

E. P. NOYES.
 AUTOMATIC STORAGE FOR COMPRESSED FLUIDS.
 APPLICATION FILED MAR. 20, 1911.

1,058,328.

Patented Apr. 8, 1913.

2 SHEETS—SHEET 1.

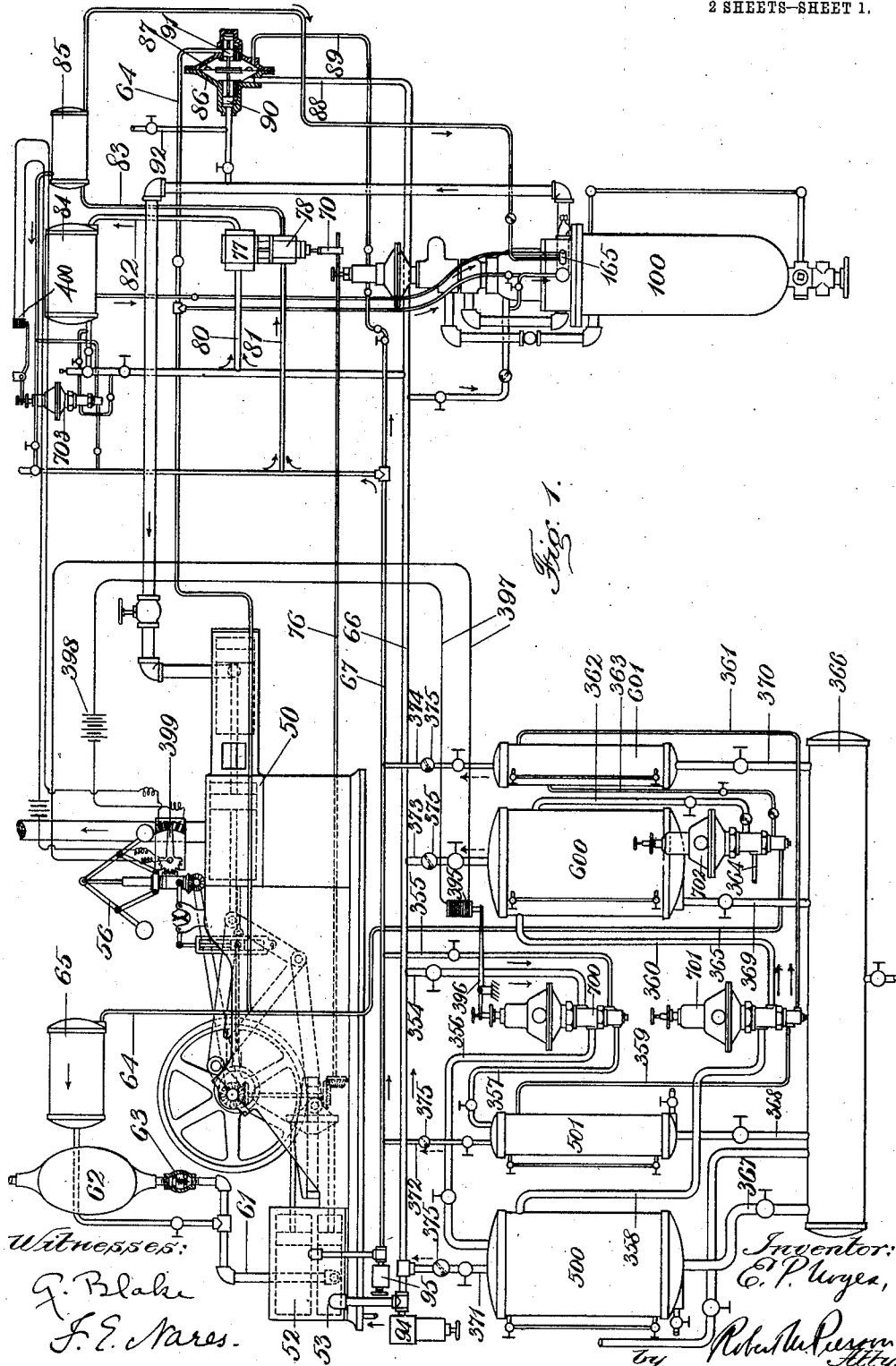


Fig. 1.

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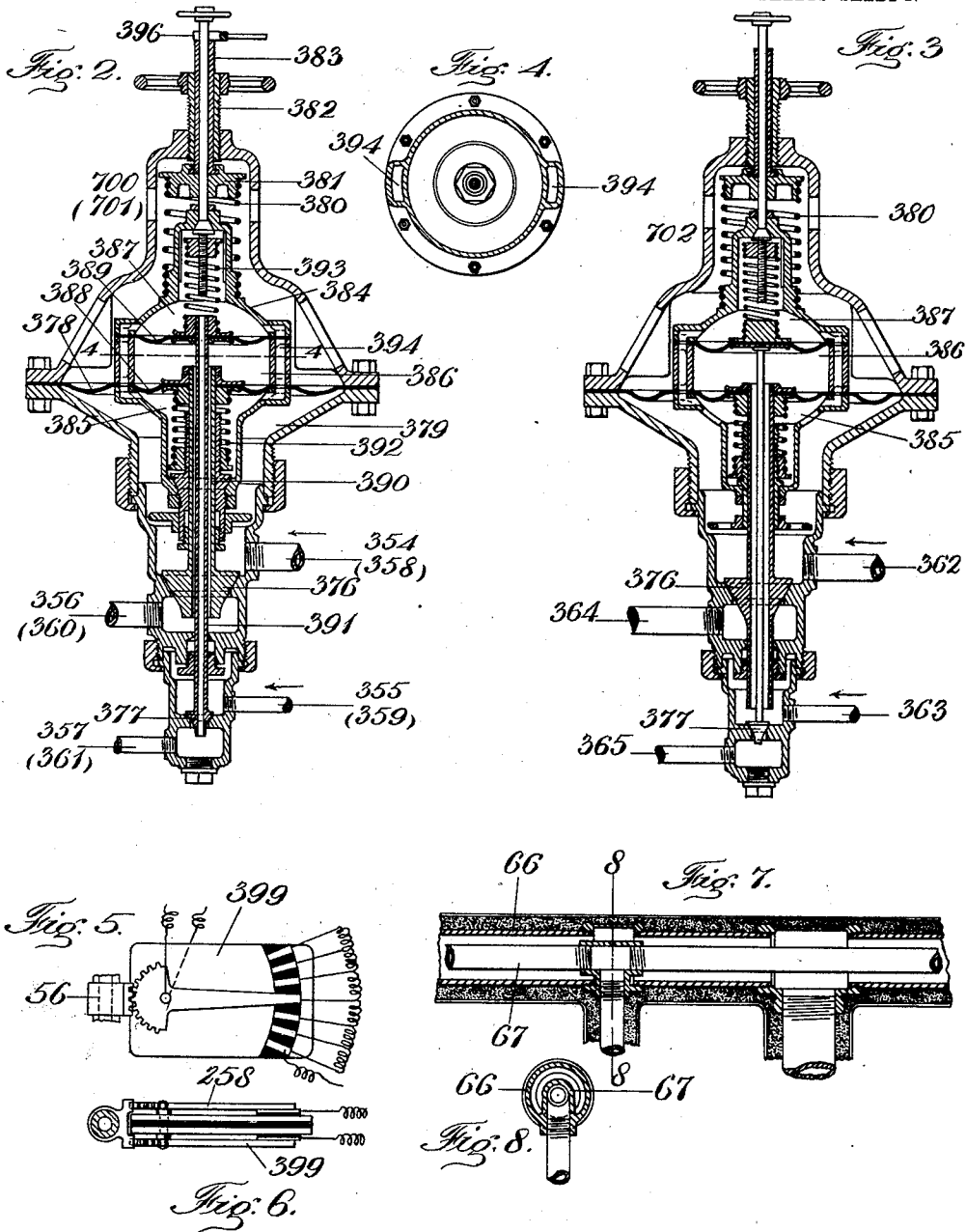
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UNITED STATES PATENT OFFICE.

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AUTOMATIC STORAGE FOR COMPRESSED FLUIDS.

1,058,328.

Specification of Letters Patent.

Patented Apr. 8, 1913.

Original application filed August 26, 1905, Serial No. 275,861. Divided and this application filed March 20, 1911. Serial No. 615,592.

To all whom it may concern:

Be it known that I, EDWARD P. NOYES, a citizen of the United States, residing at Winchester, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Automatic Storage for Compressed Fluids, of which the following is a specification.

This invention relates to the automatic impounding of compressed fluids and their subsequent utilization or release in connection with internal-combustion motor systems, and particularly those in which combustion is carried on at constant pressure, or on the Joule cycle. Its main object is to automatically store such excess portions of the combustion fluids as have been raised in pressure by the pumps or compressors but are not immediately employed in the motor and are hence available for subsequent use at times of increased load or in starting, and to automatically release these fluids when called for, into the pressure conduits leading to the generator or motor, or elsewhere, in relative quantities suitable for combustion.

The invention incidentally affords a means of disposing of the output of the compressors at times of negative load, that is, when the motor is driven by the apparatus which it ordinarily drives, as might happen with hoists, etc.

The present application is divided from my application Serial No. 275,861, filed August 26, 1905, and patented March 21, 1911, No. 987,160, and it covers improvements over the storage system described in my prior patent No. 868,358, of October 15, 1907. My present improvements are concerned with the quantity-relations of the compressed air and gas, and also with means for governing the storage pressure level according to motor speed, and for boosting the pressure of the main compressors and controlling the resulting extra-pressure supply.

Of the accompanying drawings, Figure 1 represents a diagrammatic view of a motor and storage system embodying my invention. Figs. 2 and 3 are vertical sections of two valve-mechanisms adapted to control the flow of storage fluids. Fig. 4 is a section on the line 4—4 of Fig. 2. Fig. 5 is an ele-

vation of one side of a governor-operated rheostat. Fig. 6 is a plan view thereof. Fig. 7 is a sectional view of means for jacketing the air and gas flow each by the other to equalize temperatures. Fig. 8 is a section on the line 8—8 of Fig. 7.

My invention applies to various systems employing pumps or compressors external to the motor cylinder, but I have selected for illustration a constant-pressure system in which combustion takes place in a generator 100, and preferably creates a body of steam mixed with the burnt gases.

50 is a compound motor of the steam-engine type adapted to receive the mixed motive fluid and connected to drive the air and gas compressors 52, 53, said motor having a centrifugal governor 56 for controlling its cut-off according to speed. Gas is supplied to the intake of the gas-compressor through a pipe 61 in which is a flexible gas bag 62 and a backwardly-closing check-valve 63.

64 is a release-pipe containing a reservoir-chamber 65 and connecting with the gas suction-pipe 61 for conducting released gas from several devices hereinafter described back to the gas-compressor.

66 and 67 are respectively the compressed-air and compressed-gas conduits leading from the compressors to the burner of generator 100. The present invention is not concerned with the details of the generator, motor or compressors.

500, 501, 600, 601 are air and gas storage-reservoirs for impounding the excess fluids not immediately employed in the generator, and 700, 701, 702 are automatic valve-mechanisms controlling the pressure-level and the pressure-relationship of the fluids. Of these regulators, 700 admits air and gas to the reservoirs 500, 501 upon the attainment of a predetermined pressure in the air-conduit 66, and maintains the pressures in said reservoirs equal or in a controlled relationship; 701 performs a like office, preferably at a higher pressure-level, for fluids passing from the reservoirs 500, 501 to the reservoirs 600, 601; and 702 releases excess fluids from 600, 601 without disturbing their pressure-relationship in the latter.

In the constant-pressure type of generator, pressures higher than those furnished

by the main compressors are desirable for ignition or pilot-flame purposes, and these may be supplied by means of auxiliary air and gas compressors or "boosters" 77, 78 driven by an eccentric 70 from the shaft 76, and deriving air and gas through suction-pipes 80, 81 from the conduits 66, 67 (or permissibly from other sources). The fluids, raised in pressure by these compressors, are delivered through pipes 82, 83 to auxiliary storage-reservoirs 84, 85, from whence they may be drawn for the igniter 165 as later described, the excess air and gas being released back to the conduits 66, 67 under control of a valve-mechanism 703 similar to the mechanism 702, later described in detail.

Pressure equality in the air and gas conduits is maintained by a pressure-balance mechanism 86 receiving the air and gas pressures on opposite sides of a diaphragm 87 through pipes 88, 89 and having piston-valves 90, 91 for releasing air through pipe 92 or releasing gas to the release-pipe 64, according as one pressure or the other tends to predominate.

I may further provide for equalization of temperatures of the compressed fluids by inclosing one of the conduits within the other as represented in Figs. 7 and 8, this result being of some importance in insuring proportionateness of the quantities participating in combustion and of the quantities entering the storage reservoirs. For the sake of clearness the conduits are shown separate in Figs. 1 and 2 but it will be understood that in practice they may be arranged as in Figs. 7 and 8 when equality of temperatures is desired.

Near the left-hand ends of the air and gas conduits 66, 67 in Fig. 1 are shown adjustable capacity-lobes 94, 95 whereby the capacities of these conduits may be adjusted in accordance with those of the compressors and reservoirs. While pressures remain stationary the capacities of the conduits are of comparatively little importance, as they then act merely as conductors to the burner, but during pressure-change they act also as reservoirs, and then if their relation should differ from that of the compressors, one conduit would fill or empty faster than the other and pressure-equality would be destroyed.

My invention is mainly intended to provide for special conditions which may occur when the flow of air and gas through the generator is partly or wholly cut off, such as would be the normal result of any engine-governing. Such a condition arises in a peculiar degree during periods of negative load, that is, when the normally-driven apparatus drives the engine. At such times, since there is no engine-intake, the outputs of the compressors rapidly accumulate in

pressure, and the conduits and their connections become storage spaces. Their pressures may be maintained equal or approximately so by arranging the capacities of the compressors in the same ratio as those of the conduits, and ultimately also by the action of the release-mechanism 86 as already explained. Instead of releasing the excess of pressure-fluids when such conditions arise, it is preferable to store them and make them available for future use in combustion within the generator.

There are here shown two sets of the storage reservoirs 500, 501, 600, 601, but a greater or less number could be provided. Air and gas are admitted to the first set through pipes 354, 355 and their continuations 356, 357 under control of the automatic valve-mechanism 700. Excess fluids from the first reservoirs 500, 501 pass by way of pipes 358, 359 and their extensions 360, 361 to the second reservoirs 600, 601, under control of a valve-mechanism 701 similar to 700. Excess fluids from the second set may pass through a third set and so on, and finally pass by way of pipes 362, 363 and their extensions 364, 365, to the atmosphere and to the suction side of the gas-compressor respectively, under control of an automatic valve-mechanism 702.

As proportionateness of capacity between the reservoirs and the conduits and compressors is one of the essentials to proportionateness of quantities of stored fluids in the reservoirs, I have shown a water-tank 366, connecting by pipes 367, 368, 369, 370 having suitable stop-valves, with the several reservoirs, whereby water may be admitted to said reservoirs in the necessary quantity to vary their capacities as desired. This water also serves to equalize temperatures in the two sets of reservoirs. The other requisites to proportionateness of quantities are equality of pressures and temperatures, which have been provided for by means already described.

Pipes 371, 372, 373, 374, connecting the reservoirs with the air and gas conduits 66, 67 and provided with check-valves 375 opening toward the conduits, are provided for automatically restoring the impounded pressure-fluids to the conduits when the reservoirs have filled and pressure in the conduits falls.

The general constructive principle of any of the regulators 700, 701, 702 as a separate instrumentality is claimed in my Patent No. 991,229, dated May 2, 1911. Fig. 2 represents the construction of the regulators 700 and 701. 376 and 377 are valves, interposed in the air and gas lines respectively, and carried by a single diaphragm 378 which receives on its under side in a chamber 379 the air-pressure anterior to the air-valve and on its upper side the pressure of

the atmosphere and of a spring 380, which is regulated by adjustment of the follower 381. The two valves by this arrangement are adapted to open when the anterior air-pressure reaches a predetermined point. It will be observed that the adjustment of the spring-tension may be effected either by rotation of a threaded sleeve 382 abutting on the follower or by axially sliding a sleeve 383 connected therewith. When air-conduit pressure has risen to the point determined by the set of the spring 380 in the regulator 700, said spring yields and allows the valves 376, 377 to open and admit excess air and gas to the reservoirs 500, 501. Should this abstraction of fluids be too great to allow the remainder to satisfy the demands of the motor 50, conduit-pressures will fall and the valves 376, 377 tend to close.

The diaphragm 378 carries a casing 384 having three chambers, viz.: a lower chamber 385, a middle chamber 386, and an upper chamber 387, separated by two diaphragms 388, 389, to which the hollow stems 390, 391 of the air and gas valves 376, 377 are respectively connected. These two diaphragms are supported by push-and-pull springs 392, 393, whose purpose is mainly to sustain the weights of the diaphragms and attached parts, in a neutral adjustment, in which case the pressures in the air and gas reservoirs will be equal, although these springs may be so adjusted as to maintain the two pressures in a controlled relation other than that of equality. To the middle chamber 386 the air-pressure on the posterior or reservoir side of air-valve 376, is admitted through the hollow interior of valve-stem 390. To the upper and lower chambers 387, 385 reservoir gas-pressure is admitted through the hollow interior of valve-stem 391, said pressure passing from the upper chamber to the lower chamber through ducts 394, 394. Thus it will be seen that in addition to the movement imparted to both valves 376, 377 by movements of the diaphragm 378, each valve is pressure-balanced by the pressures in the air and gas reservoirs. Thus should the air-reservoir pressure exceed the gas-reservoir pressure for any reason, the diaphragms 388, 389 would tend to separate, decreasing the opening of valve 376 and increasing that of valve 377, whereby equality of pressures is restored. Predominance of gas-reservoir pressure has the opposite effect on the valves.

The spring 380 of regulator 701 will preferably be set to a higher pressure than that of regulator 700, which would prevent the filling of reservoirs 600, 601 until the attainment of a pressure in the conduits 66, 67 and reservoirs 500, 501 higher than that at which the latter begin to fill. It may, however, be set to the same pressure as the

spring 380 of regulator 700, whereupon the reservoirs 600, 601 would begin to fill as soon as 500, 501 were filled to conduit pressure. The filling of the first set of reservoirs constitutes a postponement of any pressure-rise in the conduits exceeding the pressure at which the spring of the entrance-valves is set, but does not prevent its ultimate occurrence. The filling of the second set and any additional sets of reservoirs constitutes a still further postponement, but by thus dividing reservoir capacity into sections connected in tandem, instead of having a single set of large reservoirs, the stored pressures are in part made more immediately available to handle an increased load on the engine, since the contents of the reservoirs are available immediately they have reached the pressure of the conduits.

Since the air and gas are stored under equal pressures and temperatures in reservoirs proportionate in capacity to the conduits and compressors, they flow back to the conduits through the return branches 371, 372 or 373, 374, when pressures fall in said conduits, without disturbing pressure equality in the conduits.

The regulator 702, shown in detail in Fig. 3, is similar in construction to the regulators 700 and 701, except that since it is designed to maintain equality of pressures in the reservoirs 600, 601 behind it during release; elsewhere than to the conduits, of excess pressures from the reservoirs, its outer diaphragm-chambers 385, 387 on the one hand, and its middle diaphragm-chamber 386 on the other hand, receive respectively the air and gas reservoir pressures anterior to the valves 376, 377. The release-spring 380 of this device may be set to the same pressure as the admission-spring 380 of regulator 701.

When the load is of a fairly constant character, it would be objectionable to impose the necessity of extreme pressure-rise before accumulating excess fluids in the storage-reservoirs, but, on the other hand, when fluctuations of load are wide and frequent, advantage may be taken of such conditions in order to obtain during light load a store of fluids at extra-high pressure for handling a subsequent heavier load. For this purpose I provide a magnet or solenoid 395. (Fig. 1) whose core acts through a lever 396 on the spring-follower 381 of regulator 700 to control the tension of its spring 380. In the circuit 397 of the solenoid are a battery 398 and a rheostat 399 (Figs. 1 and 5) whose arm is controlled by the sleeve of the governor 56. When the load is light and the governor-balls rise, the resistance in the solenoid-circuit is decreased, and the solenoid increases the tension of the spring 380 of mechanism 700.

Storage will, therefore, not occur until a certain higher pressure has been attained, and this extra-high pressure becomes available for handling the subsequent heavier load.

To the super-initial storage-reservoirs 84, 85 is applied a release regulator 703, similar to 702, controlling their release back to the conduits 66, 67. To this mechanism may be applied a solenoid 400 similar to 395 and controlled by the governor through a rheostat 258 (Fig. 6), but arranged so that a long engine cut-off due to an increase in load lessens the pressure of the spring upon its diaphragm and drops the pressure-point at which the stored pressures from these reservoirs are released through the conduits. A very large power-reserve for emergencies and heavy loads is the result.

It will be understood that various modifications and omissions may be made in the foregoing embodiment without departing from my invention.

I claim,—

1. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas storage reservoirs connected therewith and having outlets provided with release-valves, and means differentially controlled by the pressures in said reservoirs for controlling said valves.

2. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas storage reservoirs having branch inlets from and outlets to said conduits, valves controlling said inlets, and means controlled differentially by the pressures in said reservoirs for reciprocally operating said valves.

3. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas storage reservoirs having branch inlets from said conduits and outlets leading elsewhere than to the conduits, release valves in said outlets, and means controlled differentially by the pressures in said reservoirs for reciprocally operating said valves.

4. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas storage reservoirs in branch connection with the respective conduits, and means responsive to the pressure-level anterior to one of the reservoirs, and also responsive to the pressure-difference in the reservoirs, for controlling the admission of the fluids to the respective reservoirs.

5. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas storage reservoirs connected therewith and having outlets leading elsewhere than to the conduits, valves controlling said outlets, and means responsive to the pressure-level in one of the res-

ervoirs and also responsive to the pressure-difference in the reservoirs for operating said valves.

6. In an internal-combustion motor system, the combination of compressed air and gas conduits, a pair of air and gas reservoirs having inlets from and outlets to said conduits, a second pair of air and gas reservoirs having inlets from the reservoirs of the first pair and outlets to the respective conduits, a regulator controlling the inlets of the first pair and responsive to the anterior pressure-level of one of the fluids and the posterior pressure-difference of the fluids, and a similar regulator controlling the inlets to the second pair of reservoirs.

7. In an internal-combustion motor system, the combination of compressed air and gas conduits, a series of pairs of air and gas reservoirs having inlet and outlet connections with the respective conduits, the last of the pairs also having independent outlets, regulators controlling the inlets from the conduits to the first of the pairs and from one pair to the next in series, each being responsive to the anterior pressure-level of one of the fluids and to their posterior pressure-difference, and another regulator controlling said independent outlets and responsive to the anterior pressure-level of one of the fluids and to the anterior pressure-difference of said fluids.

8. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas reservoirs in branch connection therewith, valves controlling the inlets to said reservoirs, differential septums connected with the respective valves and subject on opposite sides to the respective reservoir pressures for reciprocally operating the valves, a third septum carrying said valves and differential septums and subject on one side to the anterior pressure of one of the fluids for jointly opening said valves, means supplying a yielding constant pressure to said third septum for jointly closing the valves, and means for adjusting the amount of said constant pressure.

9. In an internal-combustion motor system, the combination of compressed air and gas conduits, air and gas reservoirs in branch connection therewith and having outlets elsewhere than to the conduits, valves controlling said outlets, differential septums connected with the respective valves and subject on opposite sides to the respective reservoir pressures for reciprocally operating the valves, a third septum carrying said valves and differential septums and subject on one side to the pressure of one of the reservoirs for jointly opening said valves, means supplying a yielding constant pressure to said third septum for jointly closing the valves, and means for

adjusting the amount of said constant pressure.

10. In an internal-combustion motor system, the combination of compressed air and
5 gas conduits, air and gas reservoirs adapted to discharge into said conduits, a pair of boosting compressors adapted to draw from said conduits and charge the reservoirs, and regulating means subject to the pressure-
10 level in one of the reservoirs and also to the pressure-difference of the reservoirs for controlling the discharge of the latter.

11. In an internal-combustion motor system, the combination of compressed air and
15 gas conduits, air and gas reservoirs having branch inlet and outlet connections with said conduits, an internal-combustion gen-

erator and motor supplied by said conduits, a regulator responsive to the pressure-difference in said reservoirs and to the inlet
20 pressure level of one of the fluids for controlling the admission to the respective reservoirs, and means controlled by the speed of said motor for varying the pressure level at which said regulator admits to the reser-
25 voirs.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses, this 17th day of March, 1911.

EDWARD P. NOYES.

Witnesses:

FORREST R. ROULSTONE,
P. W. PEZZETTI.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."