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DEVICE FOR REGULATING THE COMPRESSION SPACE OF INTERNAL COMBUSTION ENGINES.

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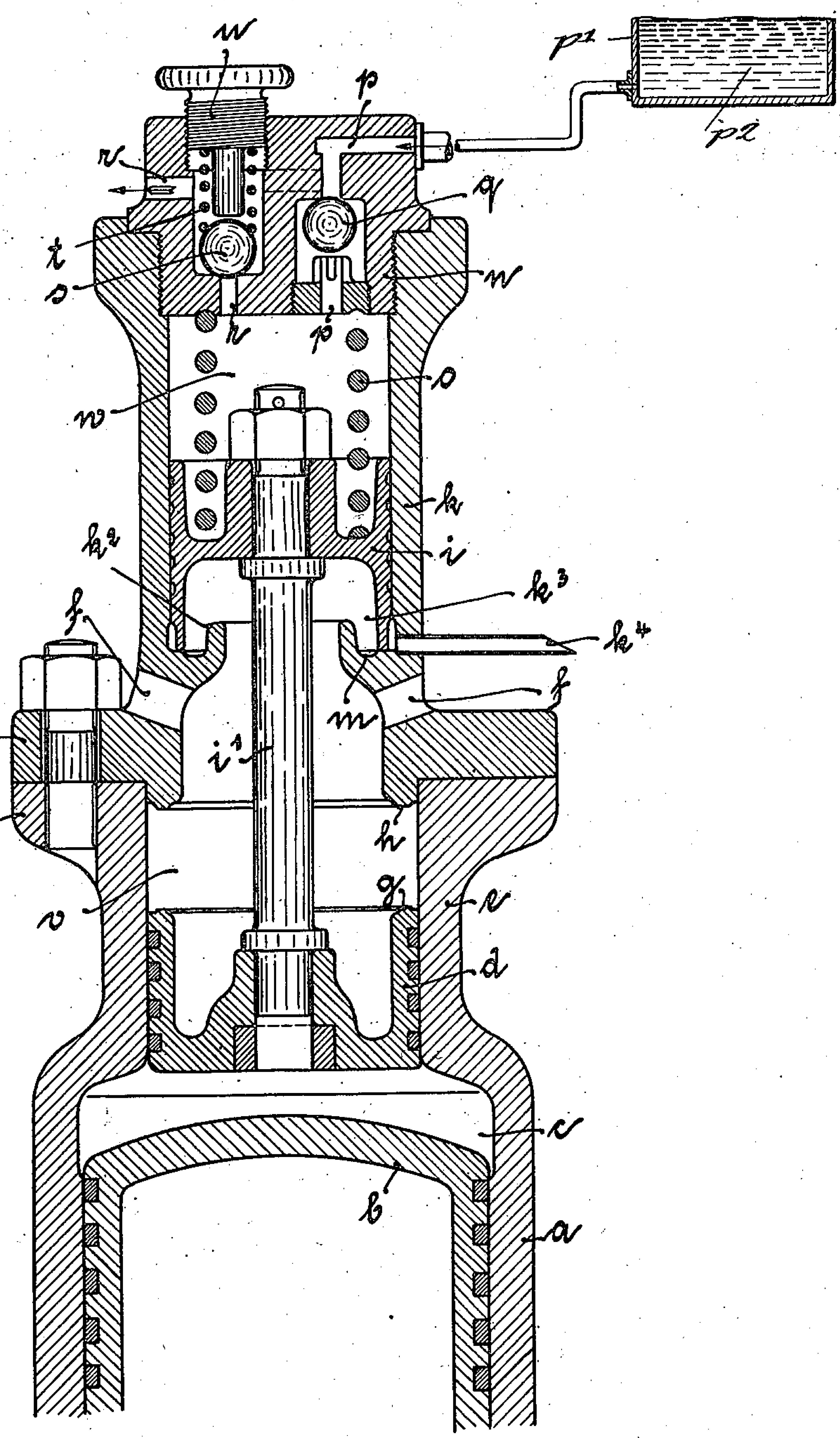
1,167,023. Patented Jan. 4, 1916.



WITNESSES

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DEVICE FOR REGULATING THE COMPRESSION-SPACE OF INTERNAL-COMBUSTION ENGINES.

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To all whom it may concern:

Be it known that I, WILHELM SCHMIDT, a citizen of the German Empire, residing at Wernigerode, Germany, have invented a certain new and useful Improvement in Devices for Regulating the Compression-Space of Internal-Combustion Engines, of which the following is a specification.

My invention relates generally to cylinders having variable compression space and is intended, particularly, for use in connection with internal combustion engines.

More especially my invention is intended for internal combustion engines which employ a special piston as part of the cylinder wall said piston being combined with means which constantly tend to place the piston in a position which will make the compression space a minimum, said piston or an extension thereof being extended into a chamber filled with liquid. This known arrangement has been practically unsuccessful by reason of its complexity and unreliability in operation.

The object of the present invention is to do away with the disadvantages attendant upon the use of known structures above referred to and this object is attained by a novel arrangement and combination of parts as will hereinafter be described.

My invention will be better understood by referring to the accompanying drawing which represents a central longitudinal section through a preferred embodiment thereof.

My invention resides essentially in a channel which contains a non-return valve and connects the liquid filled chamber behind the piston or into which the piston extends with a receptacle containing a supply of liquid, and another channel containing an over-pressure valve which opens away from said chamber.

Referring to the drawings, *a* is the working cylinder of an internal combustion engine, *b* is the working piston, and *c* is the compression space, said space being closed, opposite to the piston *b*, by an additional regulating piston *d* which may be displaced in an auxiliary cylinder *e* which forms an extension of cylinder *a*. Cylinder *e* is bolted at its rear end to a casing *k*, flanges *e'* and *k'* being provided for this purpose; flange *k'*, at its inner edge, is formed as a ring *h* which serves as an abutment for the piston *d* so as to limit the rearward movement of said piston, *i. e.*, its movement away from the cylinder *a* and the piston *d* so as to make the compression space larger. This compression space is a maximum when the piston *d* is in contact with the abutment ring *h*.

Casing *k* forms a control cylinder for another control piston *i* which is connected with piston *d* by piston rod *i'*. The space between the pistons *g* and *i* is connected by ports *f* with the outer air. The control cylinder *k* is, within the space just mentioned, provided with an internal angular projection k^2 forming with the cylinder wall an annular groove k^3 from which a drip pipe k^4 extends to the outside of the cylinder. The control cylinder *k* is closed at its upper end by a cover *n*, and the chamber *w* between this cover and the piston *i* is filled with a liquid, preferably an oil.

A helix *o* is provided in chamber *w* between cover *n* and piston *i* so as to exert a constant pressure upon said piston, and the piston *d* connected therewith, so as to decrease the compression space to a minimum, *i. e.*, to that size at which the downwardly extended peripheral rim of piston *i* is located at the bottom of groove k^3. The cover *n* has two channels *p* and *r*, the former containing a non-return valve *q*, and the latter an over-pressure valve *s*; a helix *t* tends to hold the ball of this over-pressure valve upon its seat. Channel *p* is connected with a receptacle *p'* containing a liquid p^2, and channel *r* may be connected with an overflow receptacle (not shown), similar to receptacle *p'*, adapted to receive any liquid forced out of the chamber *w*; or channel *r*, may, if desired, be connected with the receptacle *p'* so that any liquid forced out of chamber *w* will be returned to the supply from which it came.

When piston *i* is moved in the direction of the piston *g*, the oil or other liquid will flow through channel *p* into the chamber *w*, around the ball of the non-return valve *q*, but if the piston *i* is moved in the other direction, the oil or other liquid will pass through the channel *r*, around the ball of the over-pressure valve *s*, into the overflow receptacle. The helix *t* of the over-pressure valve *s* may be regulated by a threaded screw *u*.

The operation of my invention is as follows: Let the engine be assumed to be under full and constant load and the explosion to have just taken place; then the piston *d* will be in its highest position and in contact with ring *h* of flange *k'*. Compression space *c* is now the maximum, its size having been so determined that the most favorable final compression pressure, as well as the most favorable explosion pressure, is obtained with respect to that quantity of combustible mixture which corresponds to that full load. During the explosion, and during the immediately following expansion, piston *d* remains in the just stated position, because the pressure then existing within the working cylinder is greater than the tension of helix *o*. As soon, however, as the exhaust period commences, the tension of helix *o* becomes greater than the pressure within the working cylinder and this helix then tends (through control piston *i* and piston rod *i'*) to move the piston *d* off its seat. But since the over-pressure of the helix *o* is small, and since there is considerable resistance to movement by reason of friction, inertia, and throttling in the channel *p* and its valve, the extent of movement of the piston *d* in the direction of the working piston *b* is, as a matter of fact, quite small. There is, nevertheless, a corresponding quantity of oil or other liquid sucked or forced, as the case may be, through channel *p* into chamber *w* so as to keep this chamber constantly filled. The downward movement of the regulating piston *d* ceases when the compression period commences and, at the next explosion the piston *d* is again moved against, and pressed upon the seat or abutment *h*. During the return movement of piston *d*, liquid is forced out of the chamber *w* through channel *r* by means of piston *i*. This to and fro play is accurately the same during every cycle. In a four cycle engine, for instance, there are four strokes or movements of the piston *d* for every cycle, each of the strokes being very short, however, if the load of the engine remains the same. The length of the strokes is influenced to a certain extent by the R. P. M. of the engine shaft, this length tending to decrease with an increase of R. P. M. and to increase with a decrease of R. P. M.; with a sufficient number of R. P. M. the movements of the piston *d* may be practically negligible. If, now, the load of the motor be decreased, for example, to about one-half of its former magnitude, then only about half of the former quantity of explosive mixture is needed, and since the piston *d* is, at first, still in its highest position, *i. e.*, at or near to the abutment ring *h*, the compression space will be too large with respect to the reduced load. The explosion pressure will become too small, therefore, to act upon piston *i* so as to force liquid out of chamber *w* through channel *r*. In other words, pistons *i* and *d* will, at the first explosion stroke after reducing load, remain substantially in the position they assumed at the last exhaust stroke of piston *b*. At the next exhaust stroke and suction stroke the pistons *i* and *d* will sink farther, *i. e.*, they will be displaced farther toward piston *b* by means of helix *o*, and the amount of this displacement will be greater than it was during the state previously described. The pistons *i* and *e*, are now displaced, not only by the helix *o*, but also by the over-pressure which now exists in chamber *v* in comparison with the pressure within compression space *c*, since owing to the throttling of the combustible mixture upon its way to cylinder *a*, a certain partial vacuum has been produced in said space *c*. The diminution of the compression space is still quite small, and the pressure arising at the next explosion will not be sufficient to move the pistons back to their former position. Hence, at the next exhaust and suction strokes, the pistons will sink still farther and this step-by-step movement, in the direction of the working cylinder, will continue during the successive cycles until the compression space has been so far reduced that the explosion pressure will again be able to remove the piston *d* to that position which it has occupied at the commencement of the just preceding suction stroke. This reëstablished oscillatory movement of the piston *d* will continue as long as the now existing load of the engine remains unchanged, but when the load is again changed, the position of the limits between which the piston *d* will oscillate will correspondingly change, being closer to the working piston *d* or more remote therefrom, according as the load of the engine may have been still further decreased, or increased. If the load be supposed to have increased, then the explosion pressure will be greater than it was before and the piston *d* will be correspondingly raised, by steps, as before described, until the compression space has attained a size which corresponds to the new condition of constant load. It may be seen, therefore, that the changes or variations in size of the compression space take place automatically, always corresponding to the load, to the appropriate quantity of the explosive mixture, and to the explosion pressure or final explosion pressure. The magnitude of this pressure may be determined or regulated by means of screw *u* and helix *t*, and this may be done while the engine is running. Other means may be employed for changing the pressure of the helix *t* if desired; furthermore, the over-pressure valve *u* may be of any other suitable construction, as may also other details.

Having described my invention I claim:

1. In an internal combustion engine, in combination with the working cylinder, a regulating piston which constitutes a wall thereof at the compression space, an auxiliary cylinder opening into the compression

space and containing the regulating piston, a spring acting upon the regulating piston tending to move said piston toward the working cylinder, a pair of channels opening from the end of the cylinder space behind the regulating piston, one of said channels being connected with a receptacle which contains a liquid and said channel itself containing a non-return valve, and an over-pressure valve in the other channel.

2. In an internal combustion engine, in combination with the working cylinder, a regulating piston which constitutes a wall thereof at the compression space, an auxiliary cylinder opening into the compression space and containing the regulating piston, means for limiting the movement of the regulating piston within its cylinder, a spring acting upon the regulating piston tending to move said piston toward the working cylinder, a pair of channels opening from the end of the cylinder space behind the regulating piston, one of said channels being connected with a receptacle which contains a liquid and said channel itself containing a non-return valve, and an over-pressure valve in the other channel.

3. In an internal combustion engine, in combination with the working cylinder, a regulating piston which constitutes a wall thereof at the compression space, an auxiliary cylinder opening into the compression space and containing the regulating piston, a control cylinder, a control piston within the control cylinder, means connecting the regulating and control pistons so that they move simultaneously, a spring acting upon the control piston so that the regulating piston tends to move toward the working cylinder, a pair of channels opening from the end of the control cylinder behind the control piston, a non-return valve in one of said channels, an over-pressure valve in the other channel, and a receptacle containing liquid into which the channel containing the non-return valve opens.

4. In an internal combustion engine, in combination with the working cylinder, a regulating piston which constitutes a wall thereof at the compression space, an auxiliary cylinder opening into the compression space and containing the regulating piston, a control cylinder, a control piston within the control cylinder, means connecting the regulating and control pistons so that they move simultaneously, a spring acting upon the control piston so that the regulating piston tends to move toward the working cylinder, an opening from the atmosphere to the rear surface of the regulating piston, a pair of channels opening from the end of the control cylinder behind the control piston, a non-return valve in one of said channels, an over-pressure valve in the other channel, and a receptacle containing liquid into which the channel containing the non-return valve opens.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILHELM SCHMIDT.

Witnesses:
MILO A. JEWETT,
J. C. MENALLY.