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CONTROL FOR PRODUCERS OF INERT GASES

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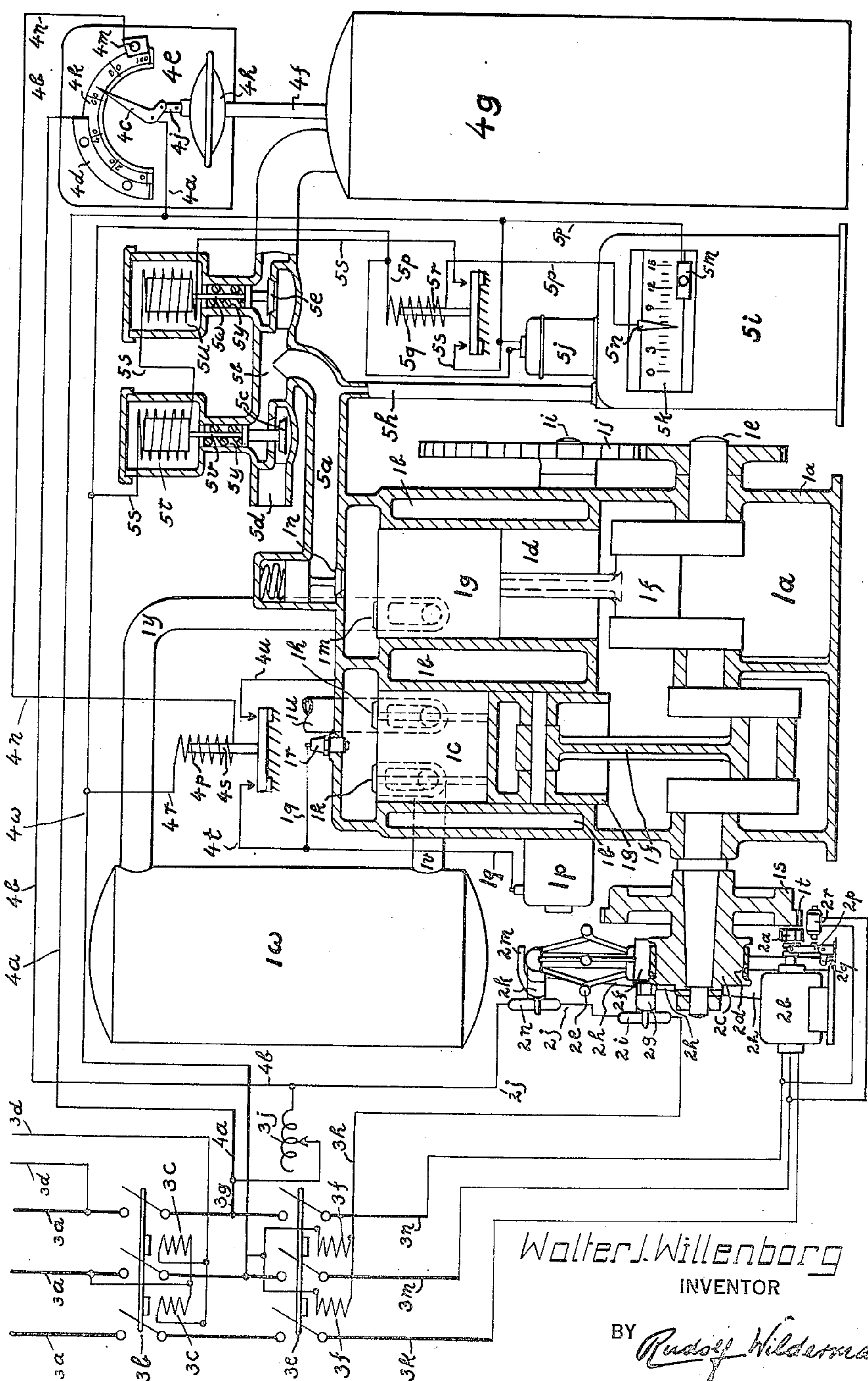

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CONTROL FOR PRODUCERS OF INERT GASES

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9 Claims. (Cl. 23—255)

My invention concerns producers of inert gases. Some features of my improvements apply to producers of this kind in general; in other respects my invention concerns producers of inert gases which involve the use of internal combustion engines. The exhaust gases from such engines are frequently used to produce nonexplosive atmospheres above and around readily burnable substances. To assure the quality of the inert gas for such a purpose, its oxygen contents must not exceed a certain maximum, so that the inert gas cannot sustain combustion of an oxidizable gas, when mixed therewith.

I have succeeded in improving upon producers of inert gases to such an extent that their operation is fully automatic and fool-proof, and some of the objects of my invention are, first, to connect with a rotary inert gas producer an electric starting motor which is automatically started when the supply of inert gases stored in a storage tank reaches a certain minimum; second, to measure the inert quality of such a gas from its CO_2 contents; third, to store only such gases, which have a certain degree of quality of inertness; fourth, to interrupt the passage of the gas from the producer to the storage tank for periods during which the quality of the gas does not come up to a certain standard of inertness; fifth, to stop the rotary producer when a certain maximum of inert gas has been stored in the storage tank; sixth, to disconnect and to stop the starting motor when the gas producer is rotating as a prime mover; seventh, to control by automatic means the production and storage of inert gases within specific limits of quantity and quality.

These and other objects I attain by the apparatus illustrated and indicated in the accompanying drawing which shows the various means used in substantially diagrammatic views.

The parts shown in the drawing may be grouped into the following classes:

1—An internal combustion engine combined with a pump.

2—A starting motor for said engine and means for controlling said motor mechanically and electrically.

3—A main power control.

4—A storage tank and pressure control means in connection therewith.

5—Apparatus for checking the quality and for controlling the delivery of the gas produced.

Parts belonging to the same one of the classes enumerated above are indicated by the corresponding numeral. Similar parts are indicated by the combination of similar numerals and letters throughout the drawing.

The housing 1*a* of the engine is provided with cooling chambers 1*b* adjoining the combustion chamber 1*c* as well as the pump chamber 1*d*. To the crank shaft 1*e*, which is rotatably mounted in the housing 1*a* of the engine, are connected by the connecting rods 1*f* the pistons 1*g*, which are directionally opposed to each other in their operation in the two cylinders 1*c* and 1*d*. The crank shaft is connected by gearing 1*j* to the cam shaft 1*i*. From the cam shaft are controlled, by suitable cams, the operations of the intake valve 1*h* and the exhaust valve 1*k* on the internal combustion chamber 1*c*,—the engine being indicated as functioning on the principle of a four-cycle internal combustion engine,—and of the intake valve 1*m* in the pump chamber 1*d*, the compressed gas leaving said pump through valve 1*n*. Intake valve 1*h* is supplied with the mixture of explosive gas through pipe 1*u* which is connected to a suitable carburetor (not shown). Exhaust valve 1*k* connects through pipe 1*v*, the exhaust manifold to the "scrubber" 1*w*, a tank which serves to suitably wash, clean and filter the exhaust gases. The upper end of the "scrubber" connects, by means of pipe 1*y*, to the intake valve 1*m* in the pump chamber. Valve 1*n* functions unidirectionally, a spring seated behind the valve stem keeping the valve normally closed. The valve 1*n* opens, when the drop of pressure between the gas in chamber 1*d* and the gas in pipe 5*a* is sufficiently large to counteract the tension of the spring in the head of valve 1*n*.

To the cam shaft is also coupled the magneto 1*p* from which a high tension current is distributed through the conductor 1*q* to the spark plug 1*r* seated in the head of the combustion chamber 1*c*. On the crank 1*e* of the engine is mounted a fly-wheel 1*s* of sufficient weight to carry the engine subsequent to an explosion cycle through the remaining three cycles as well as to perform the pumping work in chamber 1*d* during all four of these cycles. Into the circumference of the fly-wheel 1*s* is cut the spur ring 1*t*. The spur pinion 2*a* of the starting motor 2*b* meshes into the spur 1*t* on fly-wheel 1*s*. The spur pinion 2*a* is adapted to be shifted in the direction of the axis of motor 2*b*; automatic means for bringing about disengagement of the pinion from the spur gear 1*t*, when the engine has reached sufficient speed, are used, such means having been developed to a high degree of efficiency and being well known in the art of automotive gearing. Exemplarily shifting means for the pinion 2a are indicated by a shift lever 2p the free end of which is operatively coupled to the hub on pinion 2a; the shift lever is normally tensioned by a spring 2q in a counter-clockwise direction; in that position of the lever the pinion 2a is disengaged from the spur gear. A pole piece, mounted on said lever, faces an electromagnet 2r, so that energization of said electromagnet will swing the lever to the right. Such movement of the lever slides the pinion 2a along the shaft of motor 2b into mesh with spur gear 1t.

The crank shaft 1e of the engine carries on its end a pulley 2c which by means of a belt 2d drives a governor 2e. The crank shaft and the shaft of the governor extending at right angles to each other the belt 2c is of course twisted through 90 degrees to connect the respective pulleys. Upon belt 2d rests an idler pulley 2f near the pulley 2c. Said idler pulley is mounted on the free end of lever 2g which is rotatably pivoted onto bracket 2h. Lever 2g carries a mercury switch 2i which is disposed at such an angle that the swinging downward of lever 2g, when the belt 2d breaks and the idler 2f thereby loses its support, will interrupt the electric contact made in said mercury switch thereby operating the circuit 2j. Another lever 2k is rotatably pivoted onto bracket 2h, its free end 2m resting on top of the governor 2e. The mercury switch 2n is also electrically connected into circuit 2j and it is mounted on lever 2k at such an angle that the contact in said switch, which is normally closed, is opened, when the governor 2e is driven by the pulley from the engine at such a speed that the free end 2m of lever 2k drops, together with the top of the governor, for a specific distance.

The three cables 3a supply electric power from a suitable source of power. They lead to a circuit breaker 3b the control relays 3c of which are suitably connected to a remote point by wires 3d, from where the supply of power to the gas producing apparatus is to be turned on or off.

From the circuit breaker 3b the power supply connects to a second circuit breaker 3e which controls the motor 2b by means of the conductors 3k, 3m and 3n. In parallel with the motor, the electromagnet 2r is connected across the two latter conductors 3m and 3n.

The circuit breaker 3e is controlled by circuit closing relays 3f. The current required to operate these relays is tapped from one branch of the main power supply at a point between the two circuit breakers; the wires 3g and 3h indicate part of said relay circuit, the wire 3h connecting to the mercury switches 2i and 2n from which the circuit is carried back by the wire 2j. Between the wires 3g and 2j is coupled a quenching compensator 3j; wires 4a and 4b connect in parallel thereto and lead to the pointer 4c and to the low pressure contactor 4d on the pressure gage 4e, respectively. The pressure gage 4e is connected by a pipe 4f to the storage tank 4g. A Bourdon chamber 4h operates the gage 4e, so that by a lever arrangement 4j the pressure variations in tank 4g are transmitted to the pointer 4c. Pointer 4c indicates on a suitable dial 4k the pressure in the storage tank. On said dial is slidably mounted the contactor 4d serving as a contact which may be set at the point of minimum pressure desired in the storage tank. The pointer 4c is provided on its end with an electric brush member which contacts with contactor 4d when a minimum pressure is reached and the circuit 4a, 4b, is closed thereby. The maximum pressure contactor 4m is similar to the contactor 4d and is also adjustable along the arc of the dial 4k. When the contacting brush on the end of the pointer 4c contacts with said maximum pressure contactor 4m, electrical contact is established between the circuit 4a and the conductor 4n which leads to the solenoid 4p; solenoid 4p is connected by the conductor 4r to 4w, one of the legs of the source of current. Excitation of solenoid 4p will lift the contact member 4s from its position of rest shown, and will short-circuit the magneto circuit 1q, to which it is connected by a wire 4t, by means of a ground connection 4u to the housing 1a of the engine.

The pipe 5a through which the gas is expelled from the pump chamber 1d connects to a T 5b, one branch of which connects to a solenoid-operated normally-open valve 5c and from there through opening 5d to the air, whereas the other branch of the T connects to a normally closed solenoid-operated valve 5e which connects to the pressure tank 4g. Just below T 5b a pipe connection 5h connects to the CO_2 indicator 5i. Said CO_2 indicator is of Orsat type or operated on any other principle used in such indicators by those acquainted with the art of testing flue gases. The indicator is operated by a motor 5j which is connected to the main source of power through the circuit breaker 3b and therefore the indicator functions continuously while said remote control circuit breaker 3b is closed. A scale 5k is provided in the CO_2 indicator on which the CO_2 contents of the inert gases may be observed. An exemplary scale ranging from zero to 15% is indicated. On the scale 5k is slidably mounted a contactor 5m which may be set so as to establish at any point of the scale an electric contact with the pointer 5n; that pointer indicates on the scale the CO_2 contents of the gas. Suitable means for establishing a contact between said pointer and contact 5m are provided on the end of pointer 5n so that at and above a certain percentage of CO_2 indicated contact is established closing a circuit 5p. Said circuit is supplied with power from one leg of the main circuit and it includes a solenoid 5q which operates a contactor 5r. When said solenoid 5q is energized the contactor 5r closes a circuit 5s which is supplied with power from one branch of the main circuit and it includes the two solenoids 5t and 5u which operate the normally open valve 5c and the normally closed valve 5e, respectively. The stems 5v and 5w of the two valves are normally pressed downward by the springs 5y, the flux set up by the solenoid 5t and 5u counter-acting these two springs.

The function of the producer part of my invention, the engine, is readily discernible to those acquainted with the art of internal combustion engines in general, and the method of incorporating into the layout of such an engine a suitable pump is old in the art of producers of inert gases. For that reason the function of the engine itself is described only briefly in the following so that the function of my improvements may be readily explained in connection therewith. An explosive mixture is fed from a suitable carburetor into the engine by means of pipe 1u through valve 1h and the power created by the explosion in the chamber 1c is transmitted from the respective piston 1g by means of connecting rod 1f to the crank shaft 1e. Ignition of the explosive mixture is brought about by the spark plug 1r which receives, at suitably timed intervals, a high frequency current from the magneto 1p. The burned gases are driven through the exhaust valve 1k from the cylinder 1c by the upward stroke of the piston 1g, following the downward explosion stroke. They pass through the pipe 1v into the tank 1w where they are suitably cleaned, filtered and washed. From tank 1w the exhaust gases are sucked through pipe 1y and through valve 1m into the pump cylinder 1d by the downward stroke of the respective piston 1g, which is operatively connected to crank shaft 1e, and they leave said cylinder, upon the upward stroke of said piston, through the valve 1n, when they are compressed in the cylinder to a pressure sufficient to overcome the combined pressures of the spring of valve 1n and of the gases contained in the pipe 5a and in the parts connected thereto.

Prior to my invention the valve 1n represented substantially the only control used in connection with gas producers of this kind. When a sufficient pressure had been built up in the pipe line 5a and in the parts connected thereto, the exhaust gas ceased to operate the valve 1n and eventually the exhaust gases thus retained in the engine and in tank 1w prevented the entrance upon the explosion chamber of additional unburned gases, the gas in the cylinder head refused to ignite and thus the engine eventually came to a stop. This involved of course on one side the mixing of some unburned gases with the exhaust gases and thus reduced the enertness of the gas leaving the explosion chamber, on the other side it caused choking and the collection of carbon whereby the efficient operation of the engine was greatly impeded. Although I retain the valve 1n, and although by corresponding function the engine would eventually be stopped when a high pressure has been built up on the exhaust end, I do not use the reaction of the exhaust gases to bring about the stopping of the engine when a high pressure has been attained; but such stopping is brought about independent of said reaction, at the right time, i. e., when the desired maximum pressure of the exhaust gases in storage tank 4g has been attained. This interruption of the production of inert gases and of their flow is brought about by the pressure gage 4e. The contactor 4m is set upon the dial 4k so that its upper side aligns with the maximum pressure desired, as indicated on the scale of said dial 4k in the drawing. As an example, the contactor 4m has thus been set in the drawing to register with the 90 pound mark on the scale. Under these circumstances the pointer 4c will contact with the contactor 4m when it registers 90 pounds and a current will thus be set up, at and above said pressure, in the circuit 4a, 4n, 4r, 4w; the relay 4p in said circuit is excited and the contactor 4s will be caused to close the circuit 4t, 4u. Closing of circuit 4t, 4u short-circuits the circuit 1q which serves to supply current from the magneto 1p to the spark plug 1r and the ignition thus is interrupted. Interruption of the ignition brings about instantaneous stopping of the internal combustion engine, the weight of fly wheel 1s being just sufficient to carry the engine through one complete cycle, as explained above. The ignition circuit 1q will be short circuited as long as the pressure in tank 4g remains at or above 90 pounds. When said pressure drops below 90 pounds, the short-circuiting of the circuit 1q ceases, the circuit 4a, 4n, 4r, 4w being opened, as the contact between pointer 4c and contactor 4m is interrupted. But the ignition will of course not function again until the engine is started and that cannot take place until the starting motor 2b has been set into motion.

The function of the whole apparatus is controlled by the main circuit breaker 3b. Circuit breaker 3b in turn is controlled by the relay circuit 3d. This circuit includes the relays 3c which control the closing of the circuit breaker 3b. The circuit 3d leads to a remote point from where the operation of the gas producer is to be stopped or started, a suitable switch being included at that point in the circuit 3d. From the main circuit breaker 3b the current leads to the circuit breaker 3e which controls the motor 2b. Circuit breaker 3e is automatically controlled by the relays 3f. The closing of switch 3b will however start the starting motor 2b only in case the switch 3e is closed; and the closing of switch 3e on the other hand depends on whether the circuit, which includes the relays 3f, is closed. Three switches are included in the circuit of the relays 3f. These three switches or contactors are the mercury switch 2i, the mercury switch 2n and the low pressure contacting means on the pressure gage 4e. Mercury switch 2i is normally closed when the twisted belt 2d properly extends between the driving pulley 2c on the end of the crank shaft and the governor 2e. This switch is therefore open only in case said belt has been removed from the machine or is broken so as not to support the idler pulley 2f. The mercury switch 2n is closed when the engine is not running. When the engine reaches a certain speed, the rotation of the governor allows lever 2m resting on top of said governor to drop and the contact in mercury switch 2n is interrupted. When the engine is operating at its normal speed the circuit of relays 3f will therefore be open at the point of the mercury switch 2n. When the engine is at rest, the circuit of the relays 3f is closed at the point of the mercury switches, and the relays will be energized when the main switch 3b is closed and when the pointer 4c contacts with the contactor 4d on the pressure gage 4e. As an example the contactor 4d has been set on the dial 4k of the pressure gage so that the pointer contacts with the contactor when any pressure below 50 pounds is registered. When there is a pressure of more than 50 pounds in the storage tank 4g the starting motor of the engine cannot be started. But the starting motor 2b will be operated when the engine is not in operation and when the pressure in the storage tank 4g is at any point below 50 pounds.

As explained before, the relay 2r is under current when the switch 3e is closed. That means that the pinion 2a is pulled into engagement with the gear 1t whenever the starting motor 2b is in operation. After the starting motor has started the operation of the internal combustion engine, so that said engine operates as a prime mover, the mercury switch 2n is opened by means of the governor, the switch 3e is thereby opened and the starting motor comes to a stop and the driving pinion 2a is withdrawn from engagement with gear 1t.

It is seen from the above that provisions are made by means of the contactors at the pressure gage that the pressure of the gases stored in tank 4g is kept at all times between 50 and 90 pounds and that therefore a corresponding amount of inert gas is stored at all times in tank 4g. This applies of course only in case the main switch 3b is closed.

A fractional part of the inert gas leaving the engine through valve 1n is by-passed through pipe 5*h* to the CO_2 indicator 5*i*. The CO_2 indicator is continuously in operation, the operating motor 5*j*, forming part thereof, being supplied with current through the main switch 3*b*. The measurement of the CO_2 contents of the inert gases delivered by the engine may be brought about by any of the many methods known to those acquainted with the art. A dial is shown as part of the indicator which is, as an example, provided with a scale indicating CO_2 contents within the range from 0% to 15%, the pointer 5*n* indicating exemplarily the percentage of CO_2 contained in the inert gas as 6%, and the contactor 5*m* being set so as to bring about a contact between the pointer 5*n* and said contactor 5*m* at about 10% and above said percentage of CO_2. When the indicator 5*n* is in the position shown, or registers any other percentage of CO_2 contents below 10%, the circuit 5*p* is open. The solenoid 5*q* is therefore not energized and the circuit 5*e* is also open. This means that under those circumstances the solenoid valve 5*c* is open and the solenoid 5*e* is closed, which is the position in which these two valves are shown in the drawing. Under those circumstances, i. e., when the inert gas delivered from the engine contains less than 10% of CO_2, the said gases will not pass through valve 5*e* to the storage tank 4*g*, but they will pass through valve 5*c* out into the air. The gases delivered by the engine will be diverted in such manner until their CO_2 contents reach a percentage of 10%, when contact is made by the pointer 5*n* of the indicator with the contactor 5*m*, the solenoid circuit 5*p* is closed, contactor 5*r* is closed, the circuit 5*s* is thereby closed and the two solenoids 5*t* and 5*u* change the position of the respective valves, i. e., valve 5*c* will be closed and the by-passing of the gas to the air is thereby interrupted, and valve 5*e* is opened, the inert gases being delivered to the storage tank 4*g*. If at any time thereafter the CO_2 contents of the gas again drop below 10%, the percentage at which the contactor 5*m* is exemplarily set on the scale of the indicator 5*i*, the valves 5*c* and 5*e* again return to the position shown in the drawing, the inert gas of inferior quality being by-passed into the air. Therefore no gas of an inferior quality is even fed to the storage tank and the quality of gas stored in the storage tank may be kept up to any desired standard by a corresponding setting of 5*m* on scale 5*k*.

Of course the modification of the by-pass arrangement shown serves only to illustrate my method of maintaining the quality of the inert gas. The two valves 5*c* and 5*e* may be combined into a single three way valve which by means of electrical relays is connected, either to the air or to the storage tank 4*g*, according to the inferior or superior quality of the inert gases delivered from the engine. The electrical means shown may of course be reduced to a single circuit when the contacting means 5*m*, 5*n* are rugged enough to carry the full current required for the operation of the valves. Nor does the operative connection between the CO_2 indicator and the valve have to be brought about by electrical means but may be made by any other means known to the art. This also applies to the means serving to control the circuit breaker 3*e* from the governor of the engine and from the low pressure point of the pressure gage, both of which operative connections may be brought about by simple mechanical means as frequently used in the art. In corresponding manner arrangements may be made to directly short circuit the circuit 1*q*, when a certain maximum of pressure is reached in the storage tank 4*g*, instead of bringing such operation about by an auxiliary contactor 4*s*.

Although I have shown and described one form of an embodiment of my invention in great detail, yet, I do not wish to be limited thereby, except as the state of the art and the appended claims may require, for it is obvious that various modifications and changes may be made in the organization, construction and parts of my invention, without departing from the spirit thereof.

The process herein disclosed is claimed in my copending application, Serial No. 458,583.

I claim:

1. In combination with an internal combustion engine a CO_2 indicator, storage means and a branch outlet connected to the discharge of said engine, valves selectively controlling the discharge into said storage means or into said branch outlet and a device operated by said CO_2 indicator at the point of registry of a desirable percentage of CO_2 and operatively connected to said valves, so that only gases which contain the said desirable percentage of CO_2 and a higher percentage thereof are discharged into said storage means.

2. In combination with an internal combustion engine delivering exhaust gases, means to measure the CO_2 content of said delivered gases, means connected with said measuring means and automatically controlled thereby to effect the discharge to the atmosphere of those of said gases having less than a predetermined content of CO_2, means to store such of said gases as contain more than said predetermined content of CO_2, and means connected with said measuring means and automatically controlled thereby to permit the discharge of said last mentioned gases into said storage means.

3. In combination with an internal combustion engine delivering exhaust gases, means to control the operations of said engine and thereby the discharge of said gases, means to measure the CO_2 content of said gases, means connected therewith and automatically controlled thereby to effect the discharge to the atmosphere of such of said gases as have less than a predetermined content of CO_2, means to store such of said gases as contain more than a predetermined content of CO_2, and means connected with said measuring means and automatically controlled thereby to permit the discharge of said last mentioned gases into said storage means.

4. In combination with an internal combustion engine delivering exhaust gases, means automatically controlling the operation of said engine and thereby the generation of said gases, means to stop the actuation of said engine upon the storage of a predetermined quantity of gases therefrom, a pump adapted to discharge said gases from said engine, means to store said gases, means controlled by the pressure of said stored gases, a conduit leading from said engine discharge to said storage means, electrically controlled and operated mechanism associated with said conduit to control the flow of gas from said engine to said storage means and to the atmosphere, and means to analyze said gases discharged from said engine, and to control said machine whereby to store such of said gases as exceed a predetermined content of CO_2 in said storage means, and to discharge to the atmosphere such of said gases as do not equal or exceed the predetermined CO_2 contents.

5. In combination with an internal combustion

engine having an exhaust manifold, an outlet and a storage container connected with said exhaust manifold, valve means for selectively passing said gases from said exhaust manifold to said outlet or to said storage container, an analyzer connected with said exhaust manifold, registering the quality of said gases, and operatively connected with said valve means, so that exhaust gases of a certain quality are passed to said storage container and so that gases of an inferior quality are passed to said outlet, a starter on said engine, means for starting said starter, means for stopping said engine, and means actuated by the pressure of said quality gases stored in said container and operatively connected with said starting and stopping means.

6. In combination with an internal combustion engine having an exhaust manifold, an outlet and a storage container connected with said exhaust manifold, valve means for selectively passing said gases from said exhaust manifold to said outlet or to said storage container, an analyzer connected with said exhaust manifold, registering the quality of said gases, and operatively connected with said valve means, so that exhaust gases of a certain quality are passed to said storage container and so that gases of an inferior quality are passed to said outlet, a starter on said engine, means for disconnecting said starter from said engine during the period of time in which said engine is operating under its own power, means for stopping said starter when it rotates at a predetermined speed, means for starting said starter, means for stopping said engine, and means actuated by the pressure of said quality gases stored in said container and operatively connected with said starting and stopping means.

7. In combination with a producer of inert gases, an outlet and a storage container connected with said producer, valve means for selectively passing said gases from said producer to said outlet or to said storage container, and an analyzer connected with said producer, registering the quality of said gases, and operatively connected with said valve means, so that exhaust gases of a certain quality are passed to said storage container and so that gases of an inferior quality are passed to said outlet.

8. In combination with an internal combustion engine discharging exhaust gases, means to direct discharged gases selectively to a plurality of destinations, and means automatically responsive to variations in the CO_2 content of discharged gases to actuate said directing means whereby such discharge gases are discharged to one such destination when of one CO_2 content and to another such destination when of a different CO_2 content.

9. In combination with an internal combustion engine having an exhaust pipe, valve means in said pipe for selectively directing the discharge of gases therefrom, an analyzer responsive to variations of the quality of gases discharging through the pipe and means operatively connecting the analyzer to the valve means to direct the discharge according to the quality of the gas whereby gas of one quality may be discharged to one destination and gas of another quality to another destination.

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