March 3, 1953 E. ALLGAIER 2,629,941

EDUCATIONAL DEVICE FOR DEMONSTRATING THE PRINCIPLE OF INTERNAL-COMBUSTION ENGINES

Filed July 20, 1950 2 SHEETS—SHEET 1

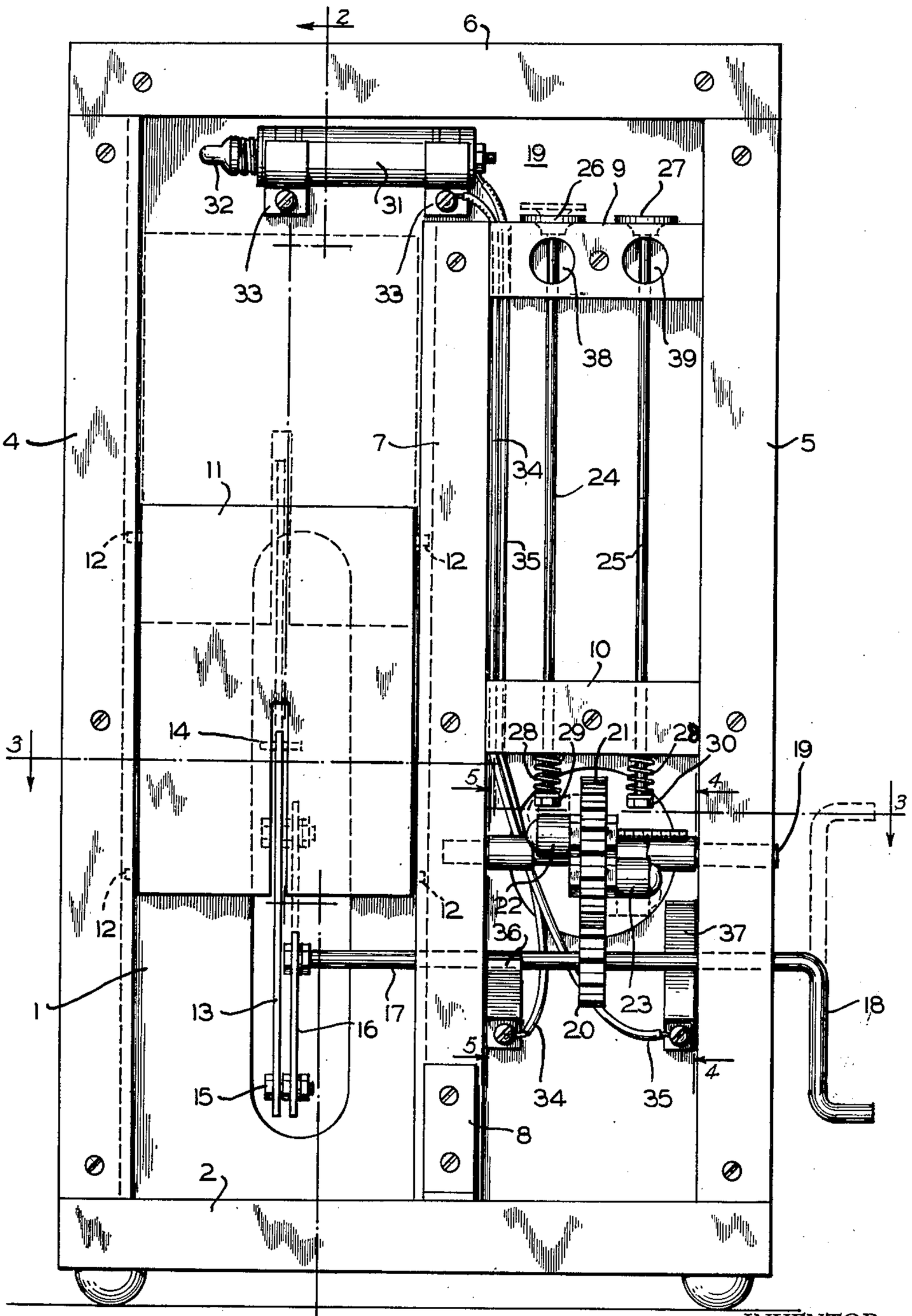

Fig. 1

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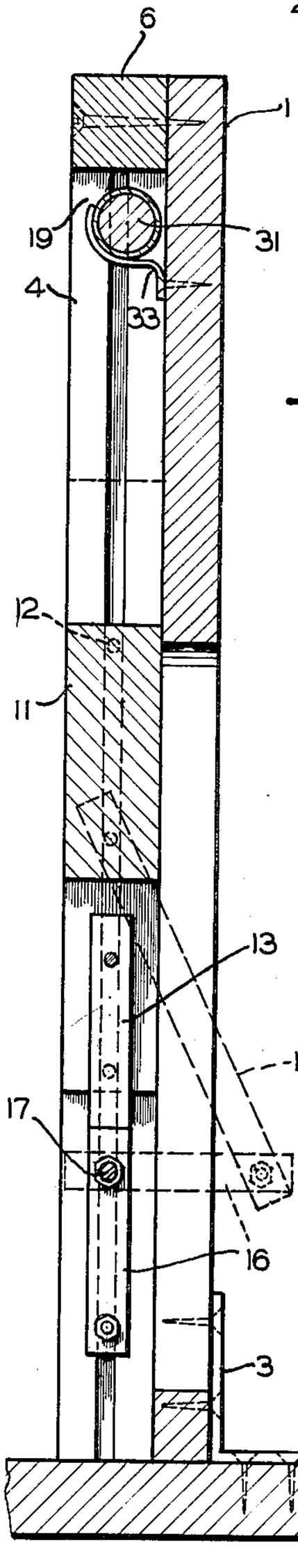
Fig. 2



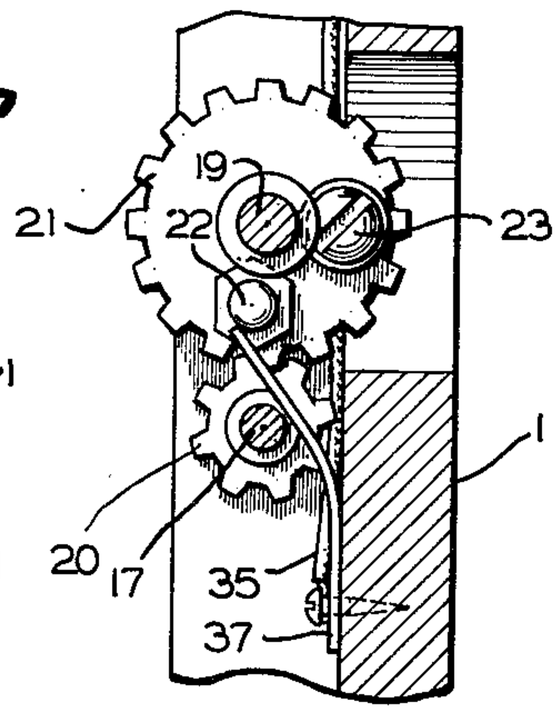


Fig. 4

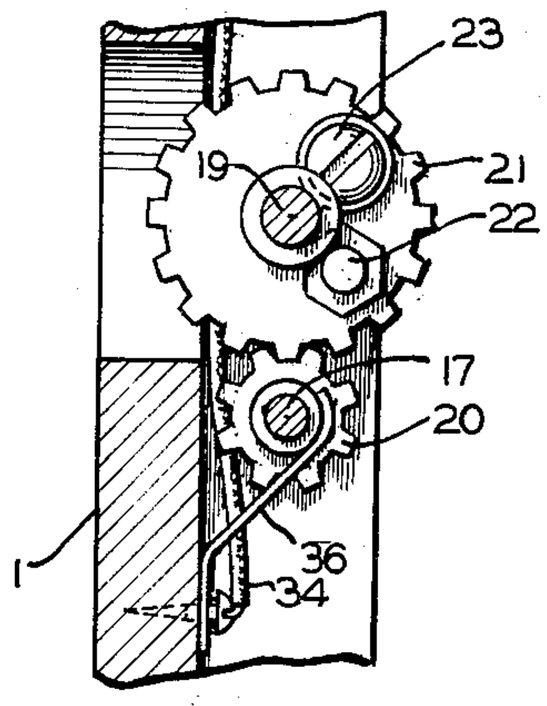


Fig. 5

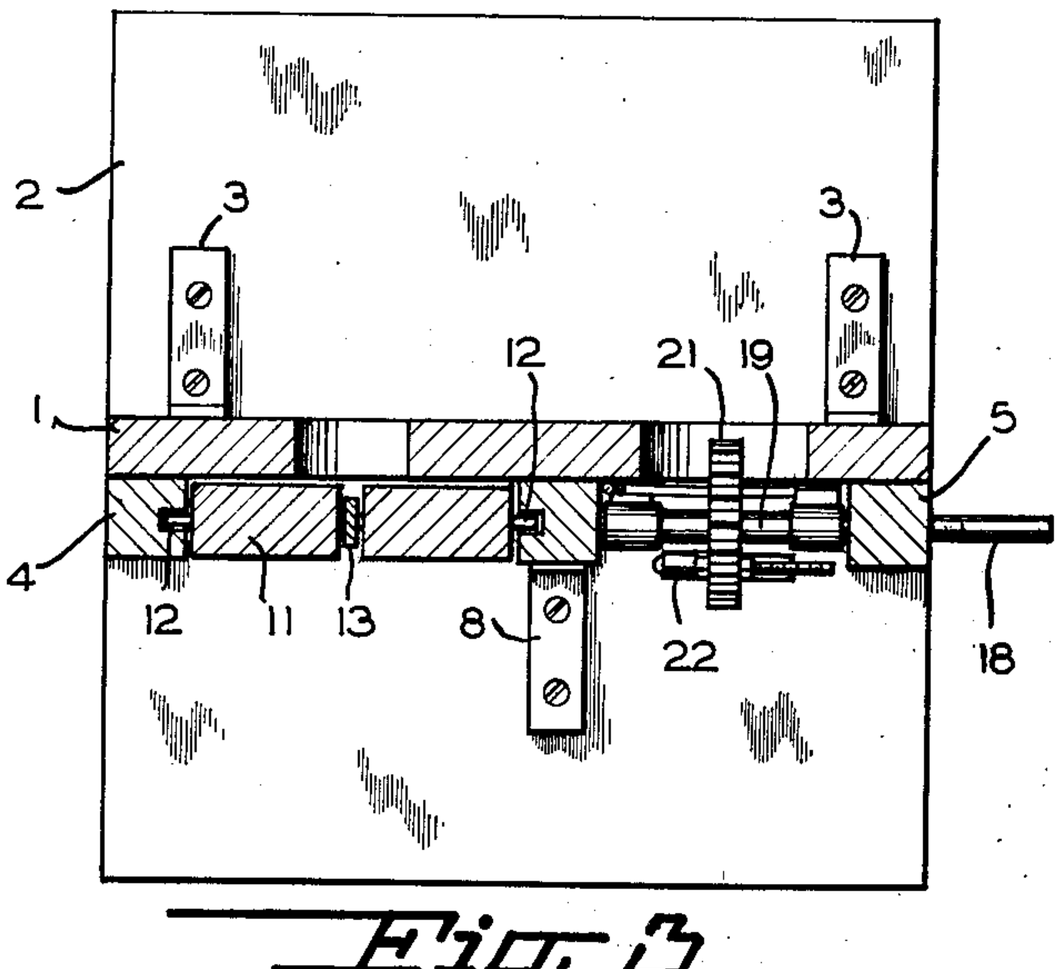


Fig. 3

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EDUCATIONAL DEVICE FOR DEMONSTRATING THE PRINCIPLE OF INTERNAL-COMBUSTION ENGINES

Earl Allgaier, Arlington County, Va.

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1 Claim. (Cl. 35—13)

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The present invention relates to educational devices, and more particularly provides demonstration apparatus useful in teaching the structural and operative principles of the four-cycle internal combustion engine commonly used in automotive vehicles.

A primary object of the invention is to provide a device of the class indicated which will be simple and inexpensive to construct and which will graphically depict in an impressive manner the operative relationship and sequential movements of the pistons, crankshaft, camshaft, valves and related elements of the standard type of internal combustion engine, including also, in a full and preferred embodiment, the action of the sparkplugs.

To this end the device comprises, generally speaking, an open framework in which elements representative of the actual mechanical parts of a four-cycle engine can be hand-operated to show the compression, power, exhaust, and intake strokes of the piston, with the related movements of the exhaust and intake valves.

A preferred embodiment of the invention is depicted in the accompanying drawings, in which:

Figure 1 is a front elevational view of the device;

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a horizontal sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a detail sectional view taken along the line 4—4 of Fig. 1; and

Fig. 5 is a detail vertical sectional view taken along the line 5—5 of Fig. 1.

In these drawings the reference numeral 1 designates an upright generally rectangular backing board, conveniently made of wood, mounted on a horizontal base 2 as by means of the small metal angles 3 shown in Figs. 2 and 3. Side risers 4 and 5 and a connecting top strip 6 are fastened to the front surface of the backing board as by means of wood screws, and approximately midway between the risers is an upright partition strip member 7 fastened to the base 2 by a metal angle 8 and to the backing board by screws and terminating at its upper end a short distance below the top 6. The partition 7 is connected to the riser 5 by a pair of vertically spaced tranverse blocks 9 and 10. The block 9 has its upper surface in the transverse plane of the top of the partition 7, and the lower block 10 is spaced about midway between the block 9 and the base 2.

All the foregoing members are securely and

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permanently connected together to form a rigid framework generally closed at its back and open at its front.

A block of wood or the like 11, representing a piston, is mounted for sliding movement in the space between the riser 4 and the partition 7, as by grooving the oppositely facing inner surfaces of the elements 4 and 7 to receive studs 12 outstanding from the block. The block is kerfed centrally upwardly from its lower end to about its horizontal middle plane, to receive a metal blade 13 acting as a connecting rod which is pivoted in the kerf by a pin 14 functioning in the manner of a wrist pin. The lower end of the connecting rod is pin-connected at 15 to a similar but shorter blade 16 which functions as a crank arm and is rigidly connected at its other end to a rod 17, representative of a crankshaft which is journaled in the partition 7 and riser 5 and projects from the latter as a handle 18.

It will be evident that manual rotation of the handle 18 will turn the shaft 17 and cause the block 11 to reciprocate in the manner of a piston in the space between the riser 4 and partition 7, which space is consequently representative of an engine cylinder.

The stroke is proportioned with relation to the heights of the riser 4 and partition 7 so that the limit of the upward movement of the block is at about the level of the top of the partition. The space 19 above this top is thus representative of the combustion chamber of the engine.

A short camshaft 19 is journaled in the riser 5 and partition 7 parallel to the crankshaft 17 and about midway between the crankshaft and the lower block 10. The camshaft is driven from the crankshaft by means of a small pinion 20 splined on the camshaft and meshed with a gear 21 fixed on the camshaft. The ratio of the gear and pinion is two to one, so that two complete rotations of the crankshaft are required to turn the camshaft through a single complete rotation.

Cam-simulating elements are operatively related to the camshaft, as by affixing studs 22 and 23 to the gear 21. These elements may take the form of simple bolts projecting laterally out from opposite sides of the gear, paralleling the axis of the camshaft, and they may be provided with bushings sleeved around the bolt shanks and rotatable thereon.

Each of the cam elements, when rotated about the axis of the camshaft, is arranged to strike and lift one of a pair of valve stems 24, 25, which extend down through aligned openings in the upper and lower blocks 9 and 10. The valve stems

carry at their upper ends valve-simulating heads **26, 27**, which normally seat down against the top surface of the upper block under the influence of coil springs **28, 28**, compressed between the bottom surface of the lower block **10** and enlargements, such as nuts **29, 30**, acting as cam followers, on the lower ends of the valve stems.

These enlargements **29, 30**, are engaged by the cam elements **22, 23**, respectively when the camshaft is rotated, and the engagement serves to lift the valves **26, 27**. The lifting is sequential and cyclic as the camshaft turns, and of course occurs only while the respective enlargement is being engaged by the respective cam element **22** or **23**, the springs serving to seat the valves after the cams turn out of engagement with the enlargements.

The cams **22, 23**, are "timed" by properly spacing them peripherally around the gear **21**, and by properly positioning them relatively to the connection of the piston block **11** relatively to the crankshaft **17**, so that they will move to open and closed positions in the manner of intake and exhaust valves in proper relation to the movements of the piston **11**, as will be more fully explained hereinafter.

To simulate ignition, a small electric lamp, battery and circuit may be used. I prefer to employ a self-contained assembly, such as the miniature flashlight **31** having a bulb **32**, bracketed as by clips **33** above the stroke limit of the piston block **11**, or above the communicating space over the valves **26, 27**, i. e., in the space corresponding to the combustion chamber of the represented engine. The bulb **32** is arranged for flashing illumination to represent the sparking of a sparkplug cyclically during operation of the device, and to this end the battery-bulb circuit may include a pair of lead wires **34, 35**, connected to a switch device which will close the circuit when and only when the piston block **11** approaches the end of that movement which represents its compression stroke. This of course is at the end of each alternate rising movement of the block.

In the preferred embodiment the lead wire **34** is connected to a brush **36** which wipes the crankshaft **17** and hence is electrically connected through the pinion **20** and gear **21** to the camshaft **19**. A second brush **37** is connected to the other lead wire **35** and extends in position to be engaged by a contact on the camshaft, which may be the elongated bolt on which the cam element **22** is formed. The brush **37** is so bent that the bolt of the cam element **22** will be wiped by it when the piston block **11** is at or near the end of one of its two up-strokes in the cycle. This contact completes the circuit and the bulb **32** lights.

In operation the handle **18** is manually turned. Assuming the parts to be in the position shown in Fig. 1, and the handle to be rotated clockwise as viewed from the right-hand side of Fig. 1, the two valves **26, 27**, are in seated position and the piston block **11** rises. This is the compression stroke of the engine. When the handle has been turned 180°, to the dotted line position in Fig. 1, the piston has risen to its dotted line position, and the bolt of cam element **22** comes into contact with the brush **37** flashing the bulb **32** to indicate ignition. A slight further rotation of the handle opens the circuit, extinguishing the bulb, and the piston block moves down on its power stroke until the handle **18** resumes its full line position in Fig. 1. Continued rotation of

the handle then brings the cam element **23** into engagement with the enlargement **30** of the valve stem **25**, so that valve **27** rises on further turning of the handle, accompanied by upward movement of the piston block. This is the exhaust stroke, and products of combustion in the cylinder and combustion chamber **19** are assumed to be exhausted past the raised valve **27**, which thus represents the exhaust valve.

With the handle **18** turned again to its dotted line position, both valves are in closed position and the piston block is at the top of the cylinder. On further rotation of the handle the cam element **22** lifts the valve **26** as the piston begins its downward stroke on intake. Thus the valve **26** functions as an intake valve, remaining open during substantially all of this downward movement of the piston block.

The valve closes at the end of the intake stroke and the parts are again in the position first described, the cycle having been completed.

To make the representation even more realistic, the block **9** may be drilled to represent intake and exhaust ports **38, 39**, open to the front of the device and communicating with the valve seats and undersides of the valves.

It will be evident that the device is easily and inexpensively constructed and extremely simple. It has been very effectively used to demonstrate the principle of the four cycle internal combustion engine universally used in automotive vehicles and has the advantages of being attractive and of inviting operation by the student.

The illustrated embodiment is the preferred one, but it is capable of being modified by changes in the specifically shown and described elements and by elimination of some of them without departure from the principles of the invention as defined by the appended claim.

I claim:

An educational device for demonstrating the principle of a four-cycle internal combustion engine comprising a base, a backing board supported by the base, and two side framing members and an intermediate partition member secured to the backing board to provide two upright side by side vertically elongated spaces both open at the front and connected across their tops by a transverse open area whereby one of said spaces represents a cylinder and said area represents a combustion chamber, a block representing a piston slidable in the cylinder-representing space, a pair of valves opening in said area and having operating rods extending slidably down into the other of the spaces, a shaft representing a crankshaft journaled in the lower portion of the device and connected with the block for rotation in response to sliding reciprocation of the block, a camshaft journaled in said other space between the crankshaft and the lower ends of the rods, cams mounted on the camshaft and operative on the lower ends of the rods, and reduction gearing connecting the two shafts to cause the valves to open and close in the manner of inlet and exhaust valves as the block reciprocates in the manner of the power, exhaust, intake and compression strokes of a piston, in combination with an electric light bulb positioned in the area representing the combustion chamber, a battery for said bulb, and a pair of contacts in circuit with the battery and bulb including a fixed contact and a contact movable with the camshaft to engage the fixed contact and close the circuit to light the bulb in representation of the ignition action of a spark plug

on each alternate rise of the block representing the terminal portion of the compression stroke of a piston.

EARL ALLGAIER.

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