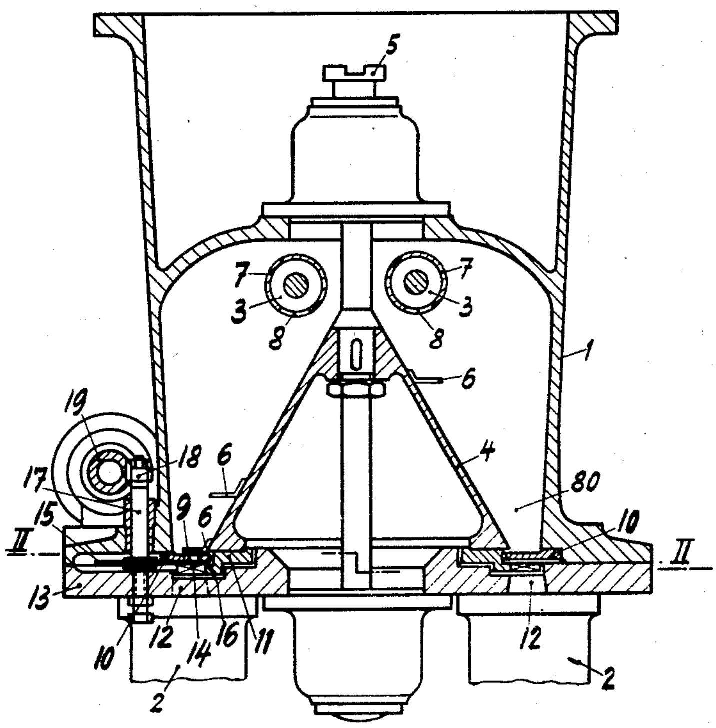
June 4, 1935. H. HOLZWARTH 2,003,293

EXPLOSION CHAMBER

Filed Aug. 17, 1932 5 Sheets-Sheet 1

Fig. 1



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EXPLOSION CHAMBER

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Fig. 2

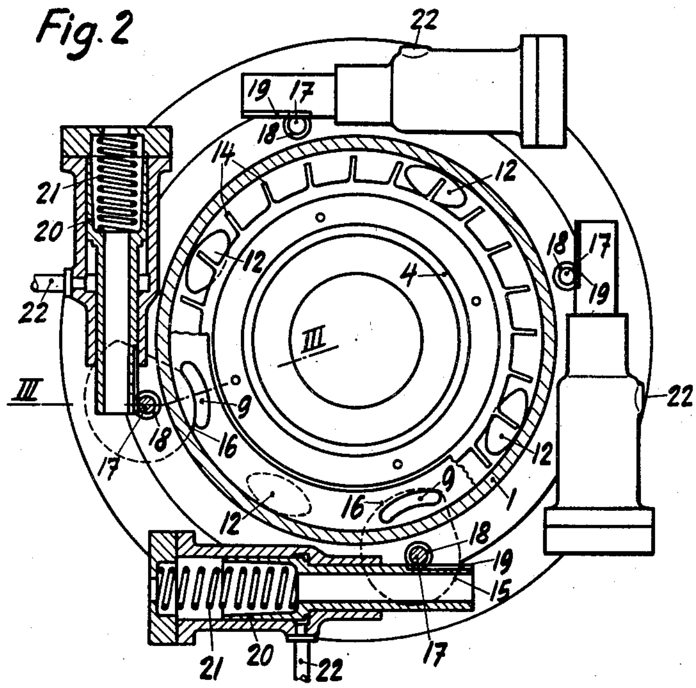
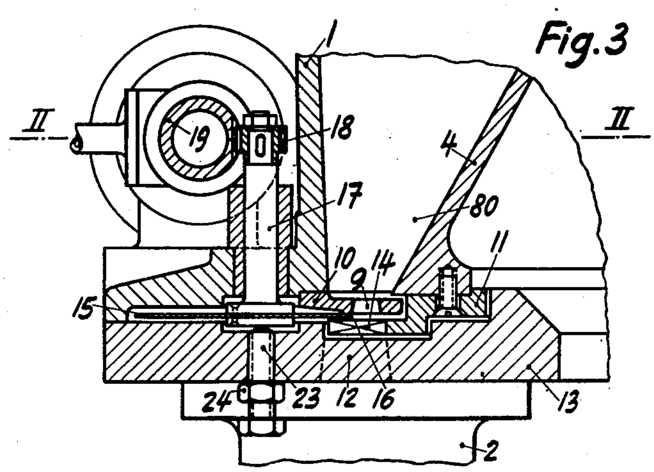


Fig. 3



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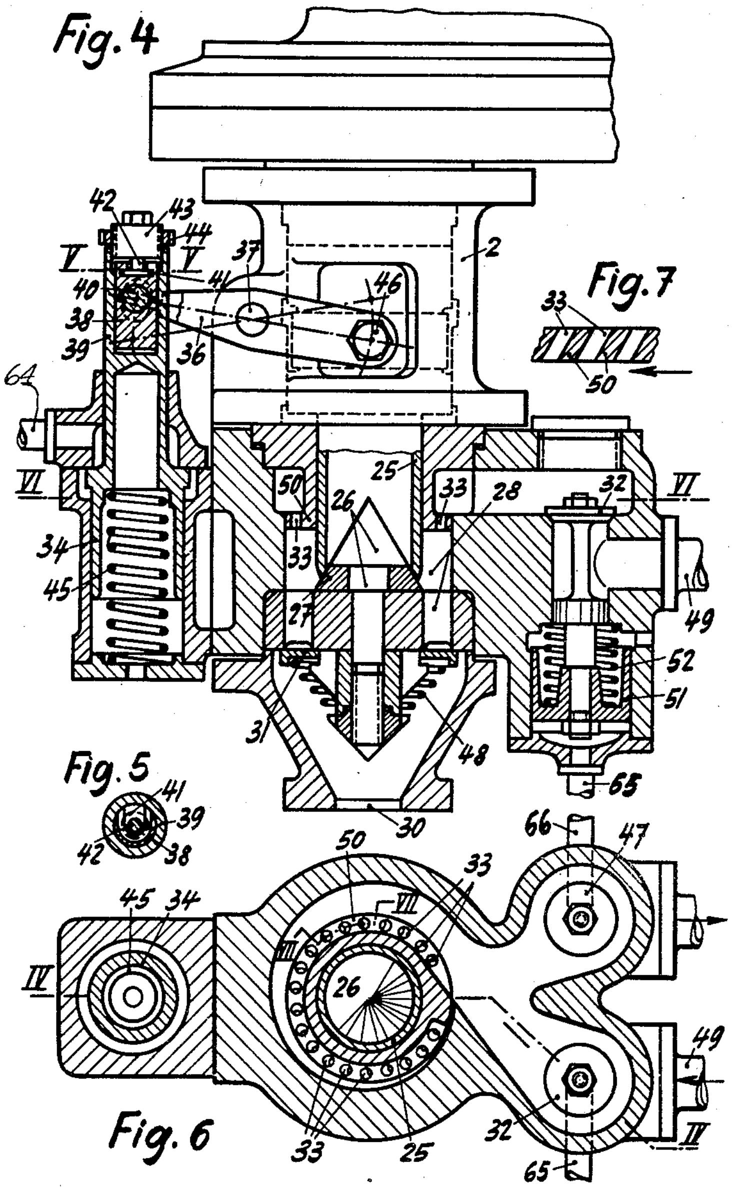

Fig. 4 Fig. 5 Fig. 6 Fig. 7

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EXPLOSION CHAMBER

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Fig. 8

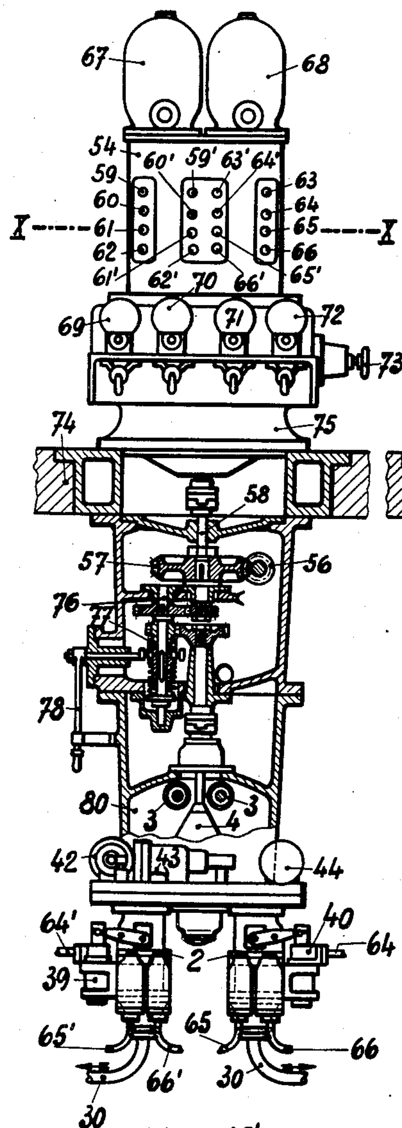
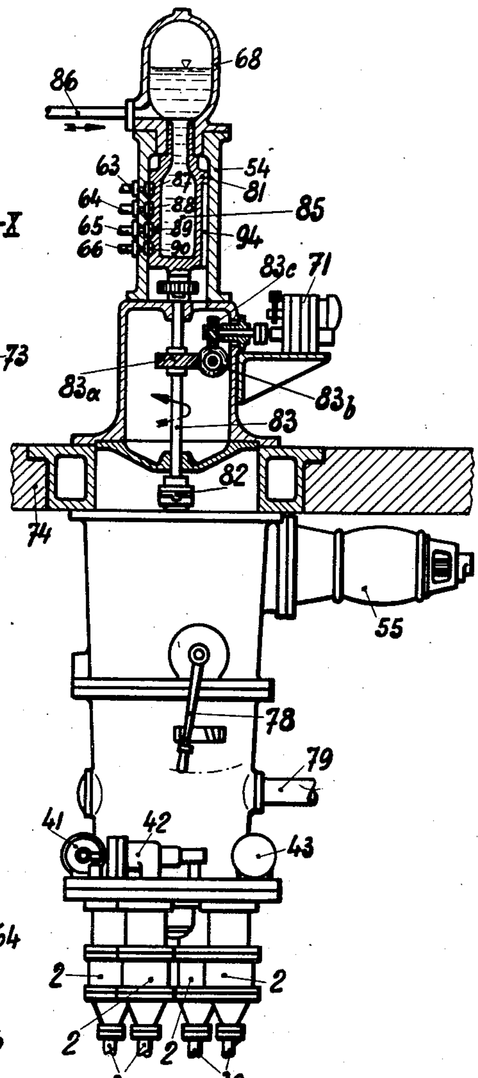


Fig. 9



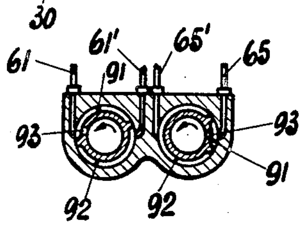


Fig. 10

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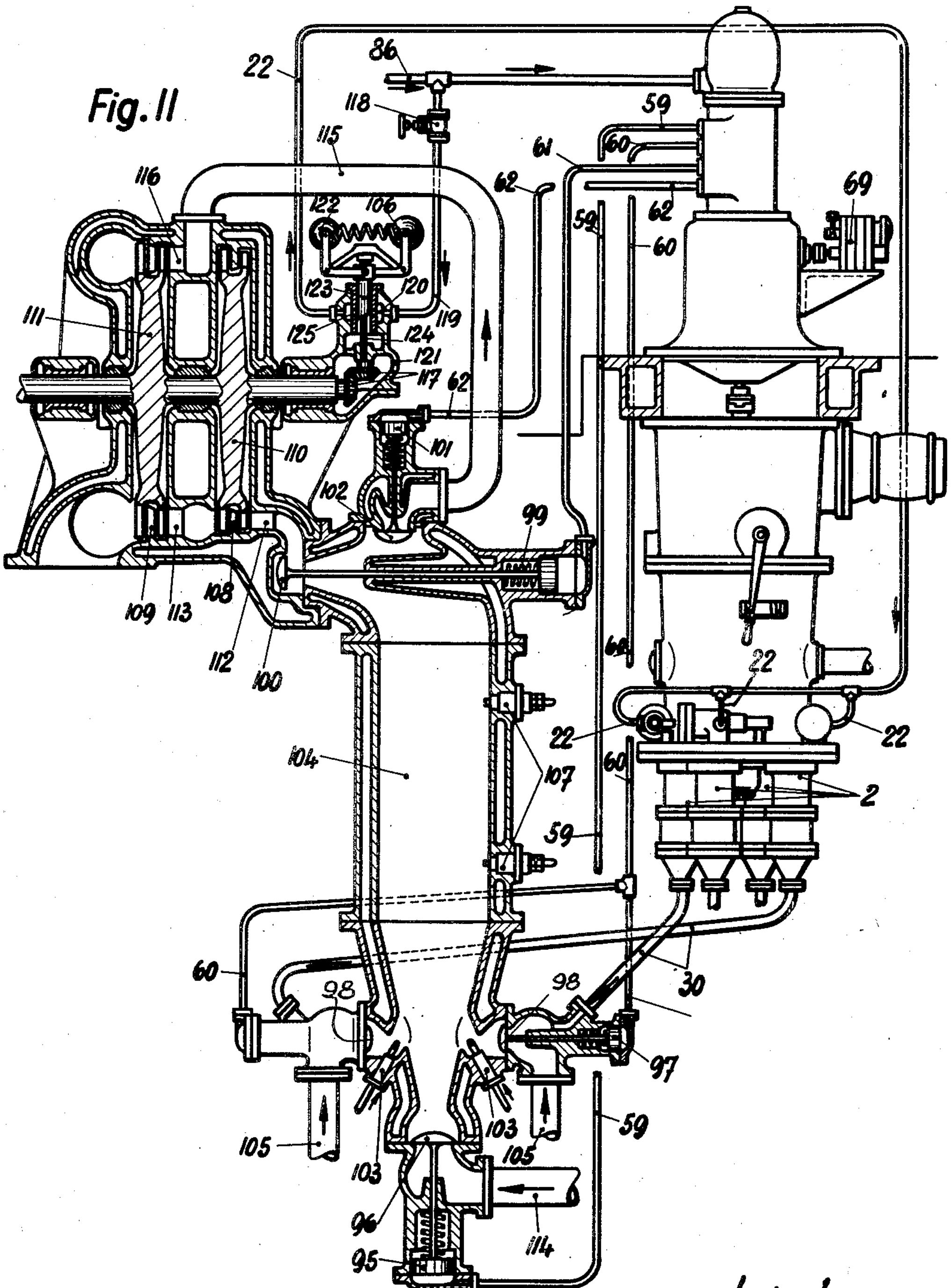
Fig. 11



Inventor

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Patented June 4, 1935

2,003,293

UNITED STATES PATENT OFFICE

2,003,293

EXPLOSION CHAMBER

Hans Holzwarth, Dusseldorf, Germany, assignor to Holzwarth Gas Turbine Co., San Francisco, Calif., a corporation of Delaware

Application August 17, 1932, Serial No. 629,218
In Germany August 19, 1931

35 Claims. (Cl. 60—41)

My invention relates to an apparatus for charging explosion chambers with pulverulent fuel and more particularly to an apparatus for measuring and diluting the pulverulent fuel in connection with a suitable control of the apparatus, the apparatus being especially suited for charging explosion chambers as used with explosion turbines.

In the development of an apparatus for operating explosion chambers, particularly for combustion turbines, with pulverulent fuels and more especially with coal dust, many and various problems present themselves and many and various conditions arise which have to be satisfied by the method and the apparatus chosen, in order that combustion of the kind referred to may proceed in an undisturbed manner and with the requisite degree of reliability. In the first place, problems arise directly from the properties of coal dust itself. Coal dust has the property of caking together into hard aggregates or lumps under the influence of the slightest degree of mechanical pressure and of tenaciously maintaining this condition. Consequently any method of introducing coal dust into the explosion chamber and of regulating it (for obviously coal dust, like any other fuel, must be supplied in quantities regulated to suit the demand on the output of the explosion chamber) in which the coal dust is subjected to the effects of such mechanical forces is ipso facto unusable. Clearly recognizing the detrimental effect of this property of coal dust on the working of explosion chambers, I have already suggested making the mixture of coal dust and air to be introduced into the chambers by repeating the dilution with air of the quantities of coal dust to be introduced. This repeated dilution affords the possibility of disintegrating, by means of the supplementary current of air, any aggregates of coal dust which may not have been broken up in the first mixing. It is now necessary to discuss what special conditions have to be fulfilled and what particular measures must be adopted, in accordance with the present invention, in order to fulfil these conditions. In this connections it has been found preferable to divide off a quantity of coal dust and then to mix it with a certain quantity of air. The mixture of coal dust and air, already brought, in this manner, into a state of flow, is then subjected to the action of another current of air, the current of diluent air being applied in the periodically actuated valve which admits the ignitable (i. e. already preformed) mixture of coal dust and air, in rythmic sequence, into the explosion chamber. Both in the actual separation of the coal dust from the supply of coal dust and in the first mixing of air with the quantity of coal dust divided off every effort must be made to carry out these operations without exerting any mechanical force on the dust. It is an object of the present invention to provide a solution to this problem. In solving it, however, it is necessary not to lose sight of the fact that, besides the conditions pertaining solely to the science of fuels, there are also conditions connected with the science of turbines that have to be fulfilled, these latter having their specific origin in the preferred application of coal dust fired explosion chambers for the operation of combustion turbines. I will now explain more particularly in what these problems of the turbine art severally consist and to what extent the solutions provided by the present invention fulfil all the conditions based on the science of turbines.

As has already been mentioned, the main problem consists in dividing off from the supply, or store, of coal dust those quantities of coal dust which, in one working cycle of the explosion chamber, have to be introduced into the latter mixed, or diluted, with the quantity of air requisite for ignition, the difficulty being to effect the dividing operation without any mechanical forces acting on the coal dust. Now it has already been mentioned that methods of operating explosion chambers with pulverulent fuels are known in which the pulverulent fuel is divided up by a sluice-like device, mixed with air and conveyed as a mixture of coal dust and air to the controlled inlet valve at the explosion chamber. In this process the sluice, has been used to divide the given quantity of fuel from the supply, while the controlled inlet valve at the explosion chamber functioned principally to control the aeriform constituent of the mixture; for instance, the air supply was opened and set going before the introduction of the mixture, after which there were introduced into this air supply the quantities of pulverulent fuel required for the charging of the explosion chamber. By these means advantages were gained as regards introducing the mixture without any possibility of the solid particles of fuel either separating out or agglomerating. The sluice used to divide off given quantities of fuel, had a charge space which was variable in size, so as to divide off the different quantities of fuel released in accordance with the varying circumstances of output or of regulation. Now it has been found that, owing to these changes in the charge space, which, of course also occur even when coal dust is collected therein, mechanical effects are set up in the said dust, thus giving rise to the danger of its caking together. It is, therefore, another object of the invention, to solve the problem of varying the quantities of coal dust while avoiding the risk of mechanical action on the coal dust while at rest. The solution to this problem according to the invention consists in this that the coal dust which is to be delivered to the sluice is delivered thereto under a controlled rate of flow. Thus, regulation of the charge is replaced by throttle control, which has the advantage that the coal dust is on the move when it is going through the regulating devices, so that such mechanical action as is unavoidable, nevertheless, is without effect. In furtherance of this idea, therefore, the coal dust taken from the storage receptacle is preferably kept in motion by screw conveyors and agitating drums and, before being introduced into the sluice is carried through openings of varying cross-section, after which the actual transfer of dust into the sluice may advantageously be effected by means of a bucket wheel.

Devices for effecting this regulation have two fundamental conditions to fulfil. No resistance to motion must oppose the flow of the coal dust and it must not be subjected to changes of direction, for otherwise the coal dust would cake together and block up the passages. On this account all valve-like devices for regulating the rate of flow are definitely excluded. There is, moreover, the further requirement that the regulating member, although it has to move about in the coal dust, must not set up any substantial frictional resistance, more especially there should be no tendency for the moving part to stick or to erode in the guide. For this reason all slides or gate-like devices are cut out as being unsuitable.

According to the invention a device for regulating the rate of flow which satisfies all requirements consists of a disc arranged between the store of coal dust and the place where the coal dust is to be used, the position of the peripheral edge of this disc being variable with respect to an opening and the flat of the disc resting, preferably under pressure, against the wall in which the opening is located. This arrangement leaves the direction of the current of coal dust and air substantially unchanged. Apart from that resistance to motion which is essentially and unalterably associated with the throttling action, no other resistance to motion exists. There are no parts which tend to become eroded, since the movements of the peripheral edge of the disc relatively to the opening are very slow and take place without setting up frictional resistance. Preferably the disc is arranged to be rotatable. If its edge runs like an Archimedian spiral while the opening is shaped like a section of a ring concentric to the axis of the disc, rotation of the disc will bring about the desired changes of crosssection in proportion to the amount of rotation so that experimental adjustment of the whole assembly is no longer necessary. Many and various ways may be adopted for causing the disc to bear under pressure against the wall containing the opening. The disc itself may be made resilient or springy throughout. On the other hand the disc may be made stiff and in this case it is pressed by resilient means, for instance, by a spring, against the wall containing the opening. Preferably the pressure used for tightening is variable in order to allow for wear and for gradual loss of elasticity. Since the main determining factor for variation of the rate of flow is its adaptation to the output requirements or, in other words, to the state of regulation or governing of the turbine it is preferable that the adjustment of the disc be effected automatically in dependence upon the governor.

The coal dust, thus controlled as to quantity and fed to the sluice must now be mixed periodically with air. Such mixing has to be affected in a closed sluice chamber, for in the absence of this precaution, there is a possibility of the compressed air used for mixing escaping into the store of coal dust without performing its intended mixing function. The shutting off of the sluice chamber and, consequently, the opening thereof to the store of coal dust must take place periodically, in rhythm with the working cycle of the explosion chamber. In connection with this periodic opening and closing of the sluice chamber for the regulated supply of coal dust thereto there arise certain definite conditions associated with the science of turbine operations, as mentioned in the earlier part of this specification. In order that these conditions may be more clearly understood, the conditions prevailing in reciprocating or piston internal combustion engines will first be considered by way of comparison. If in a piston internal combustion engine the individual phases of a working cycle be expressed as fractions of a revolution of the crank it is apparent that like phases remain alike inter se even at different speeds of rotation. For this reason the supply of fuel, expressed as fractions of a crank revolution must be maintained constant. Therefore, changes in the actual start and finish of delivery by the supply member used to introduce the fuel, when referred to the number of revolutions of the crankshaft, are determined only by the amount of fuel to be introduced into the combustion chamber.

The conditions prevailing in combustion turbines are quite different. If, in a combustion turbine with a control shaft drive the rotary speed of which is, as usual, independent of the rotary speed of the turbine, the output of the turbine be regulated by varying the number of cycles, it follows that, in spite of the variation in the number of cycles or which amounts to the same thing, in the number of revolutions of the control shaft, the individual phases of a working cycle, with suitably interposed pauses of given length, must be maintained absolutely constant, independently of the number of revolutions of the turbine shaft or of the control shaft, since the time these phases take is, like that of all physico-chemical phenomena, predetermined and unchangeable. If the phases, to correspond to the conditions prevailing in reciprocating internal combustion engines, be expressed as fractions of a revolution of the control shaft, they are in nowise equal inter se at different speeds of the control shaft. Thus it is that the fuel delivery, treated as an absolute value appears as a phase which is always the same but when measured in fractions of a control shaft revolution appears to be a variable quantity; its starting and finishing points, in respect of time, must, therefore be co-ordinated in a definite manner with the regulating conditions of the turbine.

With regard to the foregoing references to fuel delivery it is, as already stated, necessary, when pulverulent fuels are used, to distinguish between two devices for delivering the fuel. The first of these devices consists of a sluice-like member for dividing off given quantities of fuel from the fuel store or supply. In this member there is invariably added to the mass of fuel divided off a given quantity of air which facilitates delivery of the mixture to the second device. This second device is arranged directly on the explosion chamber or explosion turbine and consists of a controlled inlet valve in which, as a rule, there is added to the rich mixture of coal dust and air formed in the sluice, the quantity of diluent air necessary to form the ignitable mixture. It is the function of this controlled inlet valve to introduce the ignitable mixture of coal dust and air into the explosion chamber at predetermined moments.

Thus, if the starting and finishing points of fuel delivery have to be arranged in a given manner with respect to the different regulating conditions in the turbine, this requirement primarily applies only to the controlled inlet valve for the ignitable mixture, one of such valves being associated directly with each explosion chamber. To adopt the control of this and the other valves of the explosion chamber, more especially the scavenging air valves, nozzle valve and outlet valve, to the varying conditions of regulation in the predetermined manner, is extraordinarily difficult if mechanical means are employed and it can only be done by means of highly complicated devices involving considerable back pressures on the regulator or governor and demanding a governor of correspondingly large dimensions. In recognition of this fact, the control of the valves has, from comparatively early times been effected hydraulically. With this method of control, the control is accommodated to the most diverse conditions of regulation by means of a rotating distributor for the pressure medium, the member which sets up the controlling impulses being provided with devices for varying the degrees of advance or retard of its effective control points relatively to the movement which effects the periodic actuation of the valves as explained in detail in my copending application Serial No. 570,106.

Now the present invention is based on the knowledge that when the sluice-like member used to divide off given quantities of coal dust is hydraulically actuated, it is possible to vary the starting point and finishing points of this separation of the requisite quantity of coal dust in accordance with the temperal disposition of the introduction of the mixture of coal dust and air into the explosion chamber and to effect such variation in the same simple manner as has already been done for the valves of the said explosion chamber. This excludes the possibility of the coal dust sluice being actuated in such false relationship to the actuation of the inlet valve on the explosion chamber, when such last named actuation has been timed to suit a new condition of regulation, that the valve opens, or closes, before the sluice has effected the dividing operation or before separation of the required quantity of coal dust is completed. However, if an attempt were made to employ mechanical means for adapting the working of the coal dust sluice of each combustion chamber to the various regulating conditions, such an attempt would be doomed to failure owing to the utter inapplicability of mechanical devices.

Thus, according to the present invention, it is proposed, in the device for the periodical introduction of pulverulent fuels into combustion chambers—more especially for combustion turbines in which, in order to cut off the delivery of fuel from time to time, a fuel delivery pipe rests against an opposing member while for intermittently opening the fuel delivery the two parts are separated from each other—to operate the moving parts of the device by means of a power piston, influenced by a pressure medium, admitted thereto in a predetermined manner.

The way in which devices of this kind work depends on the degree to which the fuel delivery pipe bears on the opposing or closure member. If the contact pressure be too great the edge of the fuel delivery pipe soon works its way into the preferably yielding closure member and so roughs up the surface of the latter, thereby giving rise to accumulations of coal dust. On the next stroke of the device, the fuel delivery pipe presses on the accumulations of coal dust thus producing lumps of coal dust that have balled and caked together and cannot be broken up again by the subsequent admission of diluting air. Such lumps therefore pass unbroken into the combustion chamber where they give rise to delayed combustion, making it impossible for the combustion to be complete. If, on the other hand, the contact pressure be too small, the sluice chamber provided for dividing off the required quantity of coal dust will not be shut off from the coal dust storage chamber, so that exact measurement of the divided off quantities of coal dust will be upset.

In furtherance, therefore, of the inventive conception one or more arrangements for setting one or more points of power application are provided between the power piston and the movable part of the device, so that the closing pressure of the said movable part can be adjusted. Preferably, two associated members of the kinematic chain which transmits power from the power piston to the movable member of the device are connected by a displaceable and adjustable slide in one of said members, which slide receives the coupling element. By shifting and adjusting this slide the point of application of the power is varied and thus the closing pressure is adjusted.

If now, following on the matter of sluice actuation which has been developed from the point of view of the turbine art, one considers the conditions under which, in the sluice chamber itself, the first mixing of the coal dust with air comes about, it becomes apparent that special measures have to be adopted to prevent the forming of lumps and clots of coal dust, such as is to be apprehended during this initial mixing. Starting again from the devices already proposed wherein the fuel to be delivered to the explosion chamber at one charge is distributed by arranging behind a cut-off chamber a filling chamber of variable size which, being regulated quite automatically from time to time in dependence upon the condition of regulation of the turbine, determines the quantity of fuel transferred to the combustion chambers, the essential feature of this distribution is to be observed in the fact that the filling or charge chamber must be completely filled with coal dust in order that its size may determine the quantity of coal dust to be used in the charge. It is also of the essence of this process that at the moment of filling this charge chamber the member which determines its size shall be movable under the influence of a suddenly changing load or condition of regulation, so that a mechanical force is applied to the charge of coal dust. This, however, leads to the formation of the objectionable clots of coal dust which are sluiced over into the pipe leading to the explosion chamber without there being any chance of their being subsequently broken up. In the proposed new process for dividing off the required quantities of coal dust according to the present invention, this danger is now finally disposed of. With this method, however, if the charge chamber were made in the way known heretofore there would be a risk of the air, admitted percussively for the delivery of the charge of coal dust present in the charge chamber acting on the charge as a whole and pushing it bodily through the closure member, which is generally made yielding, into the explosion chamber. If, however, a large quantity of coal dust is started suddenly from a state of rest to one of motion the overcoming of the process resisting such change is attended by the setting up of mechanical forces on the mass of coal being accelerated and this is undesirable as it may give rise to the formation of clots, which has been so carefully avoided before. Care must therefore be taken that, notwithstanding the sudden admission of the mixing air, which now comes within the method in question, the charge of coal dust to be admitted at one charging operation is not engaged as a whole by the air but only partially, so that, in a manner of speaking, one particle of coal dust after another is "filed" off from the mass, the air mixing only with the particles thus "filed" off. According to the present invention this new effect is obtained in a very simple manner in that the chamber which receives the divided off charge of coal dust, in the device for periodically delivering the pulverulent fuel is several times greater as regards its capacity than the chamber which takes in the charge of coal dust. This makes it possible, by filling this chamber with the mixing or delivery air to impart to the latter a velocity which gives rise to "filing off" or attrition and eddying of the "filed off" particles of coal dust before the pressure of the compressed delivery air attains the value necessary for opening the yielding closure member.

Thus at the commencement of the delivery motion the coal dust is already on the move, so that the acceleration which brings it from this state of motion into the state pertaining to delivery works out very much less than the acceleration necessary for delivering a quantity of coal dust initially at rest. As the acceleration diminishes, so also do the forces acting on the coal dust, so that the formation of clots is rendered quite impossible. If in the path of the air which carries off the coal dust there be provided openings with a direction transverse to the direction of flow and if a plurality of openings for the air be arranged in circular form one behind another, a tangential eddy or vortex action is set up which acts on the whole of the divided off charge of coal dust and dilutes it without the formation of clots; even when the eddying charging coal dust and air passes through the closure member, there is no possibility of the coal dust separating out again or clogging together. The action can be still further intensified by making the transfer passage from the air inlet valve to the openings of spiral formation, so that, before the obliquely directed openings are reached the air velocity has already attained a high value which when a vortex is formed increases the whirling tendency.

In the accompanying drawings, which illustrate, by way of example, embodiments of the invention,

Fig. 1 is a longitudinal section through an apparatus adapted for carrying out the new method of working,

Fig. 2 is a horizontal section through the device of Fig. 1, the section being taken on line II—II of that figure, and the upper half of said Fig. 2 corresponding to the position at the right of the section in Fig. 1,

Fig. 3 shows a detail of Fig. 1 to an enlarged scale, the same being a section along the line III—III of Fig. 2, so as to make clear the arrangement of the device for re-adjusting the packing or leak excluding pressure of a regulating disc, or plate.

Fig. 4 shows a longitudinal section along the line IV—IV of Fig. 6 through the sluice which comes immediately after the regulating device of Figs. 1 to 3, while

Fig. 5 is a horizontal section through the slide member of Fig. 4, the section being taken on line V—V of that figure.

Fig. 6 is a horizontal section through the sluice, the section being taken on line VI—VI of Fig. 4.

Fig. 7 is a section through the wall containing the openings, the section being taken on line VII—VII of Fig. 6.

Fig. 8 illustrates an elevation, partly in section, of the whole controlling arrangement, including two rotary oil distributors for controlling the pistons associated with the valves and other controlled parts of the plant.

Fig. 9 is a side view of Fig. 8, one of the distributors being shown in section.

Fig. 10 shows a section through the controlling device for the controlling oil of Figs. 8 and 9 along the line X—X of Fig. 8.

Finally, Fig. 11 shows a longitudinal section through a gas turbine charged according to the invention.

In Fig. 1 the numeral 1 designates a casing in which the coal dust is set in motion and from which it is fed in regulated quantities to the sluices 2. The coal dust is introduced into the casing 1 from the coal dust bunker by means of rotary worm conveyors 3. A conical drum 4, which receives its drive through 5, is provided with stirring vanes 6, for the purpose of keeping in motion the coal dust which at 8 falls out of the worm housings 7. The coal dust trickling down the drum gravitates to the base thereof and through segmental openings 9 in the bottom ring 10 of the casing 1, into the ring 11, which is divided up into cells and rotates with the drum 4. As can be seen from the upper part of Fig. 2, the openings 12 in the base plate 13, which openings lead into the sluices 2, are somewhat out of line with the segmental openings 9, so that charges of coal which have passed through the latter are carried to the sluice openings 12 by the cell walls 14 of the rotating ring 11.

Now according to the invention, the coal dust to be conveyed to the sluices 2 is conveyed to them already regulated as regards the quantity passed. In order to carry out this regulation of flow, according to the invention, there are arranged below the segmental openings 9 of the bottom ring 10, discs or plates 15 the peripheral edges 16 of which are variable with respect to the said openings 9. To this end, the plates 15 are made rotatable on pins. Each pin 17 carries at its upper end a pinion 18 meshing with a rack 19. The rack 19 constitutes an extension of a piston 20 which is influenced on one side by a spring 21 and on the other side by a pressure medium which is admitted at 22. According to the way in which this pressure medium is admitted, the setting of the peripheral edge 16 relatively to the opening 9 is varied. The peripheral edge 16 is formed according to an Archimedean spiral so that the changes in cross-sectional area of flow at the openings 9 are proportional to the rotation of the plates 15. So that there may be no possibility of the coal dust penetrating between the bottom ring 10 and the plates 15, these latter are under pressure. For this purpose the plates are made resilient and the requisite contact or packing-pressure is applied to them by pressure screws 23 (see Fig. 3) fitted adjustably on the base plate 13 and secured by lock-nuts 24. It is equally satisfactory to make the plates 15 stiff and to obtain the necessary contact pressure by means of a spring arrangement.

It has been found that the resistance of the plates 15 to turning is exceedingly small, at any rate, no greater than the resistance of the pump members employed for varying the quantity of fuel delivered when liquid fuels are used. In this way it is possible to effect regulation of the quantity flowing through from the regulator or governor, by way of the plates 15. In the manner described below this action is effected through the agency of the pressure medium, preferably oil, admitted at 22, such medium exerting greater or less pressure on the surfaces of the pistons 20, according to the state of regulation of the turbine.

Now Figs. 4 to 7 illustrate the construction of the sluices 2 in detail. 25 designates the fuel supply pipe which, in a manner already proposed, rests against a closure member 26, or against a separate resilient part 27 thereof for the purpose of cutting off the supply of fuel to the dividing off chamber 28 and is withdrawn from said closure member 28 when fuel is to be supplied to said dividing off chamber. The latter is shut off by a spring annular plate 31 from the pipe 30 which leads to the controlled inlet valve arranged on the explosion chamber. As soon as the quantity of coal dust to be delivered during one working cycle of the explosion chamber has been divided off by the fuel delivery pipe 25 lifting off the closure member 27 and then coming back into contact with the same, the compressed air valve 32 opens, so that, under the influence of this compressed air which reaches the dividing off chamber 28 by way of the holes 33, the charge of coal dust present in said chamber after having been directed off from the store of coal dust in the fuel supply tube 25 is picked up with a whirling motion and, as the annular plate 31 opens, is carried as a rich mixture of coal dust and air into the pipe line 30. Now according to the invention the coal dust delivery pipe 25 is actuated by a power piston 34, which is actuated by pressure medium admitted rythmically through pipe 64 as described below. It has been stated in the introduction that with this means of actuating the fuel delivery pipe 25 the dividing off of the coal dust is co-ordinated in a very simple manner with the various conditions of regulation. Admission of the pressure medium is conveniently effected by means of a rotary distributor, hereinafter to be described.

Means are provided in accordance with the invention whereby the position of the pipe 25 with relation to the closure member 27, that is, the pressure of the pipe 25 against the member 27, may be regulated for the closed position of the pipe. This may be accomplished by making the fulcrum of the lever 36, or the points of connection of the lever with the piston 34 or the pipe 25 adjustable. In the illustrated embodiment of the invention, the point of connection of the lever 36 with the piston 34 is made regulable. Accordingly, the power piston 34 is connected with the coal dust delivery pipe 25 to be actuated, through a piston-like extension guided in the casing 2 of the coal dust sluice and a double armed lever 36 rotatably mounted at 37 in said casing 2. The slide member 38, arranged in the hollow interior of the piston-like extension 39 carries pins 40 whereby it is coupled to the forked end of the double lever 36. In a slit-like undercut recess 41 in the slide member 38 (better seen from Fig. 5) is received the pin 42 of the screw plug 43. The position of the screw plug 43 relatively to the piston-like extension 39 of the power piston 34 thus determines the position of the slide member 38 in relation to said member 39 of the power transmission and, consequently, the setting of the coal dust delivery pipe 25 relatively to the closure member 27. This setting again determines the pressure with which the sluice member 25 closes on the sluice member 27. As stated in the introduction, this closing pressure is of the utmost importance in obtaining undisturbed and accurate working of the device described. A lock nut 44 serves to fix the screw plug 43 when the latter has once been adjusted relatively to the member 39, thus maintaining the adjusted closing pressure. The spring 45, which carries the power piston 34 back to the starting position is of such dimensions that this return movement is effected with certainty and is not dependent on the resistances set up by the motion of the coal dust delivery pipe 25.

The chamber 28, which is shut off on one side by the movable fuel delivery pipe 25 and on the other side by a yielding closure member, consisting of the bottom ring 31 carried resiliently and yieldingly by a spring 48 is, in furtherance of the idea of the invention, of a capacity which is several times greater than the greatest quantity of coal dust which can be divided off into it during the longest period of opening of the fuel delivery pipe 25. This results in the following possibilities. In the path of the delivery air, which flows from the pipe line 49 through the controlled valve 32 whenever the divided off charge of coal dust is to be carried over into the pipe 30, there are interposed the openings 33 which, as Fig. 7 shows, have a direction transverse to the direction of flow. Moreover, as can be seen from Fig. 6, they are arranged one behind the other in a circle. Thus, before the air entering through the open valve 32 into the chamber 28 has reached the same pressure as it had in the pressure line 49, it has to rush through the openings 33 into said chamber in order to fill the same. In so doing it sets up, by reason of the arrangement of the openings 33, a cylindrical eddy or vortex concentric with the axis of the device, this vortex gripping the charge of coal dust lying on the bottom ring 31 and whirling it up. This whirling action continues until the diluting and delivery air has filled the whole of the chamber 28 and has finally attained the pressure at which the counter force of the spring 48 is overcome and the bottom ring 31 forced back. Still maintaining the whirling motion the charge of coal dust to be sluiced flows into the pipe 30, there being no possibility of the coal dust either separating out again or agglomerating. The action of the air vortex is still further intensified by the transfer passage from the air admission valve 32 to the intermediate wall 50 containing the openings 33 running off into a spiral, as shown in Fig. 6. In a manner known and described below the air admission valve 32 is controlled by a power piston 51 working in opposition to a spring 52, a pressure medium being admitted at a predetermined moment, through a pipe 65.

In addition to the air admission valve 32, an air discharge valve 47 is provided for relieving the chamber 28 of residues of coal dust and diluent air and preparing it for the next filling when the aforementioned operations are repeated, this valve being operated exactly in the same way as valve 32 through pipe 66.

Figs. 8 and 9 show a general arrangement of the control. First, the drawings show that the drive for the control members for the valves of the combustion chambers of, say, a combustion turbine is arranged above the coal dust distributing devices, the control members with the ignition machines being above the floor 74 and the driving means with the coal dust distributing devices below the floor. In the example illustrated two control members are arranged in parallel one beside the other in the casing 54. They receive their rotary motion from an electric motor 55 by way of a worm shaft 56, worm wheel 57, transmission shaft 58 and transmission gearing (not shown). The left hand control member, as viewed in Fig. 8 controls through the connections 59, 60, 61 and 62, the scavenging valves, the charging valves, the nozzle valves and the outlet valves of one explosion chamber and, through the connections 59', 60', 61' and 62', the corresponding valves of the other explosion chamber as shown in Fig. 11. The right hand control member controls, through the connections 63, 64, 65, and 66, the igniting gas valves or the igniting fuel pumps, the sliding pipes of the coal dust sluices, the air admission valves and the air release valves of the coal dust sluices of one chamber, while, through the connections 63', 64', 65' and 66', the corresponding valves or members of the other chamber are actuated as shown. Two air chambers 67 and 68 take care of the equalization of pressure in the oil used as the control medium. The action of the control member is described below in detail. Below the control members, or below the casing in which they are accommodated, are arranged the ignition machines (magnetos) 69, 70, 71 and 72 for the two sparking plugs of each of the two explosion chambers of a two chamber turbine. The ignition advance and retard control 73 is arranged in an easily accessible position above the floor 74. The control members and magnetos rest on a base 75 which is supported on the base plate sink into the engine room floor 74. The coupling between the moving parts above the floor and the parts below the floor is so formed that the two parts can be raised and lowered without its being necessary to get at the coupling.

The motion of the shaft 58 is transmitted through gearing 76 and an elastic coupling 77, which can be actuated by means of a handle 78, to the coal dust distributing devices which are arranged below the drive elements 55, 56, 57, 76, 77 and 78. Two conveyor worms 3 deliver the coal dust, which gravitates to them through a pipe 79, into the chamber 80 over the stirring or rouser drum 4 and through devices (see Fig. 3) for regulating the quantity flowing through, and a bucket wheel driven by the rotating rouser drum 4 the coal dust travels to the sluices 2. The pipes 30 carry the rich mixture of coal dust and air now formed to the explosion chambers of the turbine. The sluices are likewise actuated by pressure oil by means of oil actuated power pistons associated with each sluice as described below. Fig. 2 shows the pressure oil controls which actuate the sluice 2. Both figures, moreover, show the cylinders of the power piston devices which are associated with the sluices 2 for varying the quantity of coal dust flowing through.

From Fig. 9 and Fig. 10 may be seen how the controllers 54 admit periodically oil of superatmospheric pressure to the pipes 59 to 66 or relieve the oil from said pipes. Inside the housing 54 is arranged a rotary distributor 81 which is driven through the coupling 82 and the shaft 83 which shaft also drives the igniting devices 69 70, 71 and 72 by means of gears 83*a*, 83*b* and 83*c*. The oil enters the equalizer 68 and the interior 85 of the rotary distributor 81 through the pipe 86. The rotary distributor 81 has at each of the sections 87 to 90 circumferential spaces 91 and 92 as shown in Fig. 10. The spaces 91 are connected with the interior of the rotary distributor 81 through holes 93, while the spaces 92 are drained through slots 94. During one revolution of the rotary distributor 81 the pipe connections from 59 to 62, and from 63 to 66, are in turn brought into connection with the source of oil or relieved from the pressure, and in the same way the pipe connections from 59' to 62', and from 63' to 66' for the other explosion chamber. The pipes 61 and 65 of Fig. 10 lead to one explosion chamber, pipes 61' and 65' to the other.

Fig. 11 shows the action of the thus controlled oil on the different valves of a gas turbine. Section 87 of the distributor acts through pipe 59 on the piston 95 of the scavenging valve 96, section 88 through pipe 60 on the pistons 97 of the charging valves 98, section 89 through pipe 61 on the piston 99 of the nozzle valve 100 and section 90 through pipe 62 on the piston 101 of the outlet valve 102. All these valves are moved backwards by means of springs resting on the pistons as shown. The corresponding sections of the second rotary distributor (not shown in section) act in the same way through pipe 65 on the piston 51 of the valve 32, through pipe 66 on the corresponding piston of the valve 47, through pipe 64 on the piston 34 which moves the sliding pipe 25 (Fig. 4) and through pipe 63 on the device (not shown) for delivering the auxiliary igniting fuel to the injection devices 103 of Fig. 11. The timing of the ignition is changed by means of turning handwheel 73 and displacing the spiral gear 83*b* of Fig. 9 in an axial direction.

Fig. 11 shows furthermore the speed regulating device acting on the rotatable plates 15. A governor 106 is driven by the turbine itself through bevel gears 117. Oil under superatmospheric pressure, for instance from the pipe 86 supplying oil to the rotary distributor, flows through a throttling device 118 and pipe 119 to a circular recess 120 in the governor housing 121. If the speed increases the governor weights 122 fly apart and raise the sleeve 123 which is able to slide on the shaft 124. Thus openings 125 are exposed and the oil may escape from the circular recess 120. The oil pressure in this recess and in the pipe 119 goes down as not sufficient oil can flow through the throttling device 118 to replenish the oil flowing off through openings 125; in the same way the oil pressure in the pipe 22 is diminished and by this means the force counteracting the spring pressure on the pistons 20 (see Fig. 2) which move the plates 15 regulating the flow of the coal dust is reduced. For any change of the oil pressure in the pipes 22 the pistons 20 assume a predetermined position according to the characteristic of the springs 21. The power output and herewith the speed of the turbine are in this way reduced by diminishing the fuel supply. If the speed goes down openings 125 are closed, the pressure in the recess 120 and in the pipes 22 is raised and pistons 20 are moved so as to increase the flow of coal dust.

Thus a general arrangement is provided in which the pressure oil pipes 59 to 62 and 59' to 62' to the controlling members can easily be freed from air. When the air chambers 67 and 68 are lifted off the control members themselves can easily be taken out and put back again. The magnetos and ignition timing control 73 are always accessible. The driving members 56, 57, 76 and 77, which run in an oil bath and need no attention, lie directly underneath the floor and, therefore, in a place where they cause no disturbance. By operating the handle 78 the change over from ignitable fuel working to coal dust working or to coal dust and ignitable fuel working can be effected at any time, the handle being suitably connected to the regulating mechanism of the (liquid) ignitable fuel pump. By the adjustment of the lever 78 the coupling 77 may be released and in this way the transmission of the movement of the gear 76 to the shaft of drum 4 may be interrupted. As the drum 4 together with the distributing chamber 14 is now brought to rest, coal dust is no longer conducted to the sluices 2. Conversely, feed of coal dust is again begun as soon as the coupling 77 between the drum 4 and the gear 76 is again brought into engagement by reversal of the lever 78. In such condition the actuation of the sluices 2 by means of pressure oil from the distributor 54 through pipe 64 can again occur uninterruptedly. The control of the ignitable fuel itself, is known in the art. Mechanism for controlling hydraulically a liquid fuel pump is shown, for example, in Fig. 10 of applicant's copending application, Ser. No. 570,106. See also "Öl-und Gasmaschine", 1926, Julius Springer, Berlin, page 188 Fig. 197 from which the illustration in the above-mentioned application is taken. The actuation of the pump plunger of the fuel pump can be accomplished by the pressure oil in the conduit 63 controlled by the oil distributor, while the handle 78 may be connected with the mechanism which controls the quantity of fuel fed. By coupling the drive for the control members with the drive for the coal dust distributing device co-ordination of the supply of coal dust with the demand for coal dust is obtained automatically and independently of the number of working cycles taking place in the explosion chambers in any given limit of time. In the coal dust distributing devices themselves the coal dust flows naturally under gravity from one part into the other without being subjected to changes of direction. All the parts and specially all the moving parts of the coal dust distributing device are accessible on all sides, so that they can be got at directly in the event of any irregularities in the coal dust supply.

The operation of the gas turbine of Fig. 11 is as follows:

High pressure air enters the explosion chamber 104 (only one chamber has been shown) through the valves 98. A rich mixture of coal dust and air is admitted from the devices 2 into the air stream thus set up through the pipes 30. When the explosion chamber has been charged with the mixture of coal dust and charging air the valves 98 are closed and some auxiliary igniting fuel is introduced by the injection apparatus 103, which may be controlled in the manner disclosed in my copending application Ser. No. 570,106. Then ignition is effected by means of devices 107 and the mixture explodes in the closed chamber 104. After the explosion is substantially finished the nozzle valve 100 is opened and the hot gases impinge the blades of the turbine wheels 110 and 111 through nozzles 112 and 113, the gases being reversed by the stator blades 108 and 109. As soon as the pressure in the explosion chamber 104 has dropped to about the pressure of the scavenging air in the pipe 114 the scavenging valve 96 and the outlet valve 102 are opened, the nozzle valve 100 being closed. The explosion chamber 104 is thus cleansed of the remainder of the burnt gases which escape over pipe 115 and nozzle 116, impinging only the blades of turbine 111, after which a new cycle is begun.

I claim:—

1. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

2. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for automatically coordinating the rate of flow of the pulverulent fuel from said primary chamber into said duct, with the fuel demand of the explosion chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

3. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber

and means for agitating the fuel thus delivered, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

4. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber and means for agitating the fuel thus delivered, a secondary chamber, a duct between said primary and secondary chambers means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for automatically coordinating the rate of flow of the pulverulent fuel from said primary chamber into said duct with the fuel demand of the explosion chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

5. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means including openings of variable cross-section located at the base of said primary chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

6. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous deliver of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means comprising openings of variable cross-section located at the base of said primary chamber, openings of invariable cross-section arranged below said variable openings in staggered relation thereto and a rotary bucket wheel interposed between said variable and said invariable openings, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

7. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber and means in said primary chamber for agitating the fuel thus delivered, a secondary chamber, a duct between said primary and second chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means including openings of variable cross-section located at the base of said primary chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

8. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber and means in said primary chamber for agitating the fuel thus delivered, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct said rate of flow controlling means comprising openings of variable cross-section located at the base of said primary chamber, openings of invariable cross-section arranged below said variable openings in staggered relation thereto and a rotary bucket wheel interposed between said variable and said invariable openings, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

9. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said sec-

ondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means including a plurality of openings each with an associated plate adjustably movable over such opening in substantially dust-tight relationship thereto, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

10. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of puverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means comprising a plurality of upper openings each with an associated plate adjustably movable over such opening in substantially dust-tight relationship thereto, a plurality of lower openings arranged in staggered relationship to said upper openings and a rotary bucket wheel interposed between said upper and said lower openings, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

11. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means including a plurality of openings each with an associated plate movable over such opening in substantially dust-tight relationship thereto and means for shifting said plates automatically in response to varying fuel requirements in the explosion chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

12. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, means for the continuous delivery of pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means associated with said primary chamber for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, said rate of flow controlling means comprising a plurality of upper openings each with an associated plate movable over such opening in substantially dust-tight relationship thereto, a plurality of lower openings arranged in staggered relationship to said upper openings, a rotary bucket wheel interposed between said upper and said lower openings and means for shifting said plates automatically in response to varying fuel requirements in said explosion chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

13. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, a conical vaned member rotatably mounted in said primary chamber and means for rotating said conical vaned member, screw conveyor means adapted continuously to deliver pulverulent fuel on to the vaned conical surface of said conical member, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means in the base of said primary chamber below said conical member for controlling the rate of flow of the pulverulent fuel from said primary chamber into said duct, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

14. In an explosion chamber installation of the kind herein referred to, means for controlling the delivery of primary mixtures of pulverulent fuel and air to the inlet of the explosion chamber proper, said controlling means comprising a primary chamber, a conical vaned member rotatably mounted in said primary chamber and means for rotating said conical vaned member, screw conveyor means adapted continuously to deliver pulverulent fuel on to the vaned conical surface of said conical member, a secondary chamber, a duct between said primary and secondary chambers, means for intermittently admitting fuel from said duct to said secondary chamber, means in the base of said primary chamber below said conical member for automatically co-ordinating the rate of flow of the pulverulent fuel from said primary chamber into said duct with the fuel demand of the explosion chamber, means for the admixture of air with the charges of pulverulent fuel intermittently admitted to said secondary chamber, means for releasing the mixture of fuel and air from the secondary chamber and means for transferring the primary mixture so released to the point of its admission into the explosion chamber.

15. In apparatus for metering pulverulent fuel

to explosion chambers operating with combustible mixtures of pulverulent fuel and air, a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers and periodically operable timed means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, a partition including an aperture between said primary chamber and said duct a rotatably adjustable plate cooperating with said aperture and adapted, in dependence upon rotary adjustment to mask said aperture in varying degrees, means for adjusting said plate and means for discharging each fuel charge from said secondary chamber before the admission of the next fuel charge.

16. In apparatus for metering pulverulent fuel to explosion chambers operating with combustible mixtures of pulverulent fuel and air, a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers and periodically operable timed means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, a partition including an aperture between said primary chamber and said duct, a rotatably adjustable plate yieldingly pressed against said partition in a substantially dust-tight manner said plate cooperating with said aperture and being peripherally formed to mask said aperture in varying degrees dependent on its rotary adjustment means for adjusting said plate and means for discharging each fuel charge from said secondary chamber before admitting the next fuel charge.

17. In apparatus for metering pulverulent fuel to explosion chambers operating with combustible mixtures of pulverulent fuel and air, a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers and periodically operable timed, means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, a partition including an aperture between said primary chamber and said duct, a rotatably adjustable plate yieldingly and adjustably pressed against said partition in a substantially dust-tight manner, said plate co-operating with said aperture and being peripherally formed to mask said aperture in varying degrees dependent on its rotary adjustment, means for adjusting said plate and means for discharging each fuel charge from said secondary chamber before the admission of the next fuel charge.

18. In apparatus for metering pulverulent fuel to explosion chambers operating with combustible mixtures of pulverulent fuel and air, a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers and periodically operable timed means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, a partition including an aperture between said primary chamber and said duct, a rotatably adjustable plate yieldingly pressed against said partition in a substantially dust-tight manner, said plate co-operating with said aperture and having an edge formed to an Archimedean spiral arranged to overlap and mask said aperture in varying degrees dependent on the rotary adjustment of said disc, means for adjusting said plate and means for discharging each fuel charge from said secondary chamber before the admission of the next fuel charge.

19. In apparatus for metering pulverulent fuel to explosion chambers operating with combustible mixtures of pulverulent fuel and air, a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a dust between said primary and secondary chambers and periodically operable timed means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, a partition including an aperture between said primary chamber and said duct, a rotatably adjustable plate yieldingly and adjustably pressed against said partition in a substantially dust-tight manner, said plate co-operating with said aperture and having an edge formed to an Archimedean spiral arranged to overlap and mask said aperture in varying degrees dependent on the rotary adjustment of said disc, means for adjusting said plate and means for discharging each fuel charge from said secondary chamber before the admission of the next fuel charge.

20. In a combustion turbine installation including a turbine having a governor responsive to load conditions, an explosion chamber and means for delivering to said explosion chamber metered charges of air diluted and air borne pulverulent fuel adapted with further air dilution to form combustible charges for said explosion chamber, metering means comprising a primary chamber including fuel agitating means, means for continuously admitting pulverulent fuel to said primary chamber, a secondary chamber, a duct between said primary and secondary chambers and periodically operable timed means for admitting a charge of fuel from said duct to said secondary chamber and then isolating said charge in said secondary chamber, means for admitting primary diluting and carrying air to said secondary chamber, a partition including an aperture between said primary chamber and said duct a rotatably adjustable plate co-operating with said aperture and adapted in dependence upon rotary adjustment to mask said aperture in varying degrees, means responsive to the turbine governor for adjusting said plate and means for discharging each fuel charge from said secondary chamber, before the admission of the next fuel charge.

21. In apparatus for metering charges of pulverulent fuel to explosion chambers, a primary fuel chamber, a secondary fuel chamber and a sluice duct therebetween, including a reciprocable pipe opening into said secondary chamber, a pipe closing abutment member in said secondary chamber, means for reciprocating said pipe into and out of closing control with said abutment, said pipe reciprocating means including a fluid pressure actuated piston and means for discharging from said secondary chamber the fuel charges metered into it at each opening and closing of the pipe.

22. In apparatus for metering charges of pulverulent fuel to explosion chambers, a primary fuel chamber a secondary fuel chamber and a sluice duct therebetween, including a reciprocable pipe opening into said secondary chamber,

a pipe closing abutment member in said secondary chamber, means for reciprocating said pipe into and out of closing contact with said abutment, said pipe reciprocating means including a fluid pressure actuated piston, means for adjusting the contact pressure between said pipe and said abutment and means for discharging from said secondary chamber the fuel charges metered into it at each opening and closing of the pipe.

23. In apparatus for metering charges of pulverulent fuel to explosion chambers, a primary fuel chamber, a secondary fuel chamber and a sluice duct therebetween, including a reciprocable pipe opening into said secondary chamber, a pipe closing abutment member in said secondary chamber, means for reciprocating said pipe into and out of closing contact with said abutment, said pipe reciprocating means including a fluid pressure actuated piston and adjustable connecting means interposed between said piston and said pipe, and means for discharging from said secondary chamber the fuel charges metered into it at each opening and closing of the pipe.

24. In apparatus for metering charges of pulverulent fuel to explosion chambers, a primary fuel chamber, a secondary fuel chamber and a sluice duct therebetween, including a reciprocable pipe opening into said secondary chamber, a pipe closing abutment member in said secondary chamber, means for reciprocating said pipe into and out of closing contact with said abutment, said pipe reciprocating means including a fluid pressure actuated piston, an oscillatory coupling member interposed between said piston and said pipe and an adjustable slide interposed between the oscillatory and the reciprocating members of the system, and means for discharging from said secondary chamber the fuel charges metered into it at each opening and closing of the pipe.

25. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, means for bringing a predetermined quantity of air in a state of flow into intimate admixture with each fuel charge isolated in said chamber while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

26. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, said chamber having a volumetric capacity which is a multiple of the volume of the maximum fuel charge that can be admitted, means for bringing a predetermined quantity of air in a state of flow into intimate admixture with each fuel charge isolated in said chamber while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

27. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, means for bringing a predetermined quantity of air in a state of whirling motion into intimate admixture with each fuel charge isolated in said chamber while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

28. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, said chamber having a volumetric capacity which is a multiple of the volume of the maximum fuel charge that can be admitted, means for bringing a predetermined quantity of air in a state of whirling motion into intimate admixture with each fuel charge isolated in said chamber while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

29. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, said chamber having a volumetric capacity which is a multiple of the volume of the maximum fuel charge that can be admitted, means providing a plurality of obliquely disposed air inlets leading into said chamber, means for admitting a predetermined quantity of air under pressure through said obliquely disposed inlets into intermixing contact with the fuel particles isolated in said chamber, while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

30. In an explosion chamber installation operating mixture of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, said chamber having a volumetric capacity which is a multiple of the volume of the maximum fuel charge that can be admitted, means provid-

ing a circular series of obliquely disposed air inlets leading into said chamber, means for admitting a predetermined quantity of air under pressure through said inlets into intermixing contact with the fuel particles isolated in said chamber, while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

31. In an explosion chamber installation operating with mixtures of pulverulent fuel and air, means for producing a primary mixture of fuel and air, said means including a fuel sluice, a chamber associated therewith, means for intermittently transferring a predetermined charge of pulverulent fuel from said sluice to said chamber and subsequently isolating such charge in said chamber, said chamber having a volumetric capacity which is a multiple of the volume of the maximum fuel charge that can be admitted, means providing a circular series of obliquely disposed compressed air inlets leading into said chamber, a periodically operated compressed air inlet valve, a duct connecting said valve with said inlets, said duct running off into spiral form about said circular series of inlets, whence the air flows in whirling streams into intimate contact with the fuel charge while said chamber is otherwise closed, and closure means for said chamber adapted to be opened after the whirling air has suspended substantially the whole of the fuel charge in the chamber to enable the fuel suspension to escape from the chamber.

32. In control apparatus for explosion chambers operating with combustible mixtures including air and a pulverulent fuel the combination comprising fluid pressure actuating means for the valves of the explosion chambers, fluid propelling control means for said actuating means, means for distributing pulverulent fuel to the combustion chambers, common driving means for said fluid propelling control means and said pulverulent fuel distributing means and coupling means operable to disengage said fuel distributing means from said common driving means.

33. In control apparatus for explosion chambers operating with combustible mixtures including air and a pulverulent fuel the combination comprising fluid pressure actuating means for the valves of the explosion chambers, fluid propelling control means for said actuating means, means for distributing pulverulent fuel to the combustion chambers, common driving means for said fluid propelling control means and said pulverulent fuel distributing means and coupling means operable to disengage said fuel distributing means from said common driving means, said fluid propelling control means being located above said fuel distributing means.

34. The control apparatus of claim 33 characterized by its comprising the following elements arranged one below the other in the following order: air vessel, fluid propelling control means, engageable and disengageable coupling and coal dust distributing means.

35. The control apparatus of claim 33 characterized by its comprising in combination with the common driving means the following elements arranged one below the other in the following order: air vessel, fluid propelling control means engageable and disengageable coupling and coal dust distributing means and by the ignition apparatus being located between the fluid propelling control means and the common driving means.

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