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2,253,530

DEVICE INCLUDING RECEIVING ELEMENTS FED BY COMPRESSED GAS GENERATORS

Filed Jan. 19, 1939

3 Sheets-Sheet 1

Fig. 1.

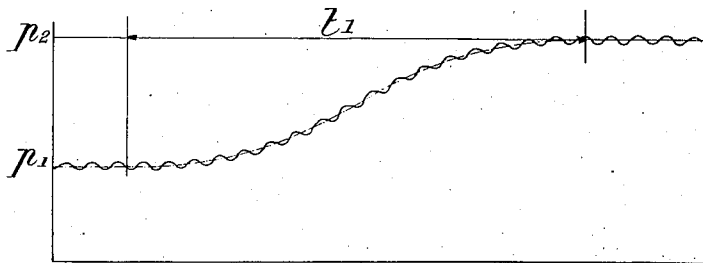


Fig. 2.

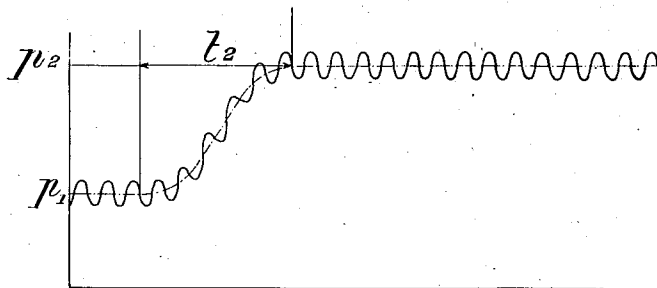
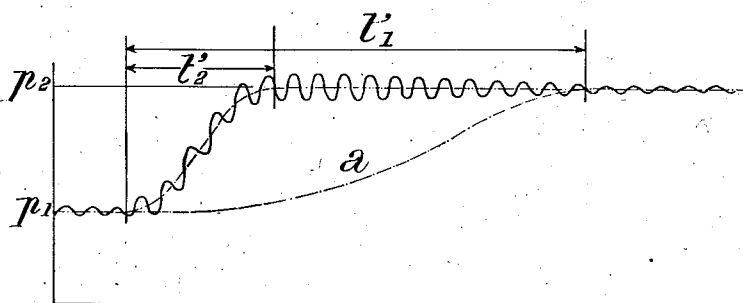


Fig. 3.



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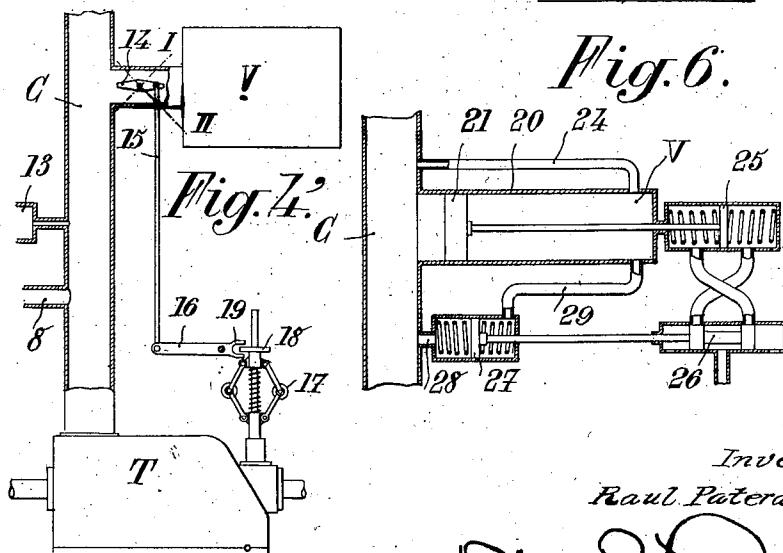
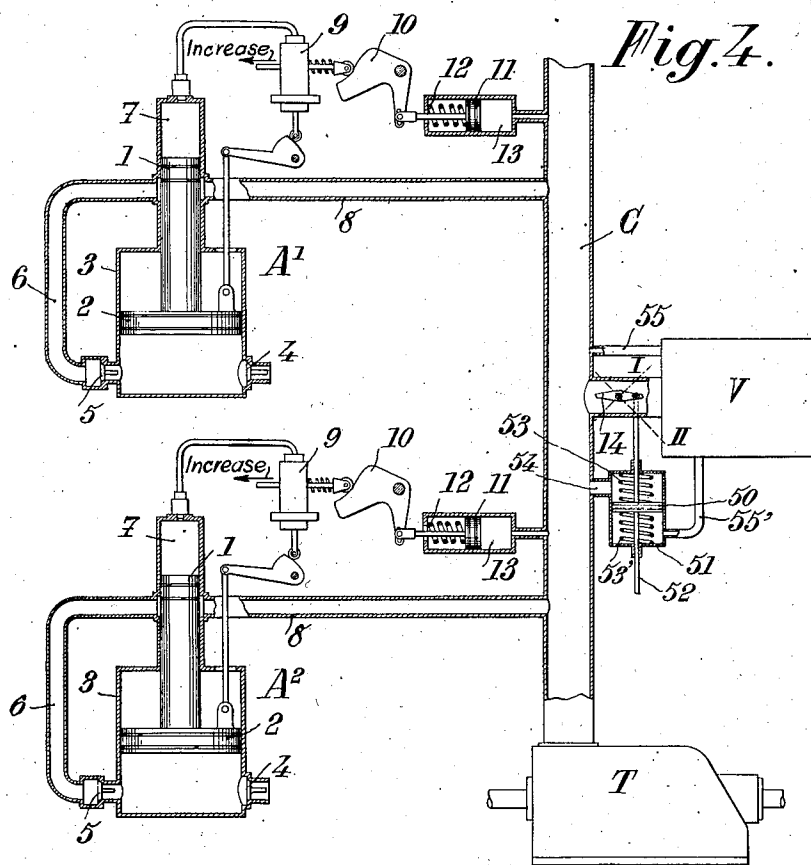
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3 Sheets-Sheet 2



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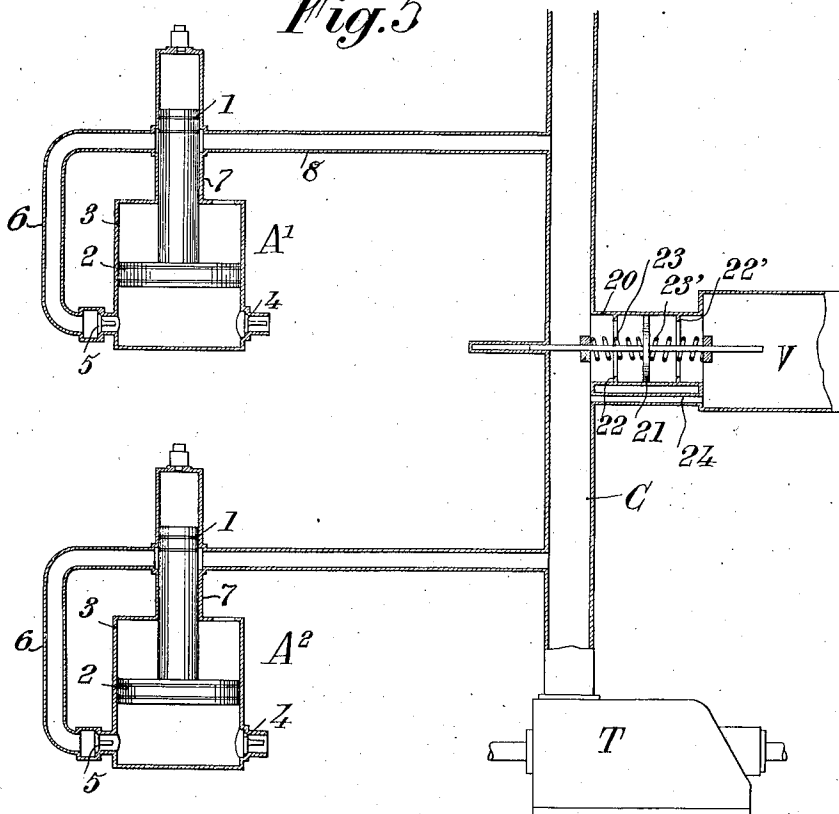
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DEVICE INCLUDING RECEIVING ELEMENTS FED BY COMPRESSED GAS GENERATORS

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3 Sheets-Sheet 3

Fig. 5



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DEVICE INCLUDING RECEIVING ELEMENTS
FED BY COMPRESSED GAS GENERATORS

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In Luxemburg January 28, 1938

14 Claims. (Cl. 60—15)

The present invention relates to devices including receiving elements fed by compressed gas generators, and it is more especially, although not exclusively, concerned, among these systems, with those in which the compressed gas is fed by a free piston generator (that is to say a compressed gas generator the piston of which moves with a variable stroke) this generator being characterized by the fact that it cannot be mechanically synchronized or regularized by means of a fly-wheel.

The object of the present invention is to provide a system of this type which is better adapted to meet the requirements of practice than those used for this purpose up to the present time.

According to an essential feature of the present invention, the system of the type above referred to includes at least one receiving element fed with compressed gas by at least one generator connected to said receiving element through a discharge manifold, at least one cushioning or absorbing chamber connected to said manifold, and means, interposed between said manifold and said cushioning chamber, for temporarily and at least partly bringing out of action said absorbing chamber in the case of variations of the mean pressure in said manifold which are of relatively high amplitude.

According to another feature of the present invention, the compressed gas generator is a free piston auto-generator, that is to say a free piston machine in which at least a portion of the compressed gas is utilised for the scavenging and feeding of the motive portion of the system, and, in order to absorb, up to a point, the pressure variations in the discharge conduit and in the scavenging air reservoir of said generator, I provide, between these two spaces, at least one movable wall capable of moving, under the effect of said pressure variations, in such manner as to produce opposed variations of the volumes of said spaces.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is a diagram illustrating the operation of a system of the kind with which the present invention is concerned;

Fig. 2 is a similar diagram corresponding to another system;

Fig. 3 is a similar diagram corresponding to a system according to the invention;

Fig. 4 is a diagrammatic sectional view of a first embodiment of a system made according to the present invention;

Fig. 5 is a similar view of another embodiment of the invention;

Fig. 4' shows a modification of the arrangement of Fig. 4;

Fig. 6 shows a modification of some elements of the system of Fig. 5.

In the following description, it will be supposed that it is desired to provide a system including at least one receiving machine, such as a turbine T, fed with compressed gas by at least one generator, or, preferably, several free piston generators such as shown at A¹ and A², said generators being connected to the turbine through a common manifold C.

Generators A¹ and A² feed gas under pressure during only a portion of their period of oscillation, so that, as a rule, it would be advisable if convenient to adjust these generators in such manner that their discharge periods are substantially equidistant, in order to avoid sudden variations of pressure in said manifold C.

However, it may happen that, for accidental causes, such as variations of one of the factors of operation, one of these generators has its working conditions modified. In this case, there are, for generators A¹ and A², common discharge periods during which instantaneous over-pressures occur, which are advantageously to be absorbed, at least partly, these over-pressures averaging, for instance, half an atmosphere.

On the other hand, if I choose, as factor for regulation of the power of generators A¹ and A² (as it is advantageous to do) the variations of mean pressure in manifold C, corresponding to variations of load of turbine T, it is of advantage to have these variations (which may be as high as several atmospheres) take place as rapidly as possible.

Now, the simultaneous obtainment of these two conditions would call for contradictory characteristics of the volume of manifold C.

As a matter of fact, if this manifold is made of considerable volume (case of the diagram of Fig. 1) the instantaneous pressure variations are absorbed in a satisfactory manner but the passage from a mean pressure p_1 to a mean pressure p_2 will call for a relatively long time, which will delay the regulation of the generators the more as the variation of mean pressure that is considered is more important.

On the contrary, if said manifold is made of a smaller volume (case of the diagram of Fig. 2)

the final pressure p_2 is indeed obtained after a time interval t_2 smaller than t_1 , but the instantaneous pressure variations keep an amplitude that is hardly admissible.

According to the present invention, these two conditions can be complied with simultaneously in the following manner:

On the one hand, I provide, in shunt with manifold C, at least one cushioning chamber V, capable of absorbing, at least partly, and temporarily, those of the mean pressure variations which are of little amplitude and result, in particular, from a bad phase interval between generators A^1 and A^2 .

On the other hand, I provide means for bringing out of action this cushioning chamber, temporarily and at least partly, in the case of mean pressure variations of large amplitude, that is to say variations which would oppose a good regulation of said generators.

The pressure variations in manifold C corresponding to a variation of the load of turbine T, will then follow a law corresponding to the diagram of Fig. 3 and the characteristics of which are the following:

When the mean pressure is p_1 , chamber V acts in order to absorb the variations of the instantaneous pressure. As soon as the load of the turbine varies, said chamber is insulated, or separated, from manifold C, so that the instantaneous pressure variations again assume their own amplitude, but the new pressure p_2 is obtained in a time t'_2 which permits a quick regulation.

When chamber V is brought back into action, after time t'_1 , these instantaneous pressure variations are again absorbed by the new mean pressure p_2 which exists in manifold C.

I will first describe how generators A^1 and A^2 are made.

Their general structure may be of any kind, either conventional or not. For instance, as shown by the drawings in a diagrammatic manner, they include a driving piston 1 rigid with a compressor piston 2 movable in a cylinder 3, said piston drawing in air from the atmosphere through a valve 4 and discharging it, through a valve 5 and a conduit 6, into a driving cylinder 7 from which the gaseous mixture under pressure is fed, through a pipe 8, corresponding to each generator, into a common manifold C.

These generators are provided with a device for regulating their working as a function of the mean pressure in said manifold C. This regulating device is made in any suitable manner, either conventional or not. For instance, as shown by Fig. 4, the discharge of the injection pump 9 of these generators is regulated through a cam 10 of suitable shape, controlled by a piston 11, movable against the action of a spring 12 in a cylinder 13 in which the pressure is equal to said mean pressure. The whole is arranged in such manner that the discharge of pump 9 increases simultaneously with this mean pressure.

Concerning now the means to be provided for preventing chamber V from retarding the regulating action of mean pressure variations in manifold C, they can be constituted, for instance, according to one of the arrangements which will be now described.

According to the first of these arrangements, which is shown by Figs. 4 and 4', chamber V and manifold C are caused to coact directly with one another, and I provide, between these two elements, at least one adjustable shutter, such for instance as shown at 14, which is controlled in

such manner that, by a device the displacements of which correspond to variations of the mean pressure, when said mean pressure changes (generally, as it will be hereinafter supposed, as a result of variations of the working conditions of turbine T) the section of flow between chamber V and manifold C is varied, being eventually reduced to zero.

In particular, according to the embodiment illustrated by Fig. 4, I make use of a movable partition, consisting, for instance, of a piston 50 movable in a cylinder 51, upon the respective faces of which the variations of the mean pressure in manifold C act after different time intervals.

In this embodiment, shutter 14 is connected to the rod 52 of said piston, which is subjected to the action of springs 53 and 53' adapted to bring it back into an intermediate position.

The ends of cylinder 51 are connected respectively to manifold C through a conduit 54 of large section and to chamber V through a calibrated conduit 55', said chamber being itself connected to said manifold through a calibrated conduit 55.

With such a device, any sufficiently strong variation of the mean pressure in manifold C will produce a displacement of piston 50 which brings shutter 14 into the closing position I or into position II, according as there is a reduction or an increase of the mean position. This shutter will then remain closed until the pressures on the respective faces of said piston are again balanced through conduits 55 and 55'.

According to another embodiment of the invention, illustrated by Fig. 4', shutter 14 is controlled through a centrifugal device operated in accordance with the working of turbine T.

In this case, preferably, the variations of large amplitude in the working conditions produce the full closing of shutter 14, the latter remaining closed until, the regulation having been effected, the turbine is again working under normal conditions corresponding to a new value of the mean pressure in manifold C.

It is possible, for instance, for this purpose, to connect shutter 14, through the intermediate of a rod 15 and a lever 16, with a centrifugal device 17 the movable sleeve of which carries a collar 18 adapted to coact with a fork 19 provided at the end of said lever 16, the whole being arranged in such manner that, when said collar moves on one side or the other of its mean position (said mean position corresponding to normal running of the turbine and to full opening of shutter 14), said shutter comes into position I or position II, according as the speed of turbine T increases or decreases.

It should be noted that, as a rule it is advantageous to leave a certain play between collar 18 and fork 19, this play corresponding to small variations of speed of the turbine for which it is not necessary to act on the generator regulating system.

The operation of such a device takes place as follows:

Every time there is a variation of some importance of the load of turbine T, that is to say a temporary perturbation of the working of said turbine, chamber V is separated from manifold C. When a final regulation of generators A^1 and A^2 has been obtained, turbine T comes back to normal working conditions, producing the opening of shutter 14, and consequently a partial absorbing of said mean pressure variation. From this time on, chamber V, which is at a pressure equal

to the stabilization value of the mean pressure, will be capable of again ensuring an absorption of small variations of the instantaneous pressure.

In the embodiment illustrated by Fig. 5, the means above mentioned are made in a different manner. In this case, chamber V and manifold C no longer cooperate directly together but there is interposed between them a structure including, for instance, a chamber 20 of cylindrical shape which may constitute at least a portion of chamber V and serves to connect it to said manifold, and a movable partition of low inertia, such for instance as a membrane or better a piston 21, capable of moving, between abutments 22 22', against the action of springs 23 and 23' which tend to return it to its intermediate position.

Preferably, the strength of springs 23 and 23' is relatively low so that the instantaneous variations of pressure, which, for instance, average half an atmosphere, are sufficient for displacing said piston 21 as far as its end positions.

Thus, the displacements of piston 21 will be limited for important variations of the mean pressure in manifold C, corresponding to the piston being brought into contact with pieces 22 and 22', which separates chamber V from manifold C, and permits of a new value of the mean pressure being established in said manifold as above explained.

It should be noted that, advantageously, the amplitude of the maximum displacements of piston 21 from its position of equilibrium is independent from the value of the mean pressure in manifold C. For this purpose, for instance, said manifold communicates with chamber V through the intermediate of a conduit 24 which is preferably of reduced section, so that the variations of mean pressure in manifold C take place but gradually in chamber V (curve *a* of the diagram of Fig. 3).

According to still another embodiment of the invention, illustrated by Fig. 6, I make use, for controlling the displacements of piston 21, of a servo-motor, for instance a hydraulic one, responsive to variations of relative pressure between manifold C and chamber V.

Advantageously, this servo-motor is made as follows:

I couple with piston 21 a balanced piston 25 toward one or the other face of which a liquid under pressure can be fed through a distributor 26.

Said distributor is controlled by a balanced piston 27 one of the faces of which is subjected to the action of the pressure in manifold C through a conduit 28, and the other face of which is subjected to the action of the pressure in chamber V through a conduit 29, the whole being arranged in such manner that the increases of instantaneous pressure in manifold C produce, through the intermediate of the servo-motor, a displacement of piston 21 tending to increase the volume of said manifold.

I connect the end of cylinder 20 with manifold C through a conduit 24 by means of which it is possible gradually to obtain the equality of the pressures on the respective faces of piston 21, and, furthermore, through the medium of conduit 29, on the respective faces of piston 27.

Whatever be the particular embodiment that is chosen, I obtain a generator-turbine system the operation of which results sufficiently clearly from the above description for making it unnecessary to give further explanations. Furthermore, this device has, among other advantages,

that of practically protecting the turbine against injurious overpressures resulting from a bad difference of phase between the cycles of the generators, while making the generator regulating system responsive to low variations of mean pressure.

It is further pointed out that the means for regularizing the discharge pressure of an autogenerator, instead of being applied to a group of generators, might be applied to a separate autogenerator.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the appended claims.

What I claim is:

1. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding fluid intermittently to said machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, and pressure responsive means for temporarily and at least partly bringing said regulating structure out of action in response to pressure variations in said manifold exceeding a predetermined value.

2. A system of the type described, which comprises, in combination, a receiving machine, at least two free piston generators for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, and means, responsive to pressure variations in said manifold exceeding a given value, for bringing said regulating structure at least partly out of action temporarily while said pressure variations take place.

3. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding fluid intermittently to said machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, valve means between said manifold and said chamber, and means, responsive to differences of pressure between said manifold and said chamber exceeding a given value, for actuating said valve means so as temporarily and at least partly to cut off the connection between said manifold and said chamber under the effect of pressure variations in said manifold exceeding a predetermined value.

4. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, valve means between said manifold and said chamber, a cylinder connected at one end to said manifold and at the other end to said chamber, a piston in said cylinder subjected to the opposed actions of the pressure in said manifold and the pressure in said chamber, and means for coupling said valve means with said piston

so that said valve means are at least partly closed when a sudden pressure variation occurs in said manifold.

5. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a conduit of large section extending between said manifold and said chamber, a conduit of small section extending between said manifold and said chamber, valve means mounted in said conduit of large section, a cylinder connected to said manifold at one end and to said chamber at the other end, a piston in said cylinder subjected to the opposed actions of the pressure in said manifold and the pressure in said chamber, and means for coupling said valve means with said piston so that said valve means are at least partly closed when a sudden pressure variation exceeding a given value occurs in said manifold.

6. A system of the type described, which comprises, in combination, a receiving machine, at least two free piston generators for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, means responsive to pressure variations in said manifold for regulating said generator, a pressure regulating structure forming a chamber connected to said manifold, and means, responsive to sudden pressure variations in said manifold exceeding a predetermined value, for bringing said regulating structure at least partly and temporarily out of action while said sudden variations take place.

7. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a passage of relatively large section between said manifold and said chamber, a movable wall forming a partition in said passage, and abutment means for limiting the displacements of said wall, so as to separate said chamber from said manifold and to stop pressure transmission from one to the other when sudden pressure variations exceeding a predetermined value occur in said manifold.

8. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a passage of relatively large section between said manifold and said chamber, a piston movable in said passage, spring means for urging said piston toward an intermediate position, abutment means for limiting the displacements of said piston in both directions, so as to stop transmission of pressure variations from said chamber to said manifold and inversely when sudden pressure variations exceeding a predetermined value occur in said manifold, and means for gradually equalizing the respective pressure variations in said chamber and said manifold.

9. A system of the type described, which com-

prises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a conduit of relatively large section extending between said manifold and said chamber, a piston movable in said conduit, spring means for urging said piston toward an intermediate position in said conduit, abutment means for limiting the displacements of said piston in both directions, so as to stop transmission of pressure variations from said chamber to said manifold and inversely when sudden pressure variations exceeding a predetermined value occur in said manifold, and a conduit of relatively small section connecting said manifold with said chamber for gradually equalizing the respective pressure variations in said chamber and said manifold.

10. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said receiving machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a cylinder connected at one end with said manifold and at the other end with said chamber, a passage opening into said manifold and forming at least a part of said chamber, a piston movable in said passage, servo-motor means for controlling the position of said piston, and a piston slidable in the first mentioned cylinder for controlling said servo-motor means.

11. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding gas under pressure intermittently to said machine, a manifold connecting said generator with said receiving machine, a pressure regulating structure forming a chamber connected to said manifold, a passage connecting said chamber with said manifold and forming at least one part of said chamber, a piston movable in said passage, servo-motor means for controlling the position of said piston in said passage, means operative by the difference between the pressures in said chamber and said manifold, respectively, for operating said servo-motor means, and means for gradually equalizing the pressures in said manifold and said chamber, respectively.

12. A system of the type described, which comprises, in combination, a receiving machine, at least one generator for feeding fluid under pressure to said machine, a manifold connecting said generator with said receiving machine, means responsive to variations in the pressure in said manifold to regulate said generator, a pressure regulating structure forming a chamber connected to said manifold, and pressure responsive means for temporarily and at least partly bringing said regulating structure out of action in response to pressure variations in said manifold exceeding a predetermined value.

13. A system of the type described which comprises, in combination, a receiving machine, at least one generator for feeding fluid under pressure to said machine, said generator having a variable output, a conduit connecting said generator with said receiving machine, means forming a chamber constituting a pneumatic cushion communicating with said conduit and capable of

damping variations of pressure in the conduit, and means responsive to sudden increase and decrease in a variable selected from the group consisting of the speed of the receiving machine and the pressure in the conduit to render said chamber inoperative, said last means being inoperative when said variable is substantially constant, whereby variations of pressure in said conduit due to variations in said variable are increased.

14. A system of the type described which comprises, in combination, a receiving machine, at least one generator for feeding fluid under pressure to said machine, said generator having a variable output, a conduit connecting said generator with said receiving machine, means form-

ing a chamber constituting a pneumatic cushion communicating with said conduit and capable of damping variations of pressure in the conduit, means responsive to sudden increase and decrease in a variable selected from the group consisting of the speed of the receiving machine and the pressure in the conduit to render said chamber inoperative, said last means being inoperative when said variable is substantially constant, whereby variations of pressure in said conduit due to variations in said variable are increased, fuel supply means for said generator, and means responsive to variations in the pressure in said conduit to control said fuel supply means.

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