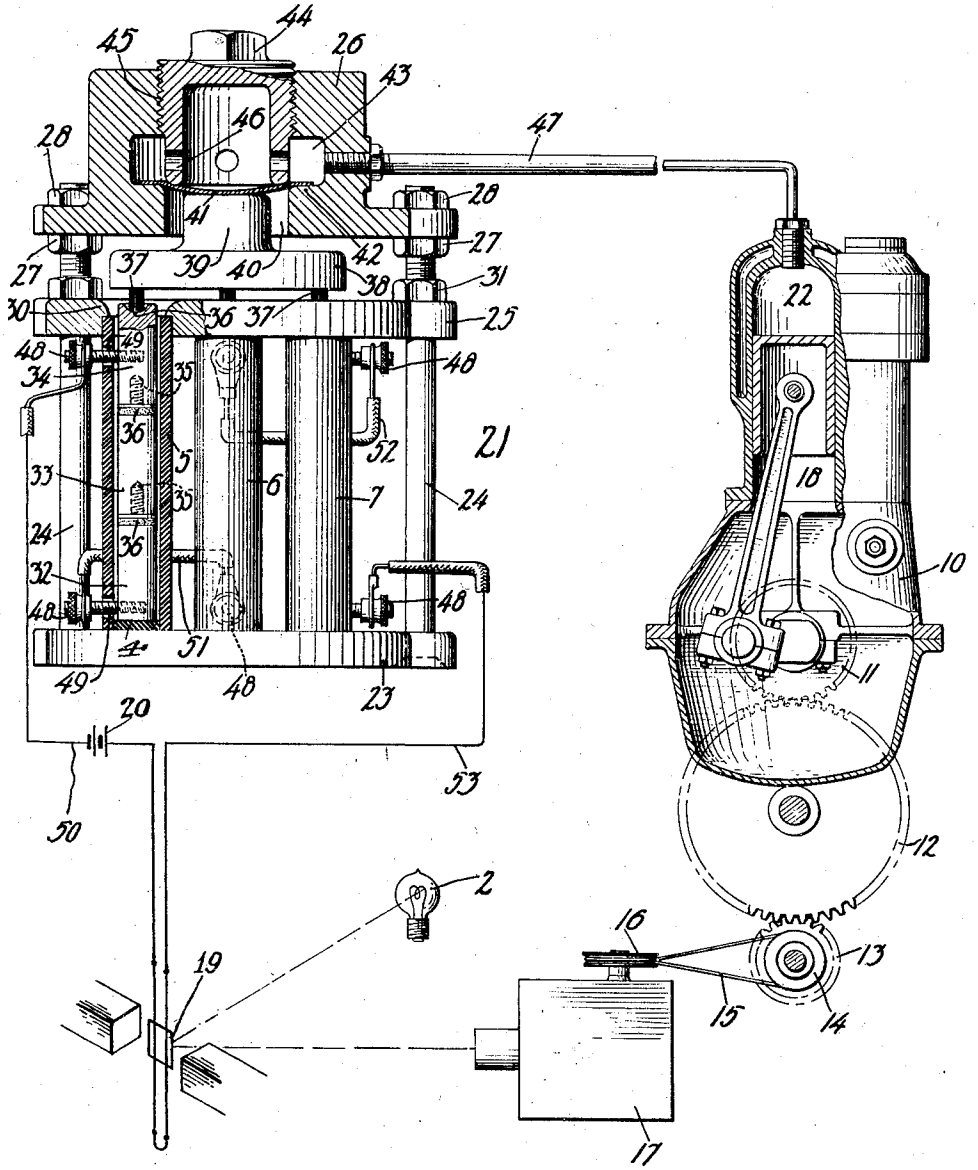
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METHOD AND APPARATUS FOR RECORDING PRESSURE.

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1,426,735. Patented Aug. 22, 1922.



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR RECORDING PRESSURE.

1,426,735. Specification of Letters Patent. Patented Aug. 22, 1922.

Application filed December 16, 1919. Serial No. 345,437.

To all whom it may concern:

Be it known that we, WILLIAM FERRIS HENDRY and CHARLES E. REDDIG, citizens of the United States, residing at New York, in the county of New York and State of New York, and at Richmond Hill, Long Island, in the county of Queens and State of New York, respectively, have invented certain new and useful Improvements in Methods and Apparatus for Recording Pressure, of which the following is a full, clear, concise, and exact description.

This invention relates to an improved method and apparatus for recording pressure which has as its primary object the recording of pressure by electrically deflecting a beam of light commensurate with the pressure fluctuations upon a photographic film.

The improved method and apparatus herein is especially adapted for application to gas, heat and other engines of this general type. In the embodiment of the invention in an apparatus, the pressure to be recorded is directed against a diaphragm, which varies the current in an electrical circuit which has interposed therein the suspended mirror of the usual type of oscillograph, the film thereof being driven synchronously with the operation of the engine, the pressure of which is to be recorded.

Devices heretofore designed for determining the pressures within the cylinders of engines have employed the use of a diaphragm which caused the physical movement of levers, links, or other suitable mechanism to actuate a recording device. In pressure measuring mechanisms where a mirror was utilized, the mirror was moved through the actuation of physical elements which were under the control of a diaphragm, against which the pressures in the engine cylinder were exerted. In these prior devices, the friction and inertia of the parts necessarily prevented the making of a complete record which would show all of the slight and minute pressures which occurred within the cylinder of the engine. In the method and apparatus for recording pressure disclosed herein, only a very slight movement is imparted to the diaphragm by the pressure directed thereagainst, which movement, however, is sufficient to vary the resistance of the carbon piles to electrically effect a movement of the mirror. Since the parts of the apparatus have no appreciable movement, the inertia and friction of these parts is very slight and, as a result, when the engine is operating at high speeds, all irregularities of expansion of the gases or similar occurrences within the cylinder of the engine are truly translated by the carbon pile resistance and mirror, producing a record which loses almost no detail due to the inertia or friction of the parts.

The accompanying drawing shows, in side elevation, and partly in section, apparatus for electrically interpreting pressures and illustrating its connection with a gasoline engine, and an oscillograph which are both represented diagrammatically.

In the embodiment of the invention illustrated in the drawings, a single cylinder internal combustion engine 10 of the usual type has a gear 11 mounted on its crank shaft which actuates a pinion 13 through the medium of an intermediate gear 12, the pinion 13 having secured thereto a pulley 14 which drives a pulley 16 through the medium of a belt 15, the pulley 16 being secured to the film driving shaft of the photographic mechanism of an oscillograph illustrated diagrammatically at 17. Due to the gear train comprising the gears 11, 12 and 13, the film of the oscillograph is driven in synchronism with the rotation of the crank shaft and hence also synchronously with the movement of the piston 18 of the engine 10. The mirror 19 of the oscillograph is positioned so that when moved it will reflect the beam of light from a source 2 onto a film (not shown) continuously driven through the actuation of the pulley 16. The mirror 19 is interposed in an electrical circuit including a battery 20 and a resistance device 21, the electrical effect of which is controlled by the pressure within the combustion chamber 22 of the engine 10 as will be hereinafter described. The mirror 19 derives its movement through the varying current in the circuit caused by the resistance device 21.

The resistance device 21 comprises a base 23 carrying standards 24 which pass through an intermediate member 25 and support a head member 26 which is held in position by means of nuts 27 and 28. Three tubes 5, 6

and 7 of hard rubber or other suitable insulating material are supported at their lower ends upon the base 23 and have their upper ends fitted within counter sunk openings 30 made in the intermediate member 25. Nuts 31 serve to clamp and firmly hold the tubes 5, 6 and 7 in position between the intermediate member 25 and the base 23. Three cylindrical sections of brass 32, 33 and 34 are placed on top of each other in each of the tubes 5, 6 and 7. The lower end of each of the sections 33 and 34 are provided with screw threaded apertures to receive screws 35, the heads of which carry disks of carbon 36. A disk of insulating material 4 is interposed between each lowermost section 32 and the base 23. Each of the uppermost cylindrical sections 34 are provided with a recess 36 to receive a pin 37 formed of insulating material carried by a follower 38, which is supported upon the upper cylindrical sections 34 and is provided with a knob 39 which projects through a vertical passage 40 formed in the head member 26 and contacts with a diaphragm 41 supported upon the lower flange 42 of an annular chamber 43 made in the head member 26. A hollow screw threaded plug 44 is screwed within a vertical passage 45 made in the head portion 26 and has its power end in engagement with the upper surface of the diaphragm 41. The screw threaded plug 44 is provided with a plurality of openings 46 which establish communication between the hollow interior of the plug 44 and the annular chamber 43 the latter being placed in communication with the combustion chamber 22 of the engine 10 by means of a pipe 47.

Terminals 48 extend through enlarged openings 49 made in the side of the tubes 5, 6 and 7 and are screwed within screw threaded apertures formed in the uppermost cylindrical sections 34 and lowermost cylindrical sections 32. One side of the battery 20 is connected by a conductor 50 with the terminal 48 which is secured to the uppermost cylindrical sections 34 within the tube 5. The terminals 48 attached to the lowermost cylindrical sections 32 within the tubes 5 and 6 are connected by a conductor 51 and the terminals 48 attached to the uppermost cylindrical sections 34 within the tubes 6 and 7 are connected by a conductor 52. The terminal 48 secured to the lowermost cylindrical sections 32 within the tube 7 is connected by a conductor 53 with the oscillograph 19 which in turn is connected with the other side of the battery 20. Due to the arrangement of the conductors just described the cylindrical sections 32, 33 and 34 within the tubes 5, 6 and 7 are connected in series with the oscillograph 19 and battery 20.

When the engine 10 is in operation, the pressures produced within the combustion chamber 22 thereof will be exerted against the upper surface of the diaphragm 41 causing it to exert varied pressures through the medium of follower 38 upon the cylindrical sections 32, 33 and 34 within each of the insulating tubes 5, 6 and 7. Due to the presence of the carbon disks 36 interposed between the cylindrical sections 32, 33 and 34 the current in the circuit including these sections and the battery 20 will be varied commensurate with the varying pressures exerted by the diaphragm 39. The varying current in the circuit causes the movement of the mirror 19 in the usual manner which will reflect a beam of light from the source 2 to produce an irregular line upon the continuously moving film within the photographic mechanism 17 of the oscillograph. Since the contour of the line formed upon the film is commensurate with the varying pressures produced within the combustion chamber 22 of the engine and since the film is driven at a speed commensurate with the movement of the piston of the engine, a film is produced from which the pressures produced within the combustion chamber 22 of the engine may be computed.

What is claimed is:

1. A method of recording pressure, consisting in varying the current in an electrical circuit commensurate with the pressure fluctuations and deflecting a beam of light upon a photographic film commensurate with the varying current in the circuit.

2. A pressure recording apparatus comprising a pressure actuated element, a resistance controlled thereby, and a circuit including said resistance and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

3. A pressure recording apparatus comprising a pressure actuated element, a resistance device in engagement with said element, and a circuit including said resistance device and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

4. A pressure recording apparatus for gas and heat engines and the like comprising a pressure actuated element, a resistance device in engagement with said element, a circuit including said resistance device and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film, and means for actuating said film in synchrony with the piston of the engine.

5. A pressure recording apparatus comprising a pressure actuated element, a plurality of resistance devices connected in series and controlled thereby, and a circuit including said resistance devices and means

actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

6. A pressure recording apparatus comprising a pressure actuated element, a plurality of resistance elements in engagement with said pressure actuating element, and a circuit including said resistance elements in series and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

7. A pressure actuated element, a member operated thereby, a resistance device in engagement with said member, and a circuit including said resistance device and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

8. A pressure recording apparatus comprising a pressure actuated element, a member controlled thereby, a plurality of resistance elements in engagement with said member, and a circuit including said resistance elements and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

9. A pressure recording apparatus for gas and heat engines and the like comprising a pressure actuated element, a member operated thereby, a resistance element in engagement with said member, a circuit including said resistance and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film, and means for actuating the said film in synchrony with the piston of the engine.

10. A pressure recording apparatus comprising a pressure actuated element, a resistance device in engagement therewith and insulated from said element, and a circuit including said resistance device and means actuated commensurate with the varying current in a circuit for deflecting a beam of light upon a photographic film.

11. A pressure recording apparatus comprising a pressure actuated element, a member operated thereby, a plurality of resistance elements in engagement with said member and insulated therefrom and a circuit including said resistance elements and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

12. A pressure recording apparatus comprising a pressure actuated element, a resistance device controlled thereby, said device comprising a series of superimposed metal and carbon members, and a circuit including said resistance device and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film.

13. A pressure recording apparatus comprising a pressure actuated element, a resistance device controlled thereby, said device comprising superimposed metal members, and a plurality of carbon members positioned therebetween, an electrical conductor having its ends connected to the uppermost and lowermost metal members of the resistance device, and a source of electrical energy and recording means connected in said conductor in series, said recording means actuated commensurate with the varying current in the conductor for deflecting a beam of light upon a photographic film.

14. A pressure recording apparatus for gas and heat engines and the like, comprising a pressure actuated element, a resistance device in engagement with said element, a circuit including said resistance device and means actuated commensurate with the varying current of the circuit for deflecting a beam of light upon a photographic film, and means for actuating said film at a constant speed.

15. A pressure recording apparatus for gas and heat engines and the like comprising a pressure actuated element, a member operated thereby, a resistance element in engagement with said member, a circuit including said resistance and means actuated commensurate with the varying current in the circuit for deflecting a beam of light upon a photographic film, and means for actuating said film at a constant speed.

16. A pressure recording apparatus for gas and heat engines and the like comprising a pressure actuated element, a resistance device controlled thereby, a circuit including said resistance device, record material, means for feeding said record material in synchronism with the piston of the engine, and means actuated commensurate with the varying current for making a record upon said record material.

In witness whereof, we hereunto subscribe our names this 10th day of December A. D., 1919.

WILLIAM FERRIS HENDRY.
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