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ATOMIZER SPRING

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Fig. 2.

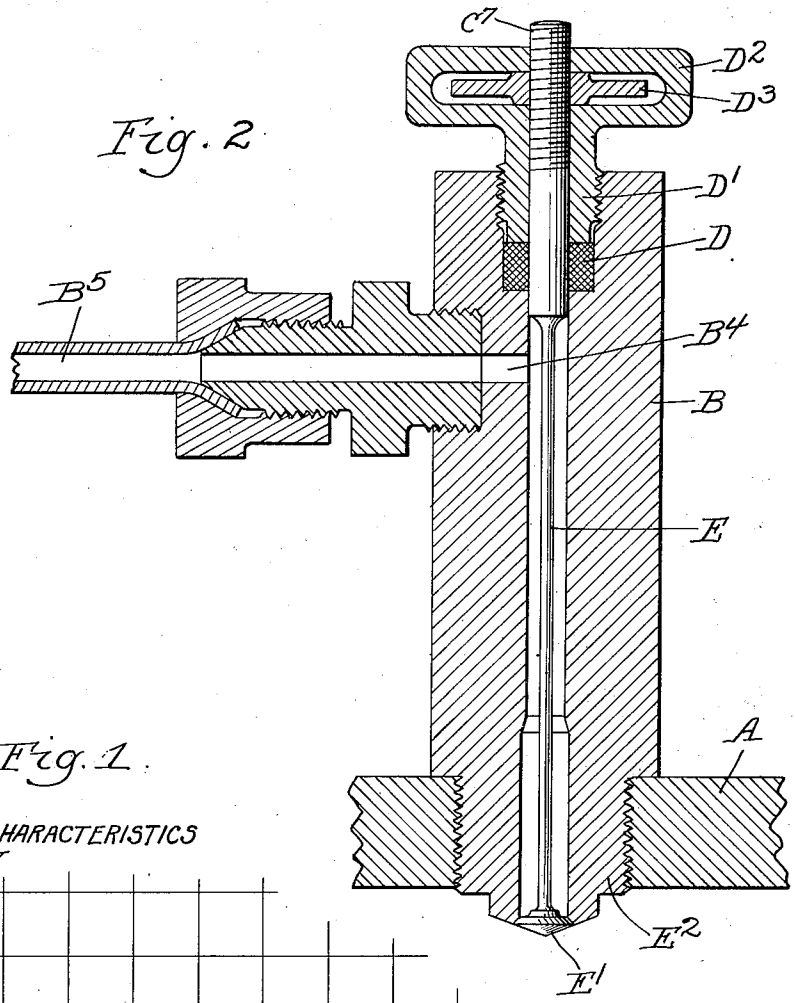
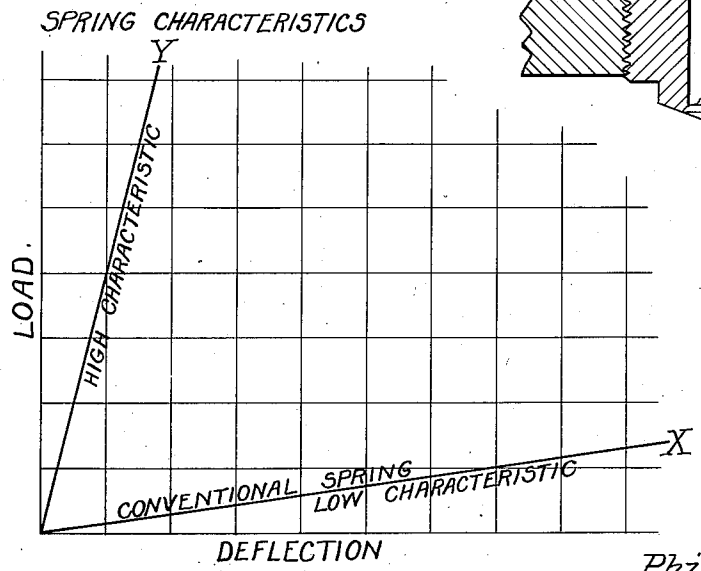


Fig. 1.



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ATOMIZER SPRING.

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In injection valves for oil engines it is, among other things, desirable to provide exceedingly minute openings through which a liquid fuel, on its way to the combustion zone, may be forced in order to secure the requisite atomization and velocity, and I have found that in order to produce the most satisfactory results, it is desirable that the valve opening be so minute as to be measured in terms of ten-thousandths of an inch.

The prior art, at the present time, shows development along the line of spring-seated or spring-closed valves, wherein the valve opening for atomization and injection is measured in terms not of ten-thousandths, but of one-thousandths of an inch, and the reason for this is that the normal type of helical, cantilever and beam spring is not adapted to give the necessary minute openings.

I have found the difficulty of normal spring types is that, without exception, they have a spring characteristic which is extremely low when compared to the load-deflection ratio which it is possible to secure. It is one of the objects of the present invention to produce a spring which when used in a spray valve, will make possible a very minute opening of the valve, and for such spring construction, I have found it essential to use a spring having a high characteristic.

For the purpose of the present invention, I have taken the expression "spring characteristic" to mean the load-deflection ratio. Referring to such classification, in Fig. 1 of the drawings, conventional spring forms are represented generally by the line X, which shows largely increased deflection for a given increase in load. The type of spring action used to secure exceedingly small valve openings is indicated generally by the line Y, in which increases in deflection are very small for the same given increases in load.

It is a fact, that compared with other ordinary commercial spring forms, the springs used at the present time in connection with spray valves have a comparatively high characteristic. However, by comparison with what is necessary to give the desired small openings in the valve, they have a very low characteristic.

In order to point out the peculiar qualities of my spring, I shall discuss spring designs with particular reference to the ratio of mass deformation to total deflection. That is, the ratio of the distortion of the particles of the spring material to the deflection of the spring at the point of its maximum motion.

Deformation of spring material is of two general kinds. First, mass deformation, in which a theoretic infinitesimal unit is considered and its change in shape under the application of load studied, and second, structural deflection of the spring. Structural deflection is the result of multiplication of the mass deformation of the infinitesimal units.

The term "mass deformation" is used herein to describe the deformation of the particles of the spring material. And for purposes of study of spring action, these particles are usually arbitrarily considered as tiny cubes which are taken, in the development of the theory of springs, as units whose action is to be studied and from whose combined actions the nature of spring deflection can be determined. For convenience, these units are usually considered as cubes. Load is applied to the spring structure and its effect on one of these particles, situated possibly at some distance from the point of application of the load, is studied. This little cubic particle will be slightly flattened and thickened if the load acts in direct compression. It will be slightly elongated and thinned, if the load acts in tension. It will be twisted if the load acts in torsion. The effect of this change in shape of this small particle is multiplied to a greater or lesser degree by the general structure of the whole spring. Considering two springs, in which these unit particles have the same distortion for a given load, one spring may be designed to multiply this distortion very greatly, so that a large deflection results. The other may be designed to reduce the multiplication as far as possible, so that the deflection for a given distortion of a unit particle will be very small in comparison with the other types of spring. All normal spring forms are deliberately designed to get a large, or as large as possible, a deflection for a given distortion of the unit particle. In my design, I do the opposite, in that I try to get as small a deflection as possible for a given distortion of the unit

particle. Of course, the smallest amount would be a direct addition of the unit mass deformation.

One form of my spring, which is shown in Fig. 2 of the drawings, I have chosen to call the "straight wire" spring. In the drawings the straight wire is designated by the letter E. This form of spring is characterized by the least possible multiplication of mass distortion, and the ultimate deflection is actually the sum of the mass deformation of the particles of spring material.

Each small unit of the spring material stretches a very minute amount and the net effect at the end of the wire, where the valve head is located, will be the arithmetical sum of these unit stretches.

In the common cantilever spring familiar as an automobile spring, the unit, arbitrarily taken to be cubic, is distorted to rhomboidal form and this distortion is not only multiplied by the length of the lever arm of the cantilever, but the distortion of the succeeding units, each multiplied by its lever arm, is also added, so that there is a very great structural deflection at the end of the spring for relatively very slight changes in form of the infinitesimal unit.

The type of multiplication of unit deformation resultant in structural deflection above described in connection with the cantilever spring, is present also in the helical and beam spring, and in all other generally known spring forms. And all such springs are designed particularly in order to produce such multiplication. In contra-distinction to such springs, my spring is designed to reduce such multiplication of unit distortion. It will be seen, therefore, that the intention in the design of my spring is diametrically the opposite of the intention in the design of customary spring types.

In a general way it can be said, therefore, that my type of spring takes advantage of "mass elasticity" or the inherent elastic property of substance and the structure is not so shaped or formed that the elastic distortion is greatly multiplied and increased kinematically as in normal spring forms, but on the contrary, is particularly shaped so that the elastic deformation under given loads is as small as possible. With this type of structure which is used in the various forms of my valves, the opening caused by pressure as liquid is fed to the valve under several thousand pounds pressure, ranges from one-half of one ten-thousandth to fifteen ten-thousandths of an inch, and with normal operation, two to four ten-thousandths. This gives in the first place, an exceedingly minute opening which is necessary for atomization of liquid fuel to a degree comparable to that secured by air injection, second—it assures that the opening will at no time during the injection period, regardless of the pressure, be so large as to coarsen the degree of atomization beyond the desired point. This is due to the fact that increased deflection for increased load in this type of spring is exceedingly small, and if the valve opens two ten-thousandths of an inch at five thousand pounds pressure, this deflection will only increase about four one hundred-thousandths under an additional thousand pounds, which still keeps the opening sufficiently small to secure the desired atomization.

This type of spring action has the advantage over other forms of maintaining a tight joint between valve head and seat at all times except during a carefully determined injection period and prevents with certainty any dripping.

This type of spring may be applied to injection valves in a number of ways and the location is more a matter of convenience and practicability than a matter of change in the atomizing operation of the valve. In the valve described, it will be seen that the elongation of a straight wire is made to serve, the valve head being attached to the end of this wire and held firmly on its seat thereby, opening only when the hydraulic pressure is sufficient to overcome the initial tension and produce additional elongation.

The principal point is that, in this type of spring when it is used in conjunction with an injection valve, microscopic openings can be secured and these microscopic openings permit the breaking up of liquid fuel into particles approaching molecular dimensions of gas, and this degree of atomization permits operation of oil engines with solid injection comparable to that formerly obtained only with air injection.

Another and perhaps more accurate way of stating the same situation is that the exceedingly minute or microscopic openings I secure for the injection of the fuel are in the order of magnitude of the mean free path of the molecules of the liquid fuel, and in fact the injection opening which I propose to use may actually be made not more than thirty times the mean free path under standard conditions of a molecule of methane, which is one of the lighter hydro-carbons whose mean free path has been approximately determined and which is considerably less than the mean free path of the molecules of the heavier hydro-carbons with which my invention is primarily concerned.

My invention, therefore, is illustrated more or less diagrammatically in the accompanying drawings, wherein:

Figure 1 is a graph illustrating spring characteristics.

Fig. 2 is a section through a form of valve, with head held on it by straight wire.

A represents the wall of a combustion

chamber of an engine or any other suitable receptacle, into which it is desired to inject an atomized liquid.

B is a housing or casing of an atomizing valve. It is provided with a central bore as shown and has adjustably and removably positioned within it a valve stem or tension member E which carries at its bottom an outwardly opening valve member E^1 which is seated in the end of the spray valve housing. This housing is provided at its end with a reduced and outwardly threaded portion E^2 which is fitted directly into the wall of the cylinder. At its upper end the stem E is provided with an enlargement which is threaded as at C^7.

D is a packing surrounding the enlarged portion of the member E. D^1 is a gland screwed into place and compressing and holding the packing D in position. This gland has a yoke D^2 formed on it and preferably integral with it. Within the yoke and positioned on the threaded portion C^7 is a hand wheel D^3. This wheel may be rotated so as to move the threaded portion C^6 in and out and thus to unseat and to seat valve E^1 and vary the degree of tension with which it is held upon its seat.

B^4 is a passageway communicating with the interior of the bore of the valve housing B, and B^5 is an oil or fuel inlet duct by means of which the fuel or other liquid to be sprayed is fed from any suitable source and by any suitable means to the valve.

Although I have shown in my drawings an operative device, still many changes might be made in size, shape and arrangement of parts without departing materially from the spirit of my invention, and I wish, therefore, my drawings be regarded as, in a sense, diagrammatic.

One characteristic of my spring form is that I rely for my spring action on resistance of the spring material in tension unmultiplied by its kinematic structure so that any displacement is merely an arithmetic sumation of molecular distortion as contrasted with normal spring forms which yield with bending or torsion and wherein the lever arm movement multiplies greatly the molecular displacement and wherein bending or torsion assume relatively greater importance with respect to tension than they do in the spring form that I have used.

What I claim is:—

1. In an atomizer having a discharge aperture, a closure, adapted to be displaced by hydraulic pressure to permit flow through the aperture, yielding means under adjustable initial tension, for resisting displacement of the closure, said means being adapted to resist displacement of the closure after the initial tension has been overcome largely by the resistance of such means to mass deformation.

2. In a direct fuel injection system for internal combustion engines, an injection valve comprising a valve head and valve seat, a valve retainer comprising a metal rod firmly holding the valve head on its seat, and means for supplying liquid fuel to the valve under a pressure sufficiently high to open the valve by elongating the said rod but well within the limit of elasticity of the rod.

3. In a direct fuel injection system for internal combustion engines, an injection valve comprising a valve head and valve seat, a valve retainer comprising a cold-drawn steel rod firmly holding the valve head on its seat, and means for supplying liquid fuel to the valve under a pressure sufficiently high to open the valve by elongating the said rod but well within the limit of elasticity of the rod.

4. In an injection valve for internal combustion engines adapted to burn liquid fuel, the combination of a casing provided with a passageway through which fuel may be supplied, a valve seat formed at the edge of said passageway at one end of the casing, a valve head co-operating with the valve seat, a rod adapted to be elongated under pressure, extending through said passageway and having one end connected to said valve head to hold it firmly to its seat, and an adjustable mounting for the other end of said rod whereby the tension of the said rod may be adjusted.

5. In a system of direct fuel injection for internal combustion engines, an injection valve comprising a valve head and valve seat, a metallic valve retainer firmly holding the valve closed, means for applying liquid fuel to the valve head under a pressure sufficient to effect the opening thereof against the resistance to linear deformation of the metal of the retainer but well within the limit of elasticity of the metal thereof, and means for adjusting the resistance to the opening of said valve, substantially as described.

6. In a system for atomizing liquids, an atomizing valve comprising a valve head and valve seat, a valve retainer comprising a metal rod firmly holding the valve head on its seat and means for supplying liquid to the valve head under a pressure sufficiently high to open the valve by elongating the said rod but well within the limit of elasticity of the rod.

Signed at Chicago, county of Cook, and State of Illinois, this 6th day of August, 1921.

PHILIP LANE SCOTT.