June 13, 1933. F. HOFMANN 1,913,593

PROCESS AND APPARATUS FOR CHARGING EXPLOSION TURBINES

Filed Aug. 6, 1928 2 Sheets-Sheet 1

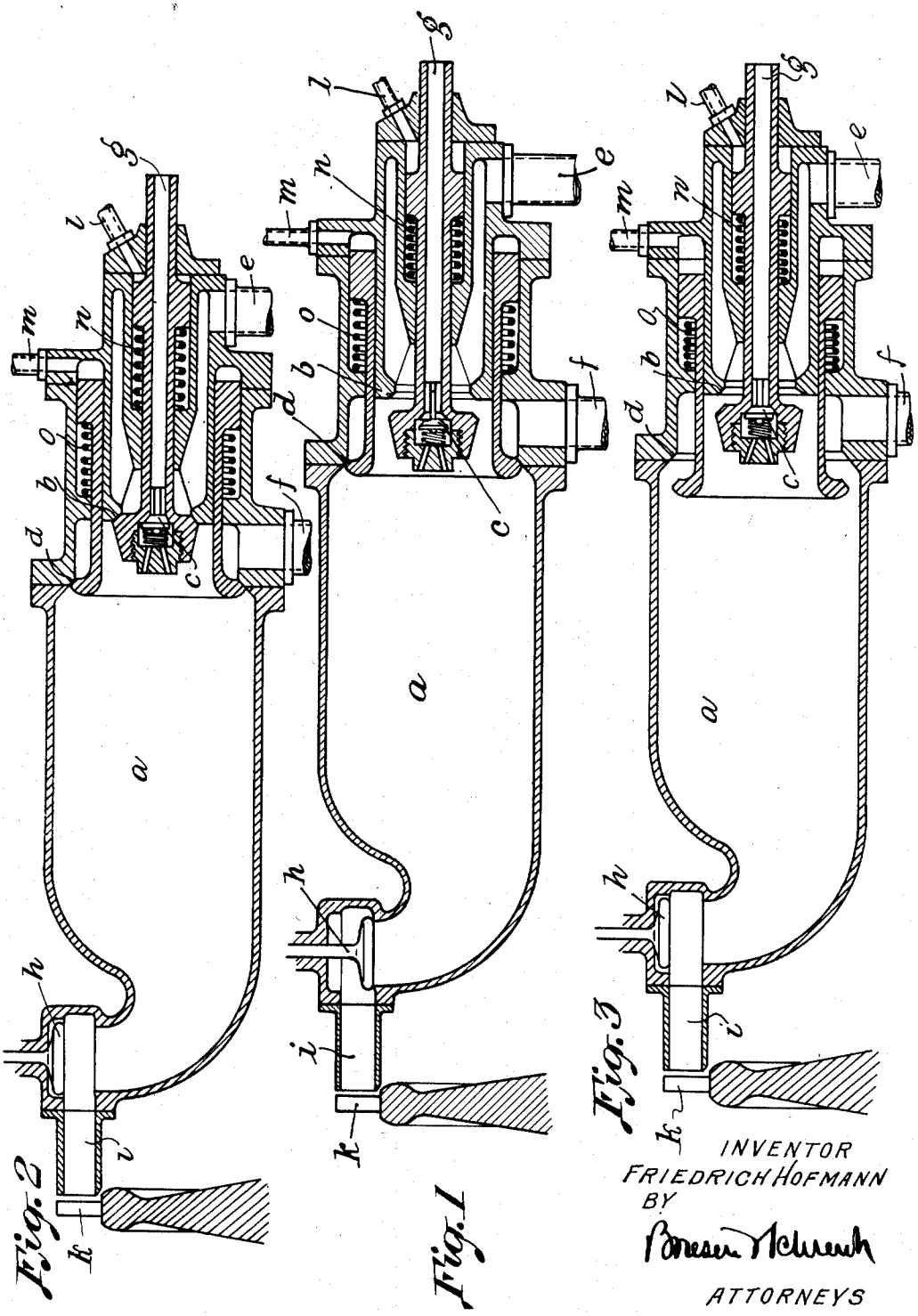


Fig. 2 Fig. 1 Fig. 3

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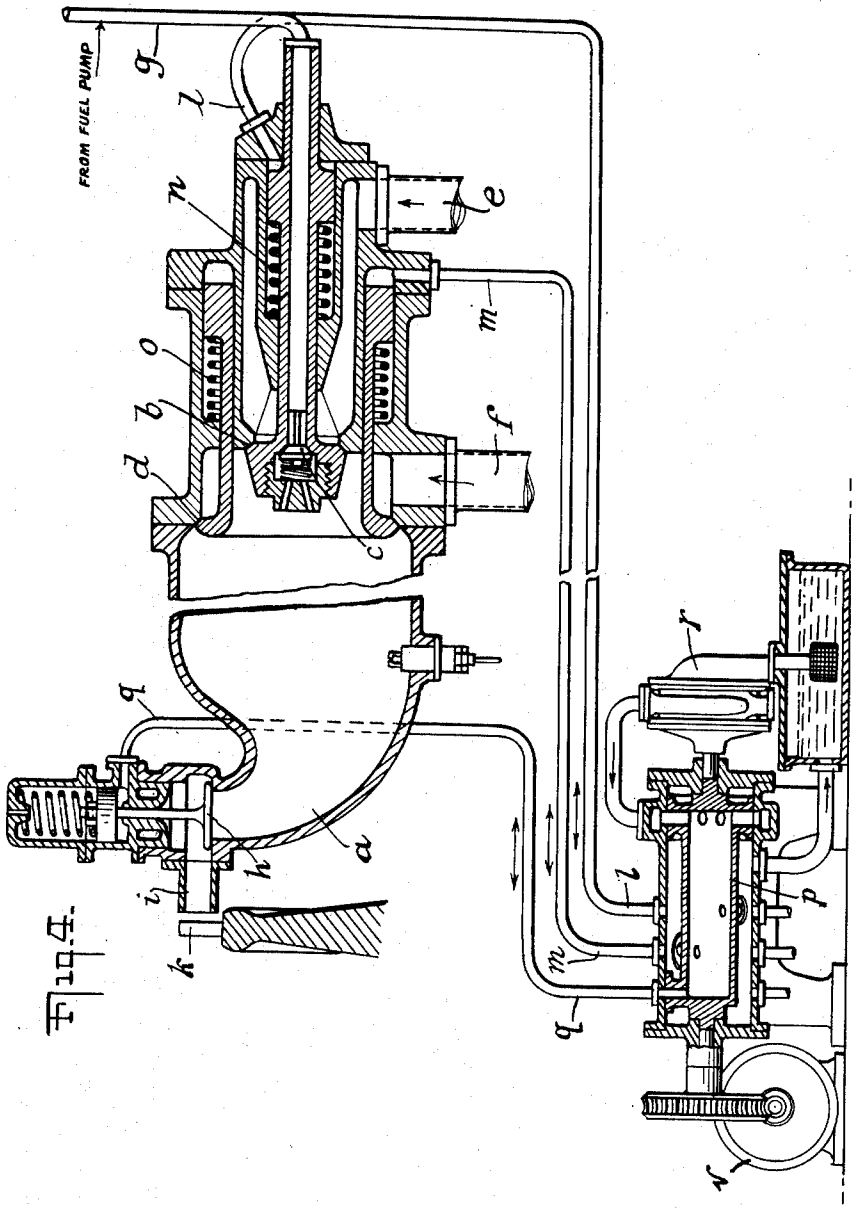


Fig. 4.

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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR CHARGING EXPLOSION TURBINES

Application filed August 6, 1928, Serial No. 297,619, and in Germany August 15, 1927.

My invention relates to explosion turbines and its object is to reduce the time required for the charging of explosion turbines in order that the individual explosions may follow each other more rapidly, thereby increasing the work performed in each unit of time, or on the other hand, reducing the size of the machine for a given capacity.

It has been the practice heretofore in the operation of explosion turbines to effect the charge of the elongated combustion chamber by means of air and fuel which are introduced at one side, i. e. the inlet side, the discharge occurring through the opening of a nozzle valve located at the other side, i. e. the exhaust side of the elongated cylindrical or pear-shaped explosion chamber. After the explosion has taken place it is necessary to remove the residual combustion gases through the nozzle valve. This nozzle valve is necessarily or rather small cross-section and as a consequence considerable time is required to effect the discharge of these residual gases. It has already been proposed to shorten this time by arranging an additional discharging element in proximity to the nozzle valve, which element thus performs the function of an auxiliary exhaust mechanism whose dimensions however, on account of its structural connection with the nozzle valve, must be relatively small, so that the reduction in the time required for scavenging the chamber due to such auxiliary mechanism cannot be very great.

The present invention proceeds along a different course. In accordance with my invention the expanded residual combustion gases are given a free exit path at the inlet side of the combustion chamber where a considerably larger cross-section of opening can be afforded. It may be left to the discretion of the designer whether or not this opening upon the inlet side is to be exposed simultaneously with the known or usual opening or openings upon the exhaust side. It is also a matter of choice whether or not only the expanded combustion gas residue is driven out through this exposed opening at the inlet side or cooling scavenging air is permitted to follow such discharged residual gas.

In the accompanying drawings which show by way of example a form of my invention without defining its limits, and represent diagrammatically the conduit ends of an explosion chamber with the appurtenant valve controlling mechanism and the associated nozzle located adjacent the turbine wheel, Fig. 1 shows my novel discharge mechanism in position during the charging of the explosion chamber, the same being shown in central longitudinal section; Fig. 2 is a similar view showing the position of the parts during the work-performing explosion and expansion of the combustion gases; Fig. 3 illustrates in longitudinal section the position of my novel mechanism during the displacement and discharge of the residual gases; and Fig. 4 is a diagrammatic view, partly in section, illustrating the control mechanism for timing the operation of the valves.

The explosion chamber is designated by the letter *a* while *b* shows the air valve, *c* the fuel valve, and *d* the discharge valve. Fresh scavenging and charging air is introduced through conduit *e* and fuel through *g*. The discharge of the expanded residual gases occurs through the conduit *f*. The nozzle valve is shown at *h*, the nozzle at *i* and the turbine blades at *k*.

In the position of the parts shown in Fig. 1 the combustible charge under appropriate pressures through the valves *b* and *c*. The nozzle valve *h* and the discharge valve *d* are closed during this period. After the closing of the inlet valves *b* and *c* the charge is ignited and immediately thereafter the nozzle valve *h* is opened (Fig. 2). The gases escape at high pressure through the nozzle and through the turbine wheel, performing work as they pass through the latter until they have expanded to the point which is most favorable for the efficiency of the turbine. The air valve *b* and discharge valve *d* are then opened at about the same time. The expanded gases are then pushed out both through the nozzle valve *h* and through the discharging mechanism *d* into the nozzle ring and into the discharging conduit *f*, respectively, by means of the air. The chamber becomes filled with air

which partly pushes the residual gases before it and partly displaces the same along the walls as they travel in counter-current relation through the valve *d* (Fig. 3). The greater part of the residual gases thus escapes through *d* because the cross-section of the opening at *d* and of the conduit *f* is essentially greater than that of *i* and for the further reason that the turbine wheel opposes a considerable resistance to the rather slowly flowing residual gases. For this reason it is quite immaterial at what time the nozzle valve is closed during this displacement process. The residual gas discharging mechanism *d* is preferably so located, as shown in the drawings, that it is out of the direct, initial path of the incoming stream of air charged by the air valve *b*, so that the air stream cannot make a short cut to such discharging mechanism but must first traverse and fill the combustion chamber. After the residual gases have been completely displaced and replaced by fresh air in the manner described, the discharge valve *d* and also the nozzle valve *h*, should the latter have been kept open to this point, are closed and at the same time the fuel valve *c* is opened. It is immaterial so far as the present invention is concerned, whether the fuel valve *c* is opened after the air valve has been closed, or is opened while such air valve is still open; it is preferred, however, to open the fuel valve while the air valve is still open, as indicated in Fig. 1.

For the sake of clearness of explanation of the invention it has been assumed that the use of air, under different pressures, i. e. lower pressure scavenging air and higher pressure charging air (customary in the present operation of turbines), has been dispensed with and that air at only one pressure is used. It is immaterial so far as the present process is concerned whether the fuel employed is liquid or gaseous.

Suitable mechanism must be provided to effect the opening and closing of the discharging mechanism and of the air charging mechanism at the proper instants. The embodiment disclosed is adapted to be provided with an oil pressure controller of the type shown in the patent to Holzwarth No. 877,194, which can be made to operate both the air charging and the residual gas discharging mechanism. The oil under pressure from such controller is conducted through pipe *l* to the air charging mechanism and to the discharging mechanism by the pipe *m*. The return of these mechanisms to closed position is effected by means of the springs *n* and *o* respectively.

A satisfactory control mechanism for the valves of the explosion chamber is illustrated schematically in Fig. 4. The oil conduits *l* and *m* are connected with a rotating distributor *p* for the pressure fluid in such a manner that at the instant in which the valves *b* and *d* are to be opened, such pressure fluid is charged into said conduits *l* and *m* and operates the valves *b* and *d* through the pistons associated with the stems of such valves and against the action of the springs *n* and *o*. A separate section of the distributor *p* serves for controlling the nozzle valve *h* through the conduit *q*. The fuel is conducted to the fuel valve *c* through conduit *g* at the proper instant by a suitable fuel pump (not shown). The distributor may be of the type described in detail in United States Patent No. 877,194. The distributor *p* and its pump *r* may be driven by a motor *v* independently of the turbine shaft.

It is of advantage to locate the air valve within the discharge mechanism, as shown, so that a central current of air travelling in the direction of the nozzle displaces a counter-current annular stream of gases travelling along the walls of the combustion chamber toward the inlet side thereof and ultimately discharged through the valve *d*.

Variations may be resorted to within the scope of the claims without departing from the spirit of the invention.

I claim:

1. In an elongated explosion chamber suitable for use in explosion turbines, the combination of a main outlet valve at one end of the chamber adapted to discharge high pressure combustion gases generated in such chamber for work outside the same, means for opening and closing said valve, an air valve at the opposite end of the chamber arranged to charge a central, cylindrical stream of air into the chamber, means for opening and closing said air valve, fuel charging mechanism at said opposite end of the chamber, means for conducting fuel periodically to said mechanism, an auxiliary outlet at said opposite end of the chamber, and means for opening and closing the same, the control means for said air and auxiliary outlet valves operative to open the latter substantially simultaneously following the expansion of the combustion gases through the open nozzle valve, whereby the residual gases are forced by said central, cylindrical stream of air to travel in the form of a hollow cylinder along the walls of the chamber toward and through the auxiliary outlet counter to the direction of flow of said air.

2. In an explosion chamber suitable for use in explosion turbines, the combination of air and fuel charging valves located at the inlet end of said chamber, a nozzle valve at the outlet end of said chamber, a residual gas discharging valve located at the inlet end of said chamber, said residual gas discharging valve surrounding the air charging valve, and control devices for opening and closing said valves at predetermined instants, said control devices operative to hold said air

charging and said residual gas discharging valves open for overlapping periods so that the entering air effects discharge of at least a part of the residual gases through said residual gas discharging valve.

3. In an explosion chamber suitable for use in explosion turbines, the combination of air and fuel charging valves located at the inlet end of said chamber, a nozzle valve at the outlet end of said chamber, a residual gas discharging valve located at the inlet end of said chamber, said air charging valve being concentrically positioned within said residual gas discharging valve, and control devices for opening and closing said valves at predetermined instants, said control devices operative to hold said air charging and said residual gas discharging valves open for overlapping periods so that the entering air effects discharge of at least a part of the residual gases through said residual gas discharging valve.

4. In an explosion chamber for explosion turbines, the combination of air and fuel charging valves located at the inlet end of said chamber, a nozzle valve at the outlet end of said chamber, a residual gas discharging valve located at the inlet end of said chamber, said air and fuel charging valves being positioned concentrically one within the other and both within said discharging valve, and control devices for opening and closing said valves at predetermined instants, said control devices operative to hold said air charging and said residual gas discharging valves open for overlapping periods so that the entering air effects discharge of at least a part of the residual gases through said residual gas discharging valve.

5. In an explosion chamber suitable for use in explosion turbines, the combination of air and fuel charging valves located at the inlet end of said chamber, a nozzle valve at the outlet end of said chamber for discharging the combustion gases following the explosion of a fuel and air charge, a residual gas discharging valve located at the inlet end of said chamber, and control devices for opening and closing said valves at predetermined instants, said control devices operative to hold said air charging and said residual gas discharging valves open for overlapping periods so that the entering air effects discharge of at least a part of the residual gases through said residual gas discharging valve, such residual gas discharging valve being positioned out of the initial path of the stream of air admitted by said air charging valve.

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