an oil well forming cup-like lower section, an opening in the bottom of the lower section, an air admission sleeve extending from the margin of the opening in said lower section upwardly in said casing and having an open upper end spaced substantially above the normal level of oil in said lower section, an annular baffle member including a cylindrical skirt portion radially spaced from said sleeve and a closed horizontal upper end in vertical spaced relation to the upper end of the sleeve, the skirt portion of said baffle terminating adjacent the normal oil level and forming with said sleeve an air reversing passage, said baffle member also forming with the casing a lower, high air velocity chamber and an upper, lower velocity chamber in communication therewith, the skirt portion defining the inner circumferential wall of the high velocity chamber and the closed upper end forming a bottom wall for the low velocity chamber, a mass of filtering material substantially filling said casing above the oil level therein and extending continuously through said high and low velocity chambers, and an air outlet tube in said casing having an inlet end portion in and embraced by said filtering material in said low velocity chamber intermediate the upper end of the casing and said closed end of the baffle member and radially inwardly of said skirt portion.

2. The structure defined in claim 1 in which the said shell-like casing is so weighted and the head thereof so formed that the cleaner will roll on to its side when placed on a relatively flat support in an upside down position.

3. The structure defined in claim 1, in which the interior of the outlet tube opens into the upper interior portion of the casing in such spaced relation to the top of the cleaner that such point of opening will remain spaced from the fluid body in all rotated positions of the cleaner.

4. An air cleaner comprising a shell-like casing providing an oil well in its bottom, and an annular expansion chamber above said oil well, an air outlet tube extending from the upper portion of the expansion chamber axially through the bottom of the oil well, an air intake opening in the oil well forming bottom of the cleaner casing, said air intake opening being concentric with but of larger dameter than the outlet tube so as to form with the outer surface of the intake tube an annular air passage, an upstanding sleeve extending from said primary annular intake passage to the interior of the casing at a point materially above the normal static fluid level in the well, and a baffle flange anchored to the outlet tube, said baffle flange comprising a top portion projecting outwardly from the outlet tube at a point above and spaced from the upper end of said sleeve and a depending skirt portion radially outwardly spaced from the upstanding sleeve but radially inwardly spaced from the outer wall of the casing and terminating with its lower edge below the upper end of the upstanding intake sleeve; said skirt forming with the upstanding sleeve a downwardly directed continuation of the upwardly directed intake passage formed by the sleeve, dividing the expansion chamber into a high velocity lower section surrounding the upper portion of the upstanding sleeve and a low velocity upper expansion chamber section overlying the high velocity lower section thereof and the upper end of the intake sleeve, and further serving as a baffle for directing oil from the expansion chamber to a level safely below the upper end of said sleeve, the inner wall of the annular upper section of the expansion chamber being formed by the air outlet tube, said lower and upper sections of the expansion chamber being filled with a filtering medium.

5. The structure defined in claim 1 in which the interior of the outlet tube opens into the upper interior portion of the casing in such spaced relation to the top of the cleaner that such point of opening will remain spaced from the fluid body in all rotated positions of the cleaner, and in which the said shell-like casing is so weighted and the head thereof is so formed that the cleaner will roll onto its side when placed on a relatively flat support in an upside down position.

WILFRED W. LOWTHER.