A. D. FERGUSON.

COMPRESSOR CONTROLLING MECHANISM.

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1,394,819. Patented Oct. 25, 1921.

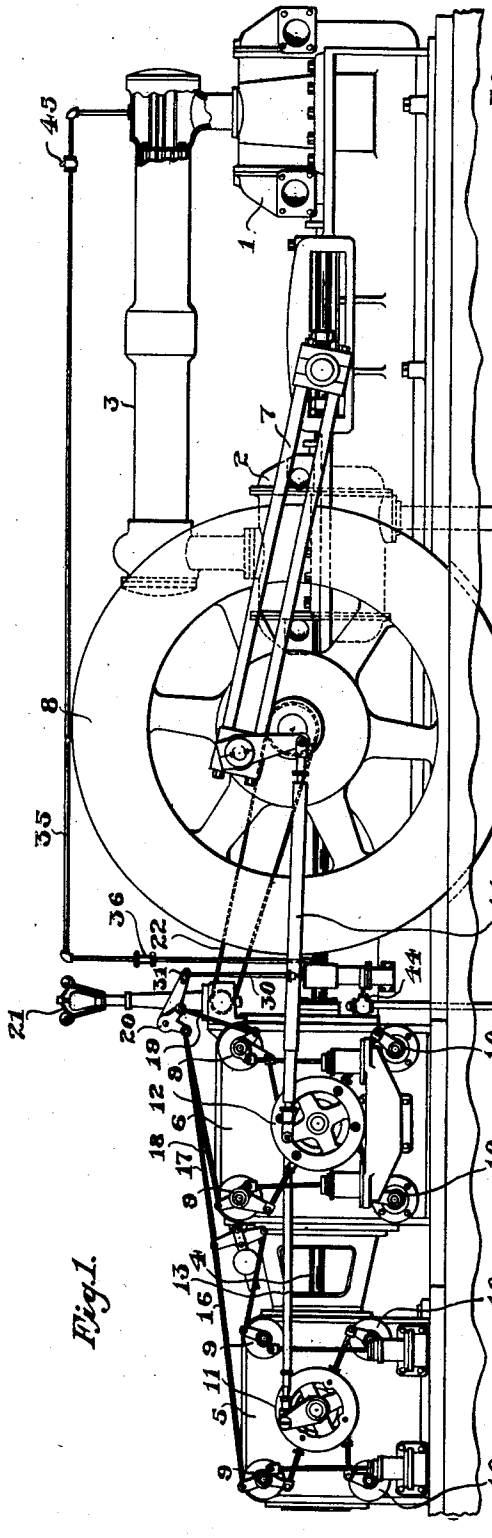


Fig. 1.

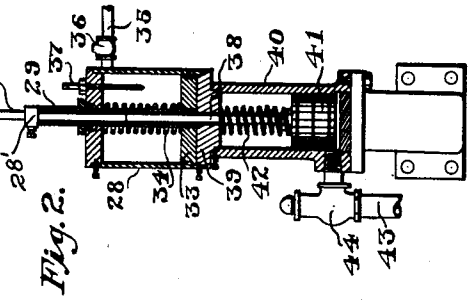


Fig. 2.

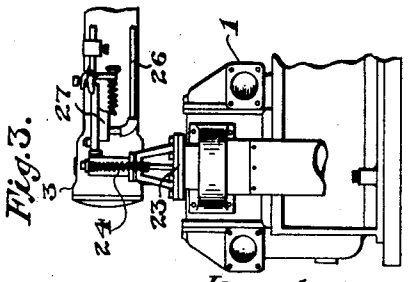


Fig. 3.

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UNITED STATES PATENT OFFICE.

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COMPRESSOR-CONTROLLING MECHANISM.

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To all whom it may concern:

Be it known that I, ALEXANDER D. FERGUSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Compressor-Controlling Mechanisms, of which the following is a full, clear, and exact specification.

My invention relates to compressor controlling mechanisms.

It has for its object to control the several controlling elements of a compressor and its driving element in an improved manner whereby the compressor may function automatically and efficiently at varying speeds and under different service conditions. A more specific object of my invention is to provide improved controlling mechanism for a compressor driven by a steam engine, whereby the valves of the engine are controlled in such a manner that the steam consumption is materially reduced when the compressor is completely unloaded. A further object of my invention is to provide an improved regulating mechanism whereby the speed of the compressor driving engine is automatically regulated in accordance with service requirements and improved cooperating mechanism for controlling this regulating mechanism in accordance with the requirements of the compressor.

In the accompanying drawings, I have shown for purposes of illustration one embodiment which my invention may assume in practice, illustrating the same in connection with a steam driven compressor of the Corliss type.

In these drawings,—

Figure 1 is a side elevation, partially in section, of the compressor equipped with my improvement.

Fig. 2 is an enlarged detail vertical sectional view through a portion of the controlling mechanism.

Fig. 3 is a detail view showing the main unloading valve for the compressor intake and the controlling connections therefor.

In this illustrative construction, I have shown a compressor having a low pressure cylinder 1 and a high pressure cylinder 2, these cylinders being connected in the usual manner by an intercooler 3 and preferably having their pistons (not shown) connected to and driven by a suitable piston rod 4 also having pistons (not shown) disposed in the high and low pressure steam cylinders 5 and 6 of a suitable steam engine, this rod 4 also being connected through a suitable connection 7 with the compressor flywheel 8 in a well known manner. As shown, each of the engine cylinders is provided with a plurality of admission and exhaust valve mechanisms 9, 10, the several valves being controlled through suitable valve operating gear of the Corliss type including the oscillating members 11, 12, suitably connected together by a rod 13 and also connected through a suitable connection 14 with the compressor flywheel 8. As in the usual Corliss construction, the valve gear shown in this illustrative construction is also connected through suitable cut-off controlling connections 16, 17, 18, 19 with crank mechanism 20 controlled by an engine speed controlling ball governor 21 driven from any suitable moving part of the engine, as by a pulley and belt connection 22. As usual, an unloading valve 23 is also provided on the low pressure cylinder of the compressor to control the supply of air through the compressor intake, this unloading valve preferably being normally held open by a spring mechanism 24 and closed by fluid pressure supplied from the receiver 25 through a pipe connection 26, the flow of fluid pressure being controlled by an unloader controlling mechanism 27 of any well known construction, such as that of the Jarecki or Judson type adapted only to supply fluid to close the valve and hold the same closed while the pressure in the receiver 25 exceeds a predetermined amount. The mode of operation of this device is similar in principle to that shown in the patent to J. L. Osborne, 1,141,975, June 18, 1915.

In my improved construction I have provided an improved supplemental regulator coöperating with the controlling mechanism 27 and with the speed controlling mechanism further to regulate the operation of the compressor, and especially adapted to reduce the speed and steam consumption of the compressor driving engine when the compressor is completely unloaded. As shown, this regulator includes a cylinder 28 located below the governor 21. In this cylinder is reciprocably mounted an upwardly projecting sleeve 29 in which is telescopically carried a rod or stem 30 piv-

otally connected through a slotted connection 31 to the crank 20, and therefore to the ball governor 21, the sleeve 29 being capable of lifting the rod 30 upon engagement with an adjustable collar 28' thereon. As shown, a piston 33 is fixed, as by threading, to the lower end of the sleeve 29 and normally held in depressed position at the bottom of the cylinder 28 by a coiled spring 34 disposed about the sleeve. As shown, this cylinder 28 has communication through a pipe 35 with a suitable space wherein the pressure is decreased after the closure of the unloading valve 23, *i. e.*, after a predetermined increase in pressure in the receiver 25. In the preferred form shown herein, the same is connected to the intercooler 4, a suitable check valve 36 being inserted in the pipe to prevent the intercooler pressure from entering the cylinder. As shown, an adjusting screw 37 also extends into the cylinder 28 in such a manner as to limit the movement therein of the piston 33 and enable the movement of the latter to be regulated as desired, from a point exterior to the cylinder. Disposed within the sleeve 29 and beneath the rod or stem 30, connected to the ball governor 21, is another rod 38 which extends downwardly through a member 39 forming the bottom of the cylinder 28 and the top of a smaller lower cylinder 40. This rod 38 in turn carries a piston 41 on its lower end, a coiled spring 42 being disposed about this rod in such a manner that it preferably always acts between the upper end of the cylinder 40 and the upper surface of the piston 41 to depress the piston to the position shown in Fig. 2. Connected to this cylinder 40 and preferably at the bottom thereof, is a suitable connection 43 which extends to the receiver 25, a suitable pilot valve, illustrated diagrammatically at 44 preferably being provided in this connection. The mode of operation of this is similar to that disclosed in the Osborne patent referred to above. Obviously also, the flow through the pipe connection 35 may be controlled by a suitable stop cock 45. It will be evident also that an ordinary pop safety valve could be used at 44 and a continuously open vent provided in the cylinder 40 below the piston 41, and that by reason of leakage past the piston 41 and out around the rod 38, a separate vent could even be dispensed with.

In the use of my improved regulator, it will be noted that when the pressure in the receiver 25 rises to a predetermined point depending on the air pressure desired, air will be admitted therefrom through the pop or pilot valve 44 under the piston 41. As a result, this piston will rise against the tension of its spring 42 and thereby lift the rod 38, the rod 30, and the crank 20 in such a manner as to cause the latter to actuate the valve gear connections 16, 17, 18, and 19 and shorten the cut-off of the engine valves 9, and thereby reduce the speed of the engine, and therefore of the compressor. It will also be noted that if the receiver pressure drops while the compressor is thus running at slow speed, the pop valve 44 will close communication between the piston 41 and the receiver so that as a result the piston 41 will drop in the cylinder 40 and thereby permit the crank 20 to drop to lengthen the cut-off and increase the speed of the compressor. If, on the other hand, the receiver pressure should continue to rise despite the fact that the compressor through the action of the regulator above described had been caused to run at slow speed, the unloading valve 23 would then be operated through its unloader mechanism 27 in such a manner as to shut off the supply of air to the compressor. Under such circumstances, a partial vacuum would soon be formed in the intercooler 3 and, as the pipe 35 is connected between the latter and the cylinder 28, a like pressure change would result in that cylinder. Consequently, the pressure above the piston 33 which, due to leakage is ordinarily the same as that of the atmosphere, would then be relieved and thereupon the piston 33 would rise, picking up and carrying the rod 30 with it to a still higher position. As a result of this movement, the compressor will be slowed down almost to the stopping point due to the shortening of the engine cut-off, but as the same is unloaded at the time, the shorter cut-off of the steam valves is sufficient to keep the machine turning over slowly. Here it will be evident that, if desired, the adjustable member 37 may also be used to limit the amount of movement of the piston 33, and therefore of the rod 30, in such a manner that any desired length of cut-off may be obtained. As the machine slows down as a result of this upward movement of the rod 30 and the consequent action of the cut-off valves, the rod 30 will obviously be supported upon the upper end of the rod 29, held up by the piston 33. Thereafter, the speed of the compressor as a result will be controlled by the vacuum in the intercooler until the receiver pressure drops to a point below the point where the unloading valve 23 opens to admit air to the machine. When this occurs, however, due to inrush of air following the opening of this valve 23, the vacuum in the machine will, of course, be destroyed, and as a result the piston 33 will drop to the bottom of its cylinder 28 in such a manner as to permit the lowering of the rod 30 and the lengthening of the cut-off of the steam valves 9, and thereby cause the compressor

to be speeded up sufficiently to carry the load. Thereafter the speed of the compressor will again be controlled by the receiver pressure supplied to the cylinder 40 until the receiver pressure drops sufficiently to close the pop valve 44, whereupon the piston 41 will drop to the bottom of the cylinder 36 and the compressor will be speeded up until the ball governor 21 goes into action.

Obviously, in the use of my improved regulator, instead of connecting the pipe 35 to the intercooler 3 as shown, the same may be connected to any suitable point wherein a vacuum is formed upon the closure of the unloading valve 23, this pipe preferably being connected at any suitable point on the inner side of that valve. It will also be obvious that, if desired, when the pipe is thus connected, the necessity for providing a check valve in the pipe 35 will be overcome. In connection with my improved regulator, attention is also directed to the fact that an independent operation of the speed governor, the pressure governor, and the vacuum governor, is permitted, the several mechanisms operating in the desired sequence in such a manner as to cause the engine and compressor to be operated with great accuracy and efficiency as conditions vary. Attention is also directed to the fact that through my improved construction the regulating means is rendered exceedingly simple and of a type readily adapted to be applied with small changes to a machine of standard construction, and manufactured at small expense. These and other advantages of my improved construction will, however, be apparent to those skilled in the art.

While I have, in this application, specifically described one embodiment which my invention may assume in practice, it is to be understood that the form thereof shown herein is used only for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit, it being my intention to include all such modifications within the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a compressor, and driving means therefor of the expansible chamber type, comprising motive fluid distributing mechanism and a plurality of means sequentially controlling said distributing mechanism and controlled by compressor discharge pressure at different intensities thereof to vary the speed of said compressor.

2. In combination, a compressor, and driving means therefor of the expansible chamber type comprising motive fluid distributing mechanism and a plurality of means controlling said distributing mechanism and sequentially controlled by compressor discharge pressure variations to successively reduce the power consumption of said driving means.

3. In combination with a compressor, a compressor driving engine, and means for controlling the speed of said driving engine comprising a plurality of means whose operation is controlled by compressor discharge pressure in excess of a predetermined desired discharge pressure, one or more of said means being operative dependent on the degree of such excess.

4. In combination with a compressor, a compressor driving engine, and means successively operable to govern the speed of said engine, said means being controlled by compressor discharge pressure when the latter is in excess of a predetermined desired discharge pressure, one or more of said means being operative dependent on the degree of such excess.

5. In combination with a compressor, a compressor driving engine, and means operable to govern the speed of said engine, said means being successively controlled by compressor discharge pressure in excess, by different amounts, of a predetermined desired discharge pressure.

6. In combination with a compressor, a compressor driving engine, and means successively operable to govern the speed of said engine, said means being controlled by compressor discharge pressure in excess of a predetermined desired maximum and one of said means being actuated also by compressor discharge pressure, one or more of said means being operated according to the degree of excess of compressor discharge pressure above said maximum.

7. In combination with a compressor, a compressor driving engine, and means successively operable to control the speed of said engine, one of said means being operated upon a rise of compressor discharge pressure above a predetermined desired maximum to slacken the speed of said engine and the other being similarly operative upon further rise of said pressure.

8. In combination with a compressor, a compressor driving engine, means for controlling the speed of operation of said engine comprising a member operable in one direction to increase the speed of said engine and in an opposite direction to retard the speed, and a plurality of coaxially arranged means coöperating with said member and controlled by variations in compressor discharge pressure in excess of a predetermined amount.

9. In combination with a compressor having an intake, an intake controlling valve, controlling means for said intake controlling

valve, a compressor driving engine, and means for controlling the speed of said engine comprising mechanism responsive to the pressure developed by said compressor in excess of a predetermined amount and independent mechanism responsive to changes in pressure conditions after closure of the compressor intake controlling valve.

10. In combination with a compressor having an intake, an intake controlling valve, controlling means for said valve, a compressor driving engine, means operable to govern the speed of said engine, and a plurality of controlling means therefor comprising means responsive directly to compressor discharge pressure above a predetermined amount and to changes in pressure conditions in said compressor system after closure of the intake controlling valve.

11. In combination with a compressor having an intake, an intake controlling valve, controlling means for said valve, a compressor driving engine, means for controlling the speed of said engine, a receiver, and coöperating means respectively responsive to changes in receiver pressure and to vacuum conditions in said compressor resulting from closure of said intake valve for controlling the speed of the engine.

12. In combination, a compressor having an intake, an intake controlling valve, controlling means for said valve, a compressor driving engine, a receiver, and coöperating means responsive respectively directly to changes in receiver pressure, and to changes in pressure in said compressor system resulting from closure of the intake valve to change the speed of said compressor driving engine, said means being sequential in operation.

13. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, controlling means for said valve, a compressor driving engine, cut-off mechanism therefor, and a plurality of means responsive respectively to the pressure developed by s id compressor, and to changes in pressure conditions therein after closure of said valve each controlling the operation of said cut-off mechanism.

14. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, controlling means for said valve, a compressor driving engine, cut-off mechanism therefor, and coöperating independently operable means responsive to the pressure developed by said compressor and to changes in pressure conditions therein after closure of said intake valve for controlling the operation of said cut-off mechanism.

15. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a compressor driving engine, cut-off mechanism therefor, a receiver, pressure responsive controlling means for said intake valve connected to said receiver and independent sequentially operative means responsive to changes in receiver pressure and to a vacuum condition in said compressor resulting from closure of said intake valve for controlling the speed of said engine.

16. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a compressor driving engine, cut-off mechanism therefor, a receiver, pressure responsive controlling means for said intake valve connected to said receiver, and coöperating independently operable means responsive respectively to changes in receiver pressure and to a vacuum condition in said compressor resulting from closure of said intake valve for controlling the speed of said engine.

17. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a compressor driving engine, pressure responsive means for reducing the speed of said engine prior to closure of said intake controlling valve, means for controlling said intake controlling valve, and automatically acting means for further reducing the speed of said engine when said compressor is completely unloaded.

18. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a compressor driving engine, pressure responsive means for reducing the speed of said engine to decrease the quantity of fluid compressed, pressure responsive means for controlling said intake controlling valve, and automatically acting means for further reducing the speed of said engine when said compressor is completely unloaded.

19. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a compressor driving engine, pressure responsive means for reducing the speed of said engine prior to unloading said compressor, pressure responsive means for controlling said intake controlling valve, and pressure controlled automatically acting means for further reducing the speed of said engine when said compressor is completely unloaded.

20. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, means responsive to receiver pressure for controlling the speed thereof, and means responsive to pressure conditions

arising from shutting off the air supply to said compressor for further reducing the speed of said engine, one or both of said means being operative dependent on receiver pressure variations.

21. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, means responsive to receiver pressure for controlling the speed thereof, and coöperating independently movable means responsive to pressure conditions arising from shutting off the air supply to said compressor for further reducing the speed of said engine.

22. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, means actuated by receiver pressure for controlling the speed of operation thereof, means responsive to pressure conditions arising from shutting off the air supply to said compressor for further reducing the speed of said engine, and means for controlling the speed reduction obtained thereby.

23. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, cut-off valve mechanism therefor, means actuated by receiver pressure for actuating said cut-off valve mechanism, and means responsive to pressure conditions arising from shutting off the air supply to said compressor for further actuating said cut-off valve mechanism.

24. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, cut-off valve mechanism therefor, means responsive to receiver pressure for actuating said cut-off valve mechanism, and coöperating independently movable means responsive to pressure conditions arising from shutting off the air supply to said compressor for further actuating said cut-off valve mechanism.

25. In an apparatus of the character described, the combination comprising a compressor, a receiver therefor, means responsive to receiver pressure for shutting off the air supply to said compressor, a compressor driving engine, cut-off valve mechanism therefor, means directly responsive to receiver pressure for actuating said cut-off valve mechanism, means responsive to pressure conditions arising from shutting off the air supply to said compressor for further actuating said cut-off valve mechanism, and means for controlling the speed reduction obtained thereby.

26. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure responsive means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, means for operating one of said members responsive to changes in receiver pressure and actuated thereby, and means for operating the other responsive to changes in pressure conditions arising from the closure of said intake valve.

27. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure responsive means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, normally inoperative means responsive to receiver pressure for actuating one of said members, and normally inoperative means responsive to changes in pressure conditions resulting from the closure of said intake valve for actuating the other of said members.

28. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure responsive means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, normally inoperative means responsive to receiver pressure for actuating one of said members, normally inoperative means responsive to changes in pressure conditions resulting from the closure of said intake valve for actuating the other of said members, and means for varying the range of movement of one of said members.

29. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure responsive means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, means responsive to receiver pressure for actuating one of said members, and means responsive to pressure changes arising from closure of said intake valve and having a

sleeve through which each of said members is reciprocable, said sleeve being engageable with the other of said members in a predetermined position thereof.

30. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure actuated means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, means including a normally inoperative pressure actuated piston responsive to receiver pressure for actuating one of said members, and means responsive to pressure conditions arising from closure of said intake valve including a normally inoperative piston having a sleeve through which each of said members is reciprocable, said sleeve being engageable with the other of said members in a predetermined position thereof.

31. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, a receiver, pressure responsive means connected thereto for controlling said valve, a compressor driving engine, cut-off valve mechanism therefor, a plurality of independently movable engageable members, one connected to said cut-off mechanism, means including a normally inoperative pressure actuated piston responsive to receiver pressure for actuating one of said members, means responsive to pressure conditions arising from closure of said intake valve including a normally inoperative piston having a sleeve through which each of said members is reciprocable, said sleeve being engageable with the other of said members in a predetermined position thereof, and means for adjusting the range of movement of said last mentioned piston.

32. In an apparatus of the character described, the combination comprising a multi-stage compressor having an intercooler and an intake, an intake controlling valve, a compressor driving engine, and means connected to said intercooler responsive to changes in pressure conditions in said compressor upon closure of said intake controlling valve for effecting a delayed controlling of the speed of said engine.

33. In an apparatus of the character described, the combination comprising a compressor having an intake, an intake controlling valve, pressure responsive means for controlling the same, a compressor driving engine, cut-off mechanism therefor, and means responsive to changes in pressure conditions on the outlet side of said compressor arising from the closure of said intake valve for effecting a delayed controlling of said cut-off valve mechanism.

34. In a multi-stage compressor, the combination comprising a compressor element having an intake, means for closing said intake to unload said compressor, a compressor driving engine and means responsive to a change in pressure conditions between two of said stages upon closure of said intake for controlling the speed of said engine.

35. In a multi-stage compressor, the combination comprising a compressor element having an intake, an intake controlling valve, an intercooler between two of said stages, a compressor driving engine and means responsive to a change in pressure condition in said intercooler for controlling the speed of said engine.

36. In a multi-stage compressor, the combination comprising a compressor element having an intake, means for closing said intake to unload said compressor, a compressor driving engine and means responsive to a change in pressure conditions between two of said stages upon closure of said intake for effecting a delayed controlling of the speed of said engine.

37. In a multi-stage compressor, the combination comprising a compressor element having an intake, an intake controlling valve, an intercooler between two of said stages, a compressor driving engine and means responsive to a change in pressure condition in said intercooler for effecting a delayed controlling of the speed of said engine.

In testimony whereof I affix my signature.

ALEXANDER D. FERGUSON.