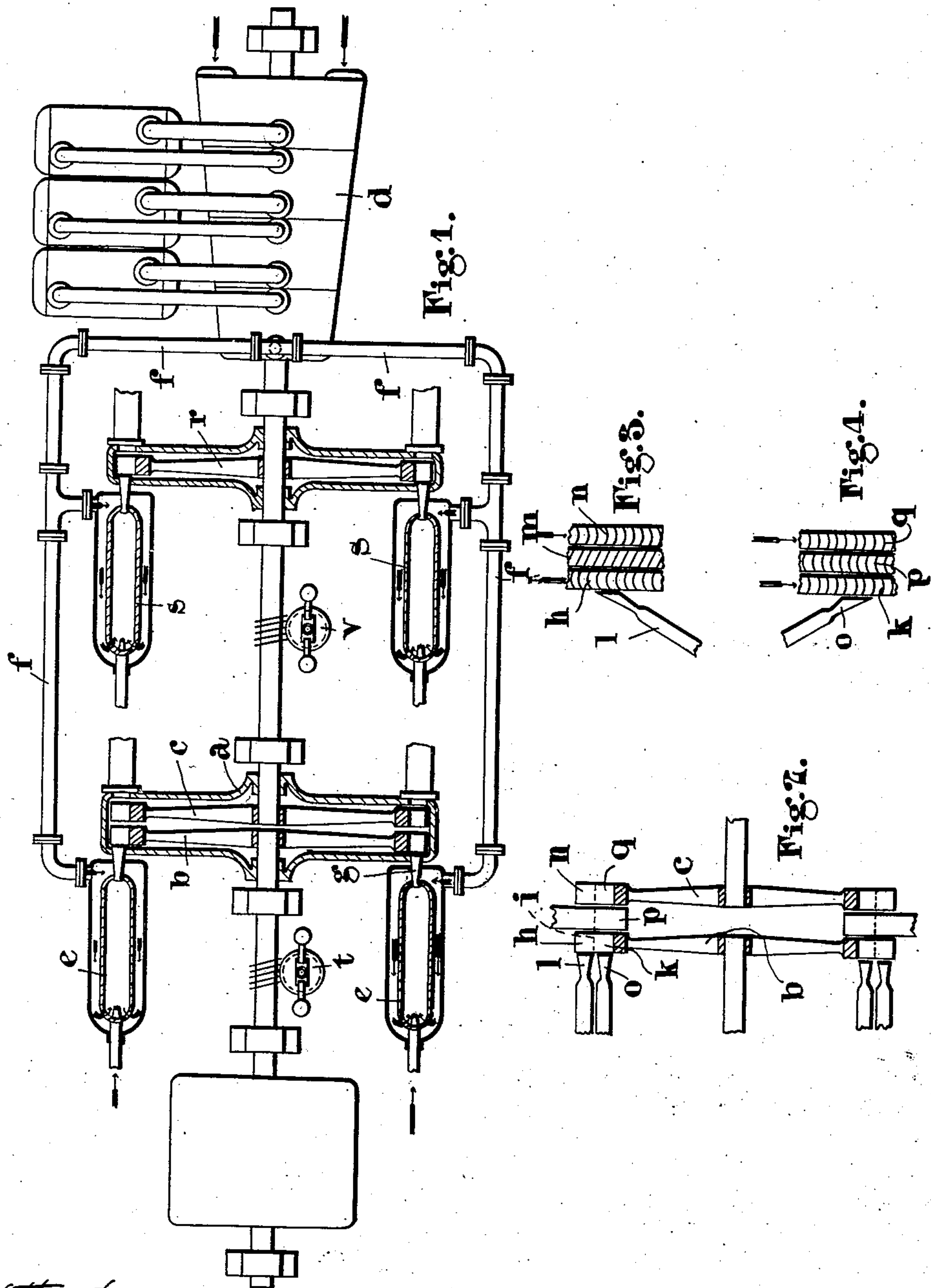


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COMBUSTION TURBINE.  
APPLICATION FILED SEPT. 20, 1906.

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Patented May 31, 1910.



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# UNITED STATES PATENT OFFICE.

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## COMBUSTION-TURBINE.

960,160.

Specification of Letters Patent.

Patented May 31, 1910.

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*To all whom it may concern:*

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, a subject of the King of Great Britain and Ireland, and residing at 31 Lyndhurst road, Hampstead, London N. W., England, have invented certain new and useful Improvements in Combustion-Turbines, of which the following is a specification.

This invention relates to turbines using an elastic fluid heated by combustion as the working medium.

The objects of the present invention are to improve the efficiency of such turbines to enable lower speeds to be efficiently run, and to facilitate reversing of the direction of rotation.

Referring to the accompanying drawings; Figure 1 shows a diagrammatic view of a turbine plant arranged according to my invention. Figs. 2, 3 and 4 show an arrangement of turbine wheels in which the compressor wheel rotates in the same direction although the direction of the motor wheels is reversed.

I wish it to be understood that the drawings are of a diagrammatic nature throughout and are not to be taken as working drawings; also in the drawings where desirable similar parts are denoted by the same reference symbols.

In carrying my invention into effect according to one modification I utilize the velocity of the working fluid so as to enable the motive part or positive work part of the apparatus to be run at the lowest convenient speed. This I accomplish in the simplest form by means of a turbine, *a*, Fig. 1 having two oppositely running wheels, *b*, and *c*. The wheel, *b*, receives and turns back the working fluid in its passage through its blades and constitutes the positive work or motor wheel of the apparatus. The wheel, *b*, is normally run at such a speed as to take out about half of the energy of the jets. The fluid rejected by this wheel at high velocity then passes through the wheel, *c*, which is the negative work or compressor driving part of the apparatus. The wheel, *c*, runs in the opposite direction at nearly three times the speed of the wheel, *b*, and absorbs the balance of the useful energy, being coupled directly to a rotary air compressor, *d*, preferably of the turbine compressor type with intercoolers or to any other suitable form. The compressor, *d*,

supplies the combustion chambers, *e*, with compressed air by the pipes, *f*, into which chambers a supply of fuel is also introduced under pressure from any convenient source and after the mixture has been ignited the hot products of combustion are expanded down to atmospheric pressure in the nozzles, *g*, thereby converting the pressure energy of the working fluid into kinetic energy and operating on the blades of the turbine wheels.

The principle involved in the above apparatus is that of taking out the energy of the working fluid in series by passing it first through a wheel or wheels doing positive work at a low speed, and secondly through a wheel or system of wheels furnishing the negative work of the system, the desired speed ratio between the positive and negative systems being secured by suitable design.

This apparatus lends itself from a practical point of view to the efficient generation of power, as almost all purposes require fairly low speeds of the motive part, whereas the rotary compressor is most efficiently run at a high speed such as that given by the negative work wheels of the apparatus.

It is clear that there are many ways in which my invention can be carried into effect without departing from the essential principles which I have laid down.

In carrying a further part of my invention into effect according to one modification I provide a turbine which not only runs at a low speed on its motor or positive work part but also is capable of easy reversing. I prefer to do this in its simplest form by means of two running wheels of blades. In each case the blades may be double the radial length that would be required for a non-reversing turbine. The motor wheel, *b*, Fig. 2, on the blades of which the working fluid is projected from either a right or left hand system of nozzles consists of first a set of blades, *h*, for running in one direction then a stiffening ring, *i*, then a set of blades, *h*, arranged oppositely to the blades, *h*, for running in the reverse direction. For the purpose of running forward I use the forward running system of nozzles *l*, Fig. 3, projecting the working fluid through say the blades, *h*, in the wheel, *b*. The fluid issuing from the wheel, *b*, is guided across to the negative work wheel, *c*, by means of blades,



*m*, set at an angle in a known manner but which do not alter its direction, simply taking it across a space which is required to be maintained as will be presently shown.

5 From the guide blades, *m*, the working fluid impinges upon the outer blades, *n*, of the negative work wheel, *c*, and runs it in the opposite direction to that of the wheel, *b*.

There are in this arrangement only two  
10 reversals of the working fluid one in the wheel, *b*, and one in the wheel, *c*. When it is desired to reverse the set of nozzles *o*, Fig. 4 arranged for the opposite direction of rotation are used, discharging the working  
15 fluid through the inner blades, *k*, on the motor wheel, *b*. As it is essential that the compressor wheel shall always run in the same direction I cause the working fluid issuing from the wheel *b*, to be redirected  
20 into its original direction by means of reversing guide blades, *p*, by which it is projected on to the inner blades, *q*, of the wheel, *c*. The blades of the wheel *c*, although of double the length necessary for a non-reversing  
25 turbine are all set in the same direction and always receive the working fluid operating thereon in the same direction irrespective of the direction in which the wheel, *b*, is run. This therefore constitutes the essential  
30 principle of this part of my invention and consists in the fractional abstraction of the energy of the jets by means of motor wheels which may be run in either direction and of the compressor driving wheels which  
35 always run in the same direction.

Such apparatus as I have described for the series abstraction of the velocity of the jets will only give the correct relative speeds at full loads and in some cases it may be  
40 necessary to augment the driving power of the compressor plant at speeds other than full load. In these circumstances I provide an auxiliary turbine, *r*, Fig. 1, on the compressor portion of the plant the wheel of  
45 which turbine is run at sufficiently high surface speed to efficiently utilize the greater portion of the energy contained in the jets of working fluid issuing from the nozzles of the combustion chambers, *s*. These jets furnish the necessary power to the compressor  
50 or negative work part of the system when power is reduced on the positive work wheels.

A suitable governing system should be provided; the location of a pair of centrifugal governors, *t* and *v*, driven one from  
55 each shaft of the plant is indicated in Fig. 1. The particular system of governing adopted forms no part of the present invention and is therefore not further illustrated  
60 here.

Any usual means may be employed for starting up the plant; a common and convenient device takes the form of a reservoir of compressed air.

65 In the foregoing specification and in the

claims appended hereto I have used the term positive work element to denote the turbine member or members which supply the power for performing the external work of the cycle *e. g.* for driving the dynamo, screw  
70 etc. while the term "negative work element" is used to denote the turbine member or members which supply the power for performing the internal work of the cycle *e. g.* compressing air, gas or other medium forming the working fluid.  
75

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. In combination, a casing, a low speed  
80 positive work turbine wheel in said casing; a high speed negative work turbine wheel in said casing; a machine connected to said positive work wheel; a compressor connected to said negative work wheel; a combustion  
85 chamber for supplying working fluid to said turbine wheels, together with means for leading compressed fluid to said combustion chamber.

2. In combination a casing; a low speed  
90 positive work turbine wheel in said casing; a high speed negative work turbine wheel in said casing; a machine connected to said positive work wheel; a compressor connected to said negative work wheel; a combustion  
95 chamber for supplying working fluid to said turbine wheels; means for leading compressed fluid to said combustion chamber together with separate motor means independent of the fluid transferred from said work  
100 wheels for augmenting the power developed by said negative work wheel.

3. In combination a casing; a low speed  
105 positive work turbine wheel in said casing; a high speed negative work turbine wheel in said casing; a machine connected to said positive work wheel; a compressor connected to said negative work wheel; a combustion chamber for supplying working fluid to said turbine wheels; means for leading compressed  
110 fluid to said combustion chamber together with motor means for assisting said negative work wheel.

4. In combination, a casing; a low speed  
115 positive work turbine wheel in said casing; a high speed negative work turbine wheel in said casing; a machine connected to said positive work wheel; a compressor connected to said negative work wheel; a combustion chamber for supplying working fluid to said  
120 turbine wheels; means for leading compressed fluid to said combustion chamber together with means for reversing the direction of said positive work wheel while the direction of the rotation of the negative  
125 work wheel remains constant.

5. In combination, a casing; a low speed  
positive work turbine wheel in said casing; a high speed negative work turbine wheel  
130 in said casing; a machine connected to said



positive work wheel, a compressor connected to said negative work wheel; a combustion chamber for supplying working fluid to said turbine wheels; means for leading compressed fluid to said combustion chamber together with means for governing the speed of said work wheels.

6. In combination a turbine casing, independently rotating turbine wheels in said casing; a compressor actuated by certain of

said wheels; a machine actuated by certain other of said wheels together with an additional motor for actuating said compressor at starting.

In testimony whereof, I affix my signature 15  
in presence of two witnesses.

SEBASTIAN ZIANI DE FERRANTI.

Witnesses:

CHAS. N. DANIELS,  
LUTHER J. PARR.