July 12, 1938. A. MOORE **2,123,485**

ANTERIOR THROTTLE CARBURETOR

Filed July 27, 1934 2 Sheets-Sheet 1

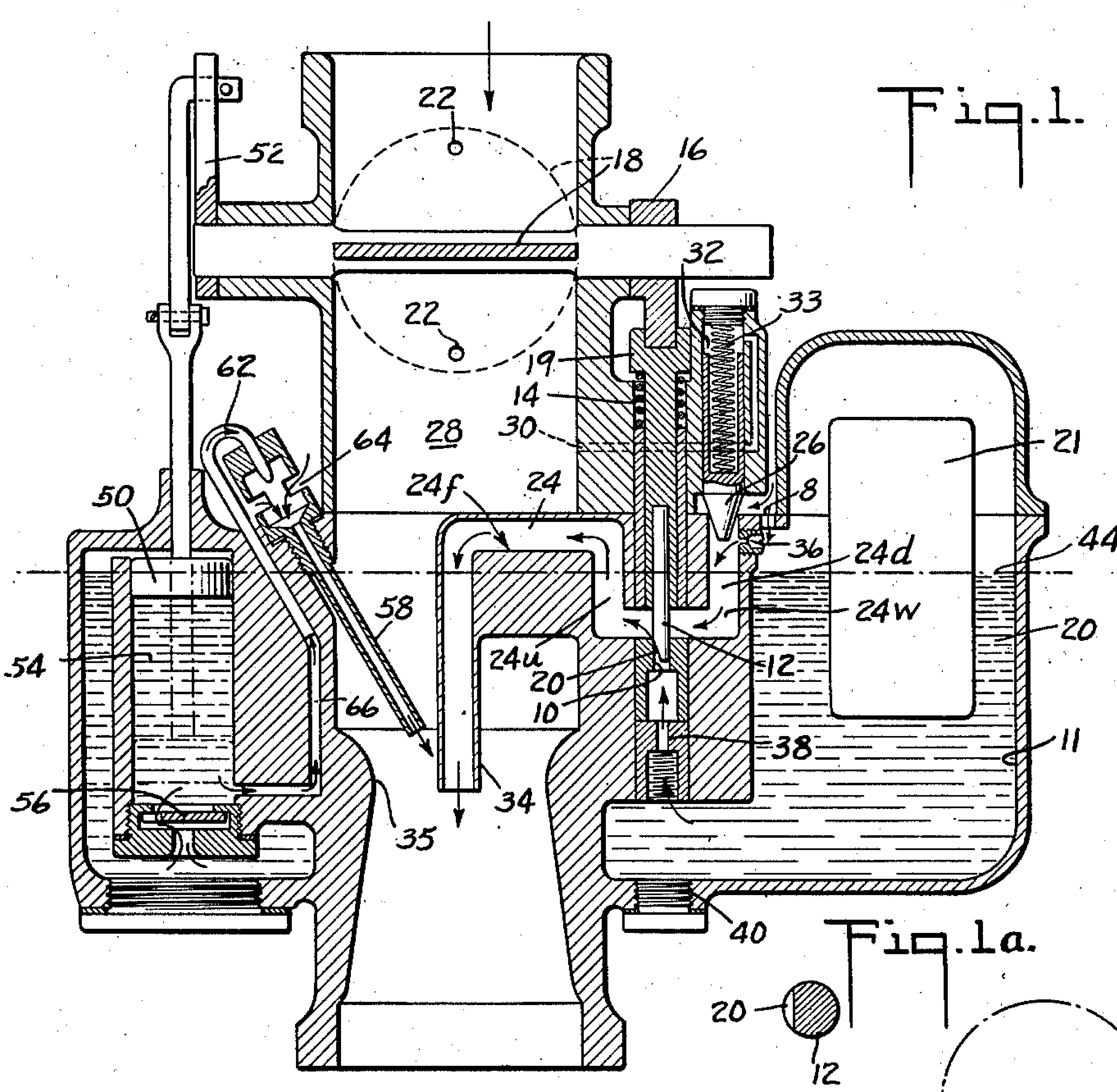

Fig. 1.

Fig. 1a.

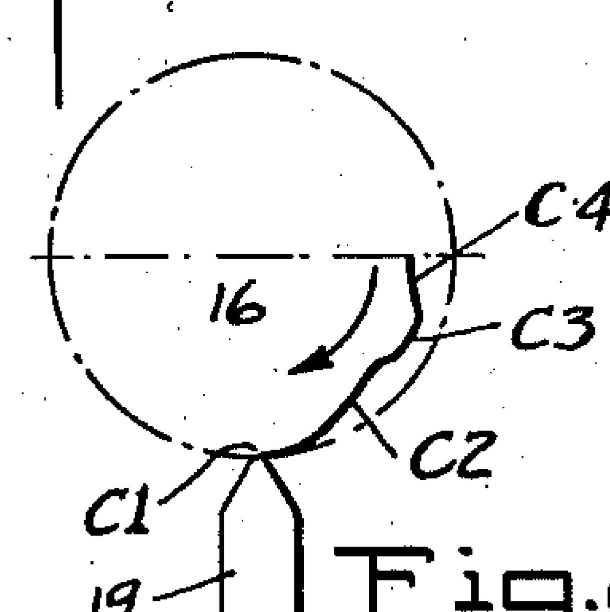

Fig. 2.

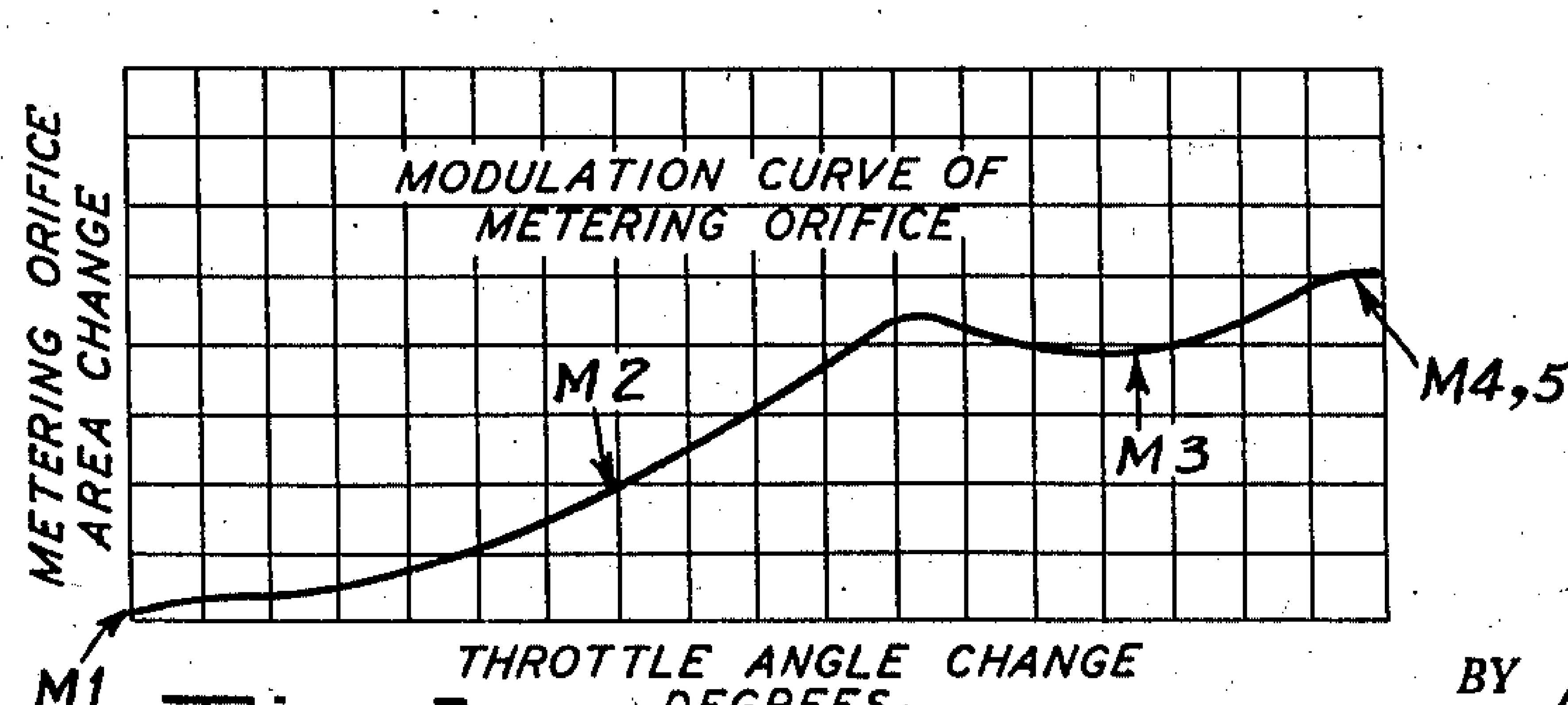

Fig. 3.

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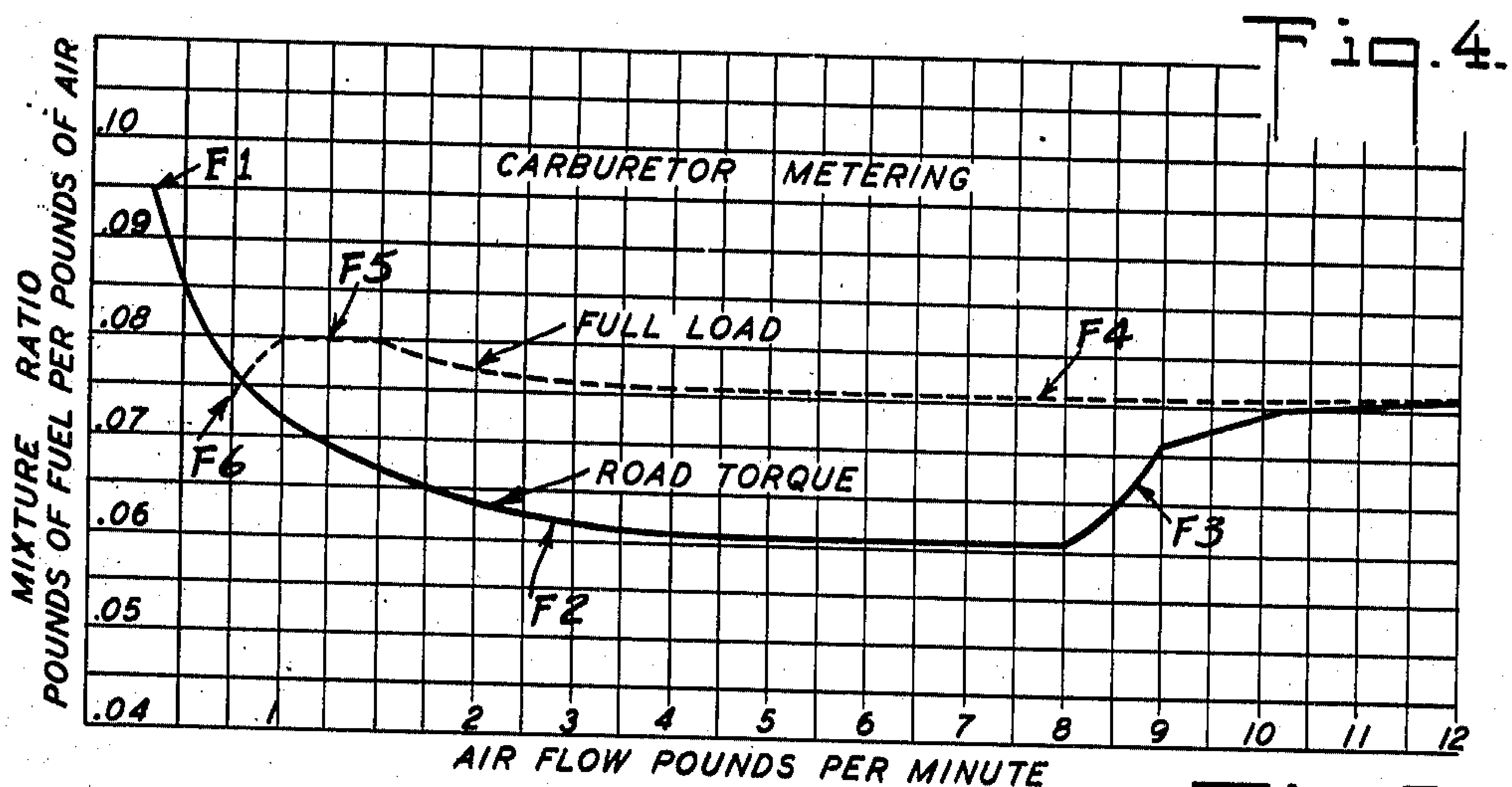

Fig. 4.

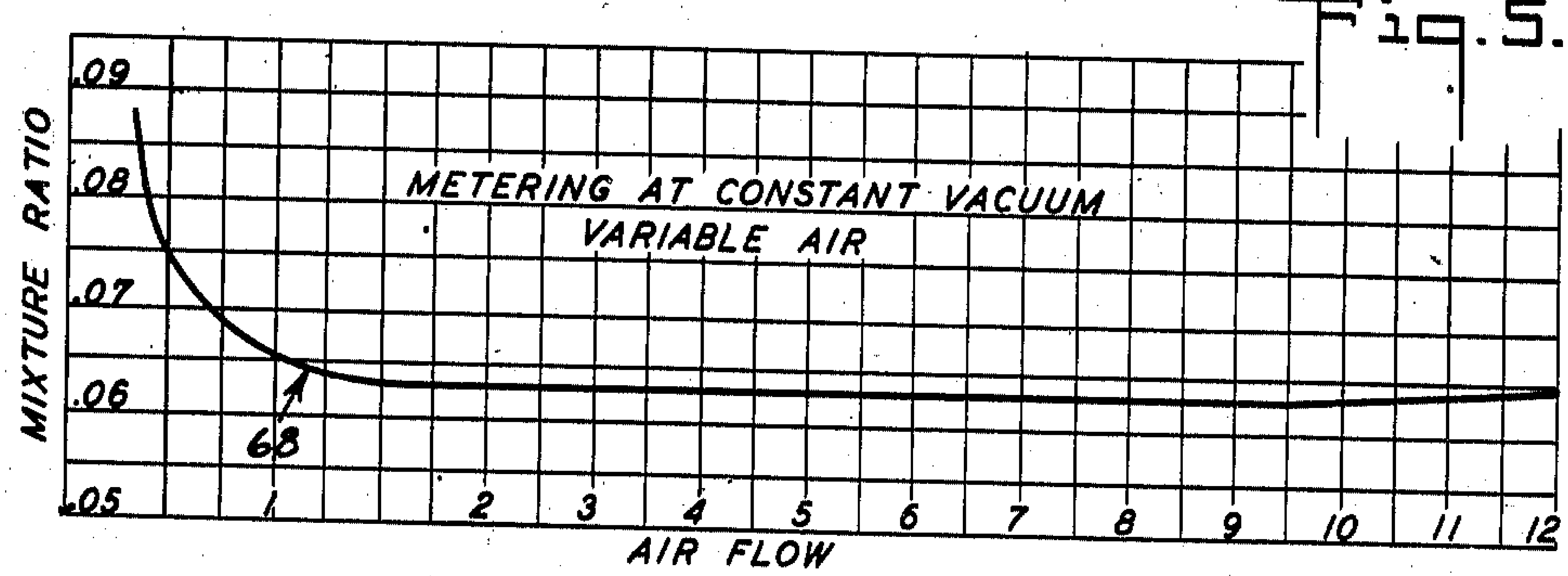

Fig. 5.

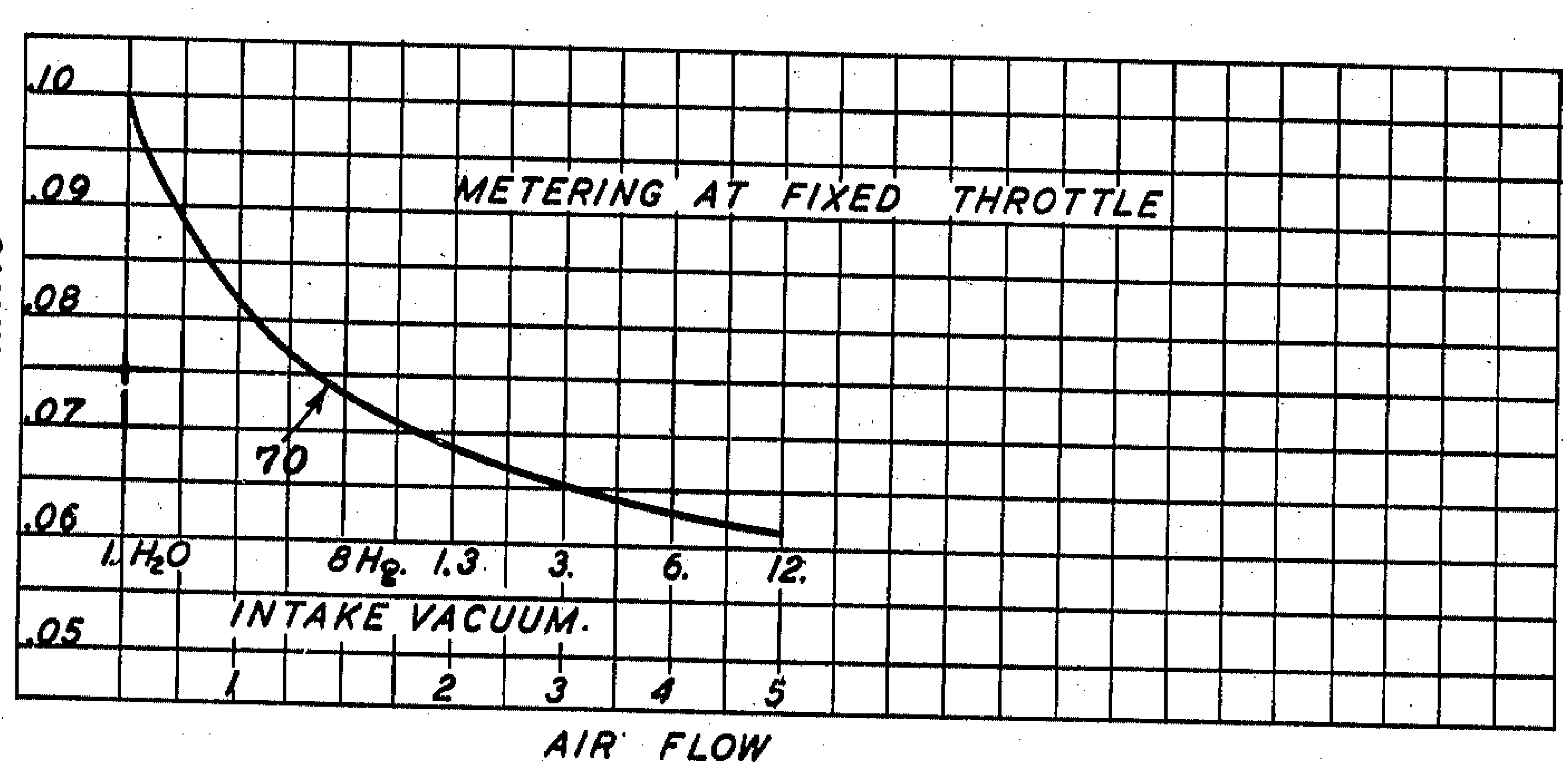

Fig. 6.

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2,123,485

ANTERIOR THROTTLE CARBURETOR

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Application July 27, 1934, Serial No. 737,186

12 Claims. (Cl. 261—50)

My invention relates to carburetors and particularly to an anterior throttle carburetor.

The general object of the invention is to provide an improved anterior throttle carburetor and system of fuel supply and mixture ratio control which will efficiently supply, meter and mix the fuel and air, in the region on the cylinder side of the throttle in manner adapted to meet the engine requirements, as they arise and vary throughout the wide range of various and rapidly changing speed and power conditions met with in operation of automotive devices, as the automobile engine, for example. Other objects subordinate to such general object will appear below, and with such objects in view my invention consists in the parts, improvements, processes and combinations hereinafter set forth and claimed. The present invention is cognate to the subject matter of my earlier applications, as for example, Serial Numbers 595,992 and 591,040.

In the drawings,

Fig. 1 is a diagrammatical sectional view of an automobile engine carburetor embodying and illustrating my invention;

Fig. 1a is a section through the fuel metering pin;

Fig. 2 is a diagrammatical side elevational view showing the development of the camming peripheral surface of the cam for actuating the fuel metering pin;

Fig. 3 is a graph of area change of metering orifice, and

Figs. 4, 5 and 6 are graphs showing relation of mixture ratio to air flow as flowed by the carburetor.

The carburetor construction shown in Figs. 1–3 will be described with reference to its ability to meet the various engine operating conditions from idling to full load.

Engine idling

Idling fuel is supplied through the main fuel jet, without resort to a separate idling fuel bypass. The extent of opening of the main fuel supply orifice 10, fed from the constant level float chamber 11, is regulated by the fuel modulating pin 12. Pin 12 is retracted by spring 14 and actuated in opposite direction by cam 16, turning with the throttle or main air valve 18, and engaging slidebar 19 which carries the pin valve 12. At idling the cam 16 is engaged at the cam part C1, providing an opening of the fuel orifice 10, as indicated at M1, Fig. 3, predetermined to supply the fuel required for engine idling operation. The slab terminal formation of the modulating pin 12, indicated at 20, Figs. 1 and 3, whereby the fuel flow is concentrated in a passage of sector-shaped cross-sectional formation, relieves the flow of the idling fuel through the metering orifice from undue frictional retardation such as would be imposed by its flow through an annular shaped passage, for example. With such arrangement, together with reduced pressure differential effective at the fuel orifice 10 as described below and whereby undue orifice restriction is avoided, a constant uniform flow of idling fuel is obtained, free from objectionable fluctuation.

The fuel-to-air ratio for idling can be regulated within desirable limits, as, for example, from about .09 to about .11 pound of fuel per pound of air (.095 being indicated for a particular engine at F1, Fig. 4) by varying the air component. One way of doing this is to alter the dimension of the small air holes 22 in the throttle blade 18. Another way is by adjustability of throttle closing position.

The fuel is delivered from metering orifice 10 into the primary air passage 24. Air inlet valve 26 to passage 24 is wide open at idling, the main air valve or throttle 18 being substantially closed, and the static depression in the main air passage at 28 being communicated through duct 30 to the induction chamber 32, thereby compressing spring 33 and retracting and opening the primary air valve 26, which is preferably of tapered pin or needle formation. The fuel is pulverized by introduction from metering orifice 10 into the high-velocity air stream moving through primary air passage 24, and this fuel and air mixture is further homogenized and the fuel vaporized by being centrally discharged through the main fuel nozzle 34 into the region of high depression at the Venturi throat 35, and there admixed with air admitted through or past the throttle 18, supplying an idling mixture well adapted for uniform distribution to the engine cylinders.

With the primary air inlet valve 26 wide open, the pressure differential upon the neighboring fuel orifice 10 is substantially reduced, and this lowered pressure differential is a material factor in permitting use of a fuel passage for idling, which is of sufficient size and has sufficiently low frictional retardation to fuel flow, to secure constant fuel flow while idling, with freedom from objectionable fluctuation.

Level road or fractional load operation of automobile engines

In this part of engine operation, in which varying and relatively low loads are imposed, the engine speeds range from minimum to substantially maximum, with the power requirements ranging up from minimum to values considerably under the maximum possibly available. Such engine operation is performed under part throttle openings with turning movement of cam 16 in engagement with slide bar 19 through substantially the portion marked C2 in Fig. 2. In such operation there is considerable variation in the efficiency obtained under the different conditions encountered. Scavenging is incomplete and a considerable part of the cylinder contents consists of residual exhaust gas. At the higher engine speeds within this range the fuel-to-air ratio can approach its leanest and most economical values. The intake depression is comparatively high throughout this range and at any given throttle opening the intake depression increases with the engine speed. In this part of the range of engine operation, uniform fuel flow is favored by having both a modulation of fuel passage 10 and a primary air influence of pressure control upon the fuel orifice that will cause the fuel to flow uniformly for any given speed at each position of the metering pin.

In this range of operation the primary air valve 26 under control of intake depression acting through the duct 30 serves at times to vary the extent of opening of the air inlet passage, the opening for admission of primary air being decreased as the engine speed decreases below certain revolutions per minute. At other times the volume of primary air varies with engine speed even though the valve 26 remains wide open, the effect thereby being to coordinate with fuel orifice modulation the differential pressures required conducive of proper fuel flow values for the most efficient and economical engine operation.

The formation of the modulating pin 12 and the formation of actuating portion C2 of the cam 16, productive of metering orifice area changes M2 are calibrated together by usual flow-bench or other testing and calibration methods so that, with the fuel modulation at 10, the accompanying partial opening and closing of the main air valve 18, and the variation in primary intake passage opening by valve 26 in direct response to certain depression changes, a flow curve is obtained, such as indicated for certain engines at F2, Fig. 4, ranging down from the idling fuel ratio of about .095 pound of fuel per pound of air to a minimum of about .062. As an example of suitable metering pin formation and movement, it may be noted that for an engine normally operated on a nominal 1¼″ size carburetor, a suitable modulated fuel orifice diameter for use with my new anterior throttle carburetor would be .093 inch diameter, with a slab angle on the metering pin of 27° to the longitudinal axis, together with actuating cam formation substantially as shown at C2, Fig. 2.

Transition to full load operation

In making the transition from level road torque operation to full load operation a point is reached as the throttle is opened at which the resulting decrease in intake depression partially closes valve 26, and materially reduces the primary air inlet opening. While the general intake depression at this time is lowered, the considerable cutting down of the extent of opening of the primary air inlet passage 24 has the effect of making a greater proportion of the general intake depression effective within the primary air passage 24, and thereby relatively increasing the pressure differential effective at the fuel metering orifice 10. Without reduction of the extent of opening of fuel orifice 10 at such periods increased fuel flow and over-enrichment of the mixture would result. To avoid this and secure properly calibrated flow at such intervals, the formation of the fuel metering cam is reversed in this neighborhood, say at about three-quarter throttle opening, as indicated at C3, Fig. 2, so that at such throttle opening the fuel modulating pin 16 is moved somewhat toward closed position, indicated at M3, Fig. 3, thus cutting down the fuel flow and avoiding over-enrichment. In this way there is no occasion in this transition period for resorting to interference with movement of the primary air valve 26 in response to changes in intake depression, as would be caused if, for example, the over-enrichment were avoided by provision of means for mechanically controlling the closing movement of valve 26. By this reversal of cam formation, proper enrichment in the transition period is accomplished in a simple, easy manner, and the fuel flow controlled with fuel-to-air ratio regulated as indicated at F3, Fig. 4, to merge with full load requirements.

Full load metering

The dotted parts, F4, F5, of the curve on the carburetor metering graph, Fig. 4, show the mixture ratio for efficient wide open throttle operation of certain engines. During full load the fuel supply is varied directly with the air flow by locating the main jet 34 in the throat of the large Venturi passage 35 of the carburetor where it is subject to maximum depression available. During full-load operation intake depression is relatively low, even for high speeds, and the spring 33 acting against the induction primary air needle valve 26 holds this induction operated valve 26 to its seat throughout full load operation. During certain ranges of full load operation substantially all available depression must be effective upon fuel orifice 10 in order to produce fuel flow productive of the needed mixture strength. The small air inlet orifice 36 provided in the wall of air conduit 24 adjacent to the seat of valve 26 permits a limited amount of air to pass through the conduit 24 during that part of full load operation in which the engine speed and the intake depression is sufficient to prevent the fuel level from filling the well portion 24*w* of passage 24, which will be referred to later. The small orifice 36 is preferably formed in a replaceable bushing and is so calibrated as not to lower the depression within the conduit 24 materially and at the same time to permit air inlet sufficient when valve 26 is closed to air vent the passage 24 and keep the fuel moving at a rate to prevent the well 24*w* from filling during full load operation, except at low speed. Portion F4 of the curve on the metering graph, Fig. 4, represents the range in which the air flows in through opening 36. By change in area of the small orifice 36, the fuel flow and the fuel-to-air ratio can be increased or decreased (with a consequent raising or lowering of portion F4 of the curve of Fig. 4). A fuel jet 38 in tandem ahead of orifice 10 and of smaller bore than said orifice 10 is used entirely for fuel metering without metering pin modulation during wide open stages of operation, the modulating pin 16 being raised by the metering cam portion C4 to produce an orifice at 10 of an area in excess of the area of the jet 38. The uniform cylindrical bore 38 of predetermined size which meters the fuel during full load operation as indicated at M4, 5, Fig. 3, is a more accurate metering instrumentality than the modulated orifice used during the other stages of operation. Using such full load fuel jet 38 of smaller diameter than metering orifice 10 for full load fuel metering simplifies the functions and design of the metering pin 12, facilitates calibration changes, and affords a simple means of changing the full load mixture ratios to get uniformly good full load operation, such changes being readily accomplished by replacement of one jet 38 by another of slightly different orifice size, plugged hole 40 being provided for this purpose. Jet 38 has preferably a force fit and has a screw threaded bore part to facilitate its withdrawal.

Full load operation at low speed

During low speed engine operation at full load, the mixture ratio should be strengthened because of the high torque or "lugging" requirements of the engine, and the need to avoid early "stalling". The depression during this part of operation is extremely low. Mixture enrichment is accomplished by the hydrostatic action of the fuel rising in well 24*w* and in both the downwardly extending branch 24*d* thereof and the upwardly extending branch 24*w* thereof by gravity when the intake depression becomes thus extremely low, thereby closing off or plugging the conduit 24 with liquid fuel, rendering inactive the air orifice 36, and thus enriching the mixture by reducing the height through which the fuel is lifted, and by producing flow of solid liquid fuel alone through passage 24 in response to the pressure differential. The depth of submergence of the fuel orifice below the level in float chamber 11 which can be varied or adjusted, as by changing the float level, together with the elevation of outflow floor line 24*f* of passage 24, above the fuel level, determine the extent of enrichment of mixture ratio during this period of operation when the fuel rises in the passage 24 and air is no longer admitted at 36. Thus fuel-to-air ratios are obtained as indicated in the portion F5 of the metering graph, Fig. 4. The fuel level in reservoir 11 as controlled by the float 21 is not critical except at low-speed full-load, when the carburetor functions at such extremely low depression. The point representative of the minimum volume of air flow that can be accompanied by fuel is designated for certain engines on the carburetor metering graph, Fig. 4, at F6. With parts disposed about as shown in Fig. 1 and the floor level part 24*f* of passage 24 at about the height shown above the fuel level line 44, the carburetor will function to supply metered fuel at an intake depression of about one inch of water.

When depression goes to practically zero, as upon sudden opening of the throttle, (accompanied by pumping in of acceleration or stall preventing fuel, described below), conduit 24 and its well 24*w* are momentarily filled with liquid fuel with resulting momentary lowering of the fuel level 44, and this must be taken into account in adjusting the normal fuel level, and also in fixing the dimensions of conduit 24. Siphoning adjustment of fuel level, as adjustment thereof up to near the passage floor 24*f*, can be resorted to, if desired, to furnish fuel for minimum engine speed at full load, but siphoning fuel losses will not take place when the engine is at rest, with throttle (and metering pin 12) closed by the usual throttle spring since the orifice at 10 is too small to permit fuel to flow at atmospheric pressures.

Engine acceleration

Pump piston 50 actuated with the main throttle, as by crank 52, and working in fuel well 54 supplied with check valve 56 can supply fuel for starting and deliver accelerating fuel charges upon opening throttle movement. Acceleration fuel nozzle 58 directs the acceleration fuel discharge downward and for impingement against the main nozzle 34, located at the Venturi throat 35 of the main air passage 28. A tube 62 having an orifice at its top about No. 80 size supplies the fuel to nozzle 58. When the engine is operating normally, slots 64 leading from nozzle 58 to atmosphere function to contribute to idling air through nozzle 58, and short-circuit and reduce the depression effective upon the fuel supply tube 62 so that fuel will not flow from the pump well 54 by influence of depression. The relationship of the discharge orifice from tube 62 to the slots 64 is predetermined to elevate the level of liquid within the passage 66 leading to tube 62 sufficiently so that upon pumping movements of acceleration the fuel delivery through the nozzle 58 will be instantaneous, even from slight opening changes in throttle position. With this arrangement, fuel is instantaneously supplied to the engine to materially supplement the main fuel supply at periods when intake depression falls to zero, and the quantity of accelerating fuel supplied corresponds to the stroke given to the piston 50 upon advancing the throttle for accelerating the engine.

Other metering characteristics

In Fig. 5 a curve is shown representing the metering at constant vacuum with variable air supply. It will be noted that at minimum air flow the mixture ratio is at maximum strength, and as the air flow increases the curve straightens out, maintaining a uniform ratio over a wide range of increased air flow. This characteristic of metering is ideal, and when the carburetor is flowed at constant air variable vacuum the characteristics of the curve are similar.

Fig. 6 shows a back flow curve 70 of the carburetor metering at fixed throttle. The throttle position was fixed to flow five pounds of air per minute and locked in position, the vacuum then was reduced from its initial value of twelve inches of mercury to one inch of water, the mixture ratio responding to strengthened values as the value of the intake depression decreased.

This curve 70 illustrates the ability of the carburetor to pass from relatively lean mixture ratio for part load into the richer ratios required for full load operation without opening the throttle to wide open position. As an example illustrating the value of this characteristic, an automobile engine may be running at thirty miles per hour car speed on level road and a grade approached with the throttle remaining at a constant position. The speed of the engine will decrease as the grade is encountered, and with the decrease in speed the intake depression will decrease, but the engine torque will increase substantially as the speed decreases due to increase in strength of mixture automatically supplied.

It is to be understood that the showing made is for illustration only, and affording an understanding of the principles of my invention, and such showing is not to be construed in a limiting sense.

I claim:

1. In an anterior throttle carburetor, an intake passage, a throttle, a fuel passage, throttle actuated means including a cam for controlling the fuel passage opening, whereby the latter is in part varied with change in throttle opening, is in part varied substantially inversely to throttle opening, and in part is a fixed area, a primary air passage into which the fuel passage delivers, a fixed air opening for said primary air passage, and a variable air opening for said primary air passage controlled by engine intake vacuum, the fixed opening being posterior to the variable opening to admit air when the variable passage is closed.

2. In apparatus for supplying and proportioning charges for internal combustion engines comprising an intake having a throttle therein, a passage for conducting primary air into the intake at the side of the throttle toward the engine cylinders, two air inlets in tandem to such primary air passage, a float chamber having a fuel metering orifice therefrom into the primary air passage, means responsive to pressure reduction in the intake during full load operation for closing one of the primary air inlet openings, said float chamber and said primary air passage being so related that the fuel closes off the remaining opening for primary air with resulting mixture enrichment at the low depression present in the intake during full load operation at low speed.

3. In an apparatus for supplying and proportioning charges for internal combustion engines, comprising an intake having an air throttle therein and a passage for conducting primary air in on the engine side of said throttle, means for reducing the extent of opening of said primary air passage for operation at full load, a float chamber having a metering orifice therefrom to the primary air passage, means for varying the fuel orifice area partly directly with throttle opening area and partly substantially inversely to throttle opening area variation, said metering orifice being submerged below the fuel level and said passage hydrostatically loading with fuel at the low depression existing during full load operation for closing off the primary air to thereby produce a temporarily enriched mixture.

4. In apparatus for supplying and proportioning charges for internal combustion engines comprising an intake, a throttle therein, a float chamber, means partially submerged below the float chamber fuel level for conducting primary air into the intake at the engine side of the throttle, said submerged portion filling with fuel to close off the primary air at low depression, a fuel metering orifice opening into the submerged portion of said primary air conducting means, and having a variable pressure differential thereon attenuated by the primary air, means operated adjunctively to throttling for producing at various throttle positions fuel metering orifice areas varying partly directly with and partly substantially inversely to variation in throttle opening area and coordinated with the pressure differential effective on the orifice for producing desired mixture ratios while reducing frictional coefficients on the orifice, and means responsive to the intake depression for reducing the extent of opening of the primary air passage as full load operation is approached.

5. Apparatus in accordance with claim 4 in which at full load fuel is metered through a fixed orifice.

6. In apparatus for supplying and proportioning charges for internal combustion engines, an intake, a throttle therein, means in the intake at the engine side of the throttle for supplementing intake depression in promoting fuel flow, a fuel line having a metering orifice, and terminating in fuel flow inducing relation to said means, means for modulating said orifice so that for lowest openings same varies directly with throttle opening, and for somewhat higher openings varies substantially inversely therewith, and means for introducing primary air into the fuel line at the anterior side of the metering orifice for reducing the variable pressure differential thereon, said modulating means and said air introducing means being coordinated at fractional loads to allow orifice areas minimizing orifice frictional coefficients, and said two last named means being coordinated at full load operation with said first named means to keep the fuel flow at the higher speeds within a desirable range.

7. Apparatus in accordance with claim 6 in which the fuel orifice area is constant when the throttle is fully open.

8. In apparatus for supplying and proportioning charges for internal combustion engines, an intake, a throttle therein, means for conducting fuel through a fuel orifice into the intake at the engine side of the throttle, means for introducing primary air into said fuel conducting means for attenuating the variable pressure differential on said orifice, and fuel metering means in said orifice for metering the idling fuel, and for varying the orifice area during fractional load directly with throttle opening variation and upon transition from fractional to full load operation varying the orifice area substantially inversely to throttle opening area.

9. Apparatus as in claim 8 in which during full load operation at wide open throttle the fuel is not modulated but supplied through a fixed orifice area.

10. In apparatus for supplying and proportioning charges for internal combustion engines comprising an intake conduit, an air throttle therein, means for supplying fuel to the intake conduit at the engine side of the throttle, including a metering orifice, means for introducing variable quantities of air into the fuel supplying means at the discharge side of said metering orifice to reduce the pressure differential thereon, means for introducing a fixed quantity of air into the fuel supplying means at the discharge side of said metering orifice, a cam actuated with the air throttle and having a contour including an intermediate reversed part, and a valve operated by said cam and coacting with said metering orifice to form a concentrated orifice opening, the concentrated orifice area and the reduced pressure differential on the orifice being coordinated at each throttle position to reduce orifice frictional coefficients, while allowing a fuel flow in suitable ratio to the air, the reversed cam part serving to cause local partial closing of the fuel valve whereby to avoid overenrichment in such part of the metering range.

11. In apparatus for supplying and proportioning charges for internal combustion engines, an air intake, a throttle therein, means including a metering orifice for conducting fuel into the intake at the engine side of the throttle, means for introducing primary air into said fuel conducting means at the anterior side of said orifice to attenuate the pressure differential therein, and means

for modulating said orifice to vary its opening in general directly with throttle opening while during certain transitions from fractional load to full load operation such variation is substantially reversed to reduce the admission of fuel, said modulating means including a pin controlled by said throttle, said pin during full load operation at wide open throttle being moved relative to said orifice whereby the fuel is not modulated but metered through a fixed orifice.

12. In a carburetor, an intake passage, a throttle therein, a fuel orifice, a spring-pressed metering pin in said orifice, a cam having an irregular contour actuated by said throttle for variably controlling said metering pin, a conduit communicating with said orifice, said intake passage and the atmosphere and adapted to supply fuel and air to said intake passage, said conduit having a fixed air vent and a variable air vent therein, and suction operated means for controlling the variable air vent, said conduit being so arranged that the fuel shuts off the air supply when said suction operated means closes the variable air vent.

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