

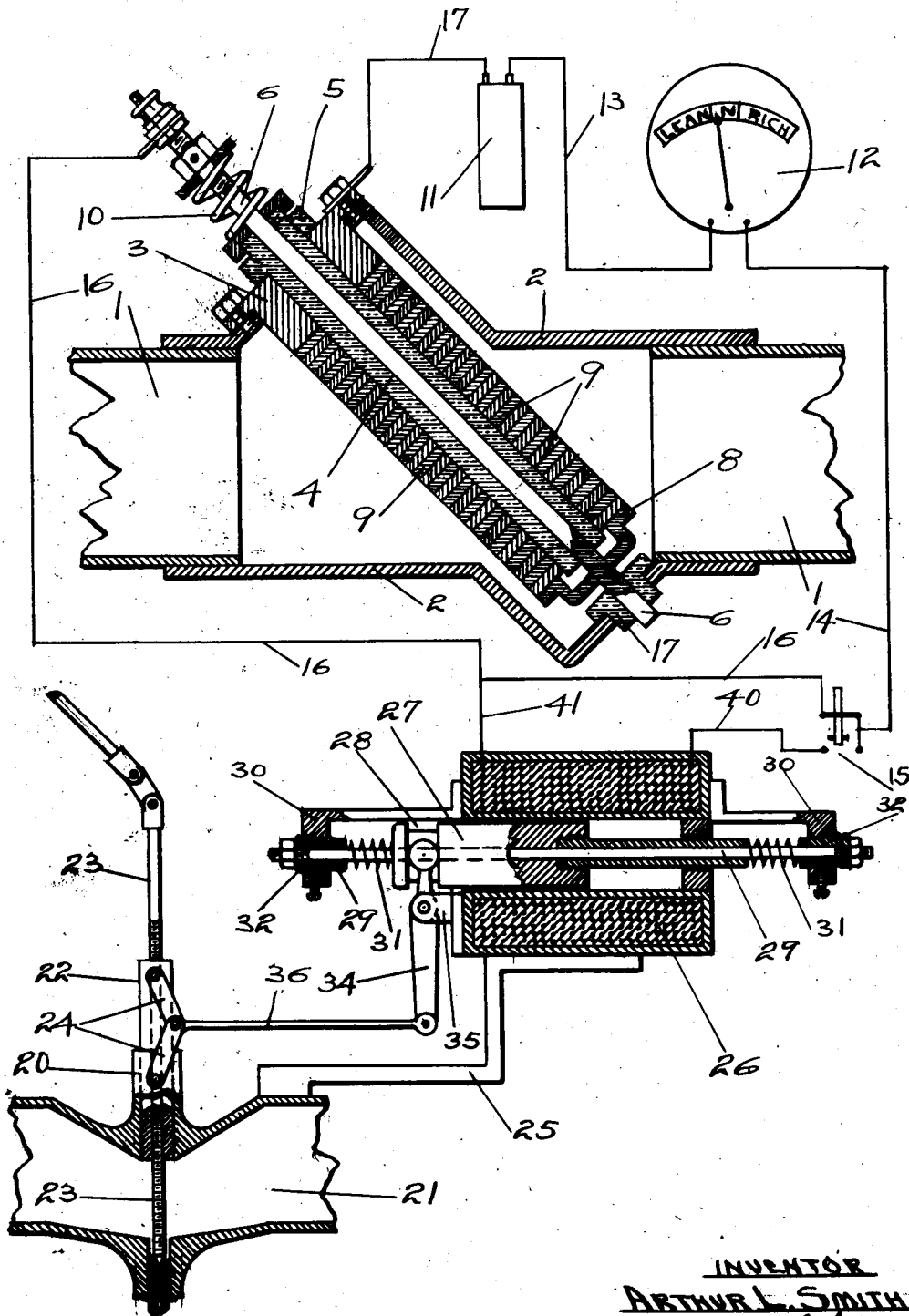
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A. L. SMITH

ELECTRIC TESTER

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UNITED STATES PATENT OFFICE.

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ELECTRIC TESTER.

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My invention relates to electric testers in general, and particularly to such devices as are used for testing and regulating the fuel fed to furnaces of various sorts, boilers, internal combustion motors, and the like, the device being substantially the same work as the well known CO₂ machine commonly used for analyzing the products of combustion, the object being to provide a device without chemicals, liquids or containers therefor, and without moving parts or parts subject to wear, that will analyze the products of combustion and visibly display the results thereof before the operator, showing at all times whether the fuel is too rich in hydrocarbons or too lean therein, or normal.

Although my device may be adapted for any sort of fuel, it is particularly designed for use with liquid fuels, and also while it may be adapted for boilers, furnaces, kilns, retorts, bake ovens, or any location where fuel is consumed, it is particularly adapted for use with internal combustion motors and is so illustrated and described herein.

I accomplish the above objects by means of the construction illustrated in the accompanying drawing, which is a part of this application for Letters Patent, and which is a diagrammatic view of my device.

In the drawing the analyzing unit of my device is shown mounted upon the exhaust pipe 1 of an internal combustion motor.

In general my device consists of an analyzing unit mountable within the path of the products of combustion from the motor, a recording unit mountable within convenient view of the operator, and such operating means connecting said units as will cause to be registered upon the latter the results obtained at the former, and connected with said operating means a device operated by said means to operate the fuel supply valve.

There are several analyzing units that may be used for this purpose, such as heat units, chemical units, and the like. I have discovered, however, that an electro-chemical analyzing unit is preferable for this service, and have accordingly invented and developed into commercial form such an analyzing unit, one convenient form thereof being illustrated in the accompanying drawing. This unit may be mounted in any convenient

position where it will come into contact with and be acted upon by the products of combustion from the motor. Thus it may be introduced into one of the motor cylinders, the exhaust manifold, the exhaust pipe, or any such position. I have found, however, that the intense heat as well as the violence of combustion within the motor cylinder is not conducive to delicate action of the analyzing unit, and also in that position such unit will analyze the products of combustion within that particular cylinder only. If mounted within the exhaust manifold, or the exhaust pipe as illustrated in the drawing, the analyzing unit will be removed from the intense heat and violent combustion within the motor cylinder, and will also be acted upon by the combined products of combustion from all the motor cylinders.

Certain metallic oxides are very good electrical insulators, and I have found that such oxides are readily formed upon metals introduced into the hot fuel mixture rich in oxygen and lean in hydrocarbons, and are as readily again reduced to metallic form when introduced into a hot fuel mixture lean in oxygen and rich in hydrocarbons. The same results are obtained from hot products of combustion as from hot fuel mixtures, and since all fuel mixtures are not heated, and all products of combustion are, and since a certain amount of heat is necessary for prompt action of the analyzing unit, I prefer to mount such unit within the path of the products of combustion as illustrated in the drawing.

If a pair of metallic members, such as copper or the like, be mounted in contact one with the other in the path of the products of combustion from an internal combustion motor, an oxide of such metal will be formed upon the surfaces of such members, and will extend to the surfaces thereof in contact, if such products of combustion are over rich in oxygen and lean in hydrocarbons, the over supply of hot oxygen being the oxidizing agent. On the other hand, if the products of combustion are lean in oxygen and rich in hydrocarbons, the excess of hot carbon will attack such oxide as has been previously formed and reduce the same to metallic form. If, however, the fuel mixture has been proper for the motor, contain-

ing neither excess of air (oxygen) or of hydrocarbon (fuel), then the products of combustion will neither contain an excess of oxygen or of carbon, hence there will be no oxide formed or reduced.

If an electric current be passed through said metallic members from one to the other, its amperage or its voltage may be measured by a suitable recording instrument, which will record the effect upon such electric current of the resistance or lack of resistance caused by the presence or absence of such oxide between said metallic members.

I have illustrated in the drawing a convenient form of the analyzing unit, wherein I show a casing 2 adapted for insertion in the exhaust pipe 1, and having a cap 3 secured thereupon. Mounted in cap 3 is an insulating core 4 with a shoulder 5 thereupon, said core being preferably of porcelain. A stem 6 is passed through said core, and mounted in an insulating bushing 7 in the casing 2. Integral with said stem is a cupped washer 8 embracing the end of the core 4 with clearance for said stem and said washer to move longitudinally upon said core a short distance. Metallic washers 9 are mounted upon the core 4 between the cap 3 and the washer 8, and these metallic washers are slightly clamped between said cap and said washer 8 by means of a spring 10 upon the stem 6.

A source of electric current, as the battery 11 is provided, as well as the recording instrument 12, which latter may be either an ammeter or a voltmeter. The electric current circuit is from the battery 11 through wire 13 to the recording instrument 12, wire 14, double pole switch 15, wire 16, stem 6, washer 8, metallic washers 9, cap 3, and wire 17 to the battery.

Let it be supposed that the device is started on a motor with a predetermined correct fuel mixture, and with the disks in contact one with the other. Also that the recording instrument 12 is so adjusted that after the motor has been running a sufficient time for a normal amount of copper oxide to form on the disks 9 the pointer of said recording instrument stands at the point marked N representing a normal mixture of the fuel, and also that the fuel mixture is right for the motor. If then, through any circumstances, the fuel mixture becomes too lean, and thus contains too great a percentage of oxygen, this hot oxygen in passing the analyzing unit will oxidize the metallic disks or washers 9, and there will thus be deposited between the adjacent washers a thin film of metallic oxide. This metallic oxide being an insulator will thus insert resistance into the electric circuit, and thus affect the recording instrument, and cause the pointer thereof to move toward the left, indicating that the fuel mixture is too lean, whereupon

the operator may open the needle valve of the carburetor and thus enrich the fuel mixture.

Should the fuel mixture thereafter become too rich, and thus contain too great a percentage of carbon, this hot carbon passing the analyzing unit will reduce the oxide between the metallic washers to metallic form, thus decreasing the resistance in the electrical circuit, which will effect the recording instrument, and cause the pointer thereof to move to the right, indicating that the fuel mixture is too rich. Whereupon the operator may close the needle valve of the carburetor and thus lean the fuel mixture. As long as the fuel mixture remains proper for the motor the hand of the recording instrument will remain fixed at N or normal.

The operation of the analyzing unit is continuous, registering upon the recording instrument any change in the fuel mixture that may occur for any reason, the products of combustion being constantly analyzed by the electro-chemical action of the analyzing unit, and the results registered on the recording instrument.

As so far explained the device simply analyzes the products of combustion and records the results upon a recording instrument, but it is desirable that the device be enabled to operate the carburetor independently of the operator and thus render the adjustment of the carburetor an automatic function of the analyzing unit, and this I accomplish as follows.

Within the hub 20 of the carburetor 21 I mount a slidable sleeve 22 within which the needle valve is threaded. I connect said sleeve 22 with said hub 20 by means of a pair of toggle arms 24, one of said arms being secured to said sleeve and the other arm to said hub. Mounted adjacent the carburetor, conveniently upon a bracket 25 secured thereto, is a solenoid 26 having a core 27 with an annular groove 28 therein. Said core rides upon a rod 29 which is mounted upon suitable brackets 30 at each end of the solenoid, and spring 31 are provided to retain the core 27 in its central position normally, but to allow movement thereof when caused by the solenoid. Thimbles 32 are threaded into said bracket 30 for the purpose of adjusting the tension of the springs 31. A lever 34 is pivoted upon a bracket 35, one end thereof being adapted to engage the groove 28 in the core 27. The opposite end of said lever is connected to the common pivotal point of said toggle arms 24 by a rod 36.

Let it now be supposed that the switch 15 is thrown to open the circuit previously described, and to close the circuit through the solenoid. Then the current passes from the battery 11 through wire 13, recording

instrument 12, wire 14, switch 15, wire 40, solenoid 26, wire 41, wire 16, stem 6, metallic washers 9, cap 3, wire 17, to the battery. Thus any variation in the electric current 5 caused by variation in the fuel mixture will not only be recorded upon the recording instrument, but will also energize the solenoid 26 and thus cause movement of the lever 34 and operation of the toggle 24 to open or 10 close the needle valve 23. Thus the fuel mixture will be automatically adjusted to the needs of the motor at all times.

My device may be made of any size and constructed of any materials deemed convenient and suitable for a device of this character, and while I have illustrated and described a form of construction and arrangement of parts found desirable in materializing my invention, I wish to include in this 15 application all mechanical equivalents and substitutes that may fairly be considered to come within the scope and purview of my invention as defined in the appended claims.

Having disclosed my invention so that 20 others may be enabled to construct and to use the same what I claim as new and desire to secure by Letters Patent is:

1. In an electrical tester: an electro-chemical analyzing unit mountable in the path of

the products of combustion from a fuel 30 burning device; an electrical recording instrument; and an electric circuit connecting said analyzing unit and said instrument.

2. Metallic contacting members mountable in the path of the products of combustion 35 of burning fuel; an electrical recording instrument; and an electric circuit including said metallic members, said recording instrument, and a source of electric energy.

3. In an electric tester for liquid fuel: an 40 electro-chemical analyzing unit mountable in the path of the products of combustion; a fuel regulating device; and an electromagnetic mechanism controlled by said analyzing unit for controlling said fuel regulating 45 device.

4. In an electric tester: an electro-chemical analyzing unit mountable in the path of the products of combustion of a burning fuel; an electro-magnet; mechanism to operate the 50 needle valve of a carburetor from said electro-magnet; and an electric circuit including said analyzing unit and said electro-magnet.

In testimony whereof I claim the foregoing as my own I hereunto affix my signature 55 at Portland, county of Multnomah, State of Oregon, this 23rd day of June, 1926.

ARTHUR L. SMITH.