H. F. SMITH.

SPEED GOVERNING MECHANISM FOR PRIME MOVERS.

APPLICATION FILED OCT. 1, 1917.

1,381,512. Patented June 14, 1921.

3 SHEETS—SHEET 1.

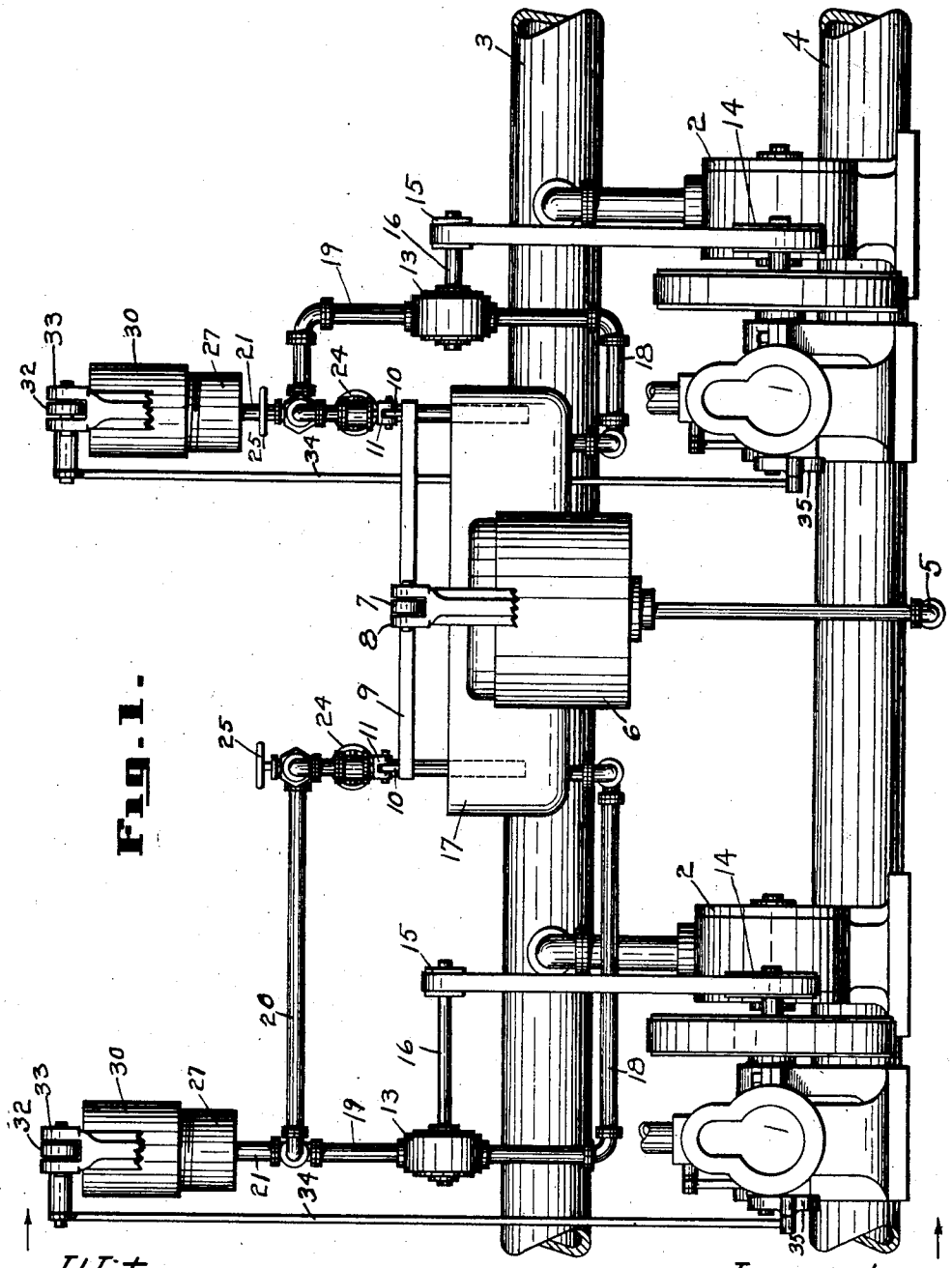


Fig. 1.

Witnesses.
Edwin James.

Inventor.
Harry F. Smith
By Kerr, Page, Cooper & Hayward.
Attorneys

H. F. SMITH.

SPEED GOVERNING MECHANISM FOR PRIME MOVERS.

APPLICATION FILED OCT. 1, 1917.

1,381,512.

Patented June 14, 1921.

3 SHEETS—SHEET 2.

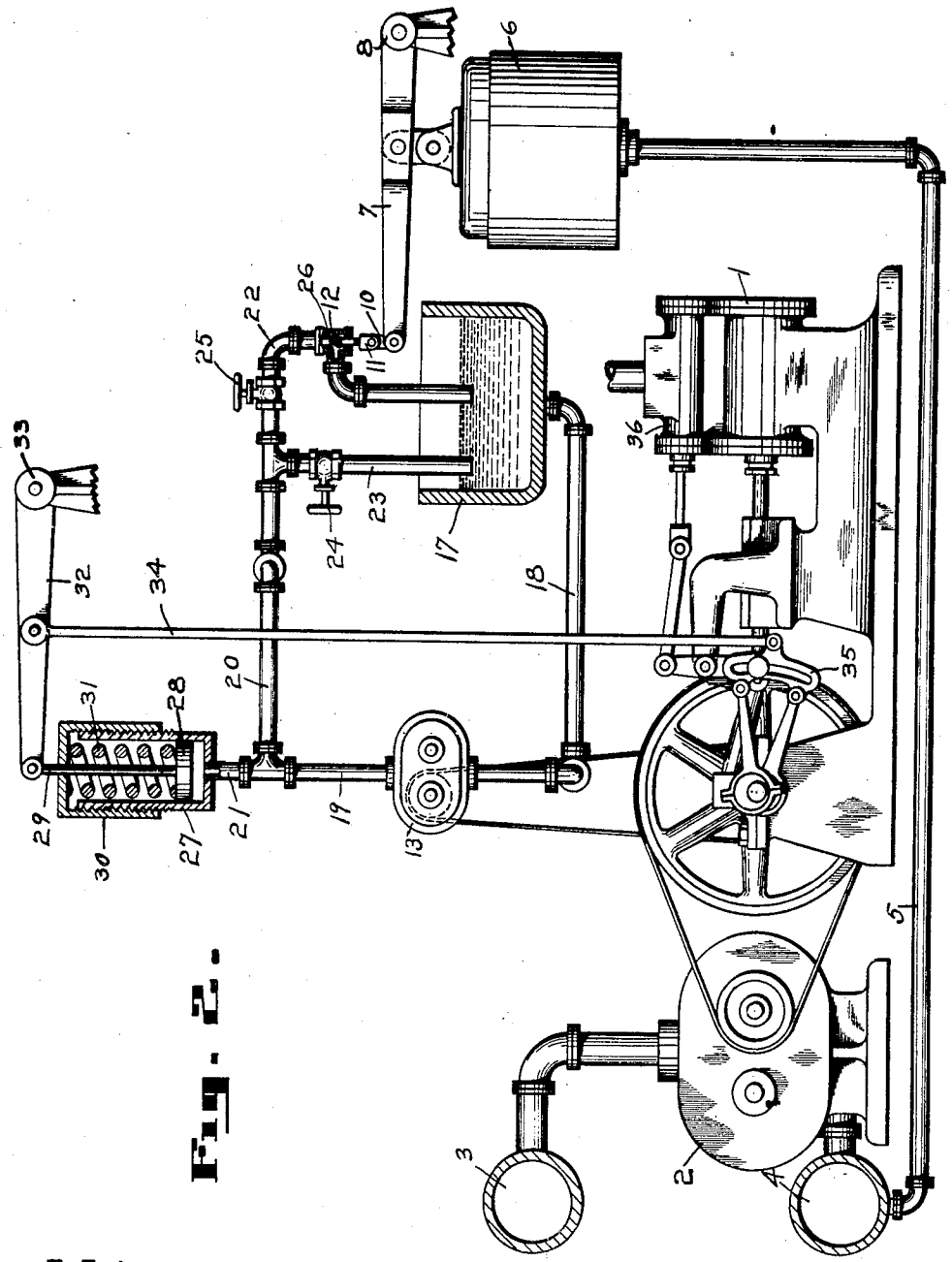


Fig. 2.

Witnesses.
Edwin James

Inventor.
Harry F. Smith

By Kerr, Page, Cooper & Hayward
Attorneys.

H. F. SMITH.

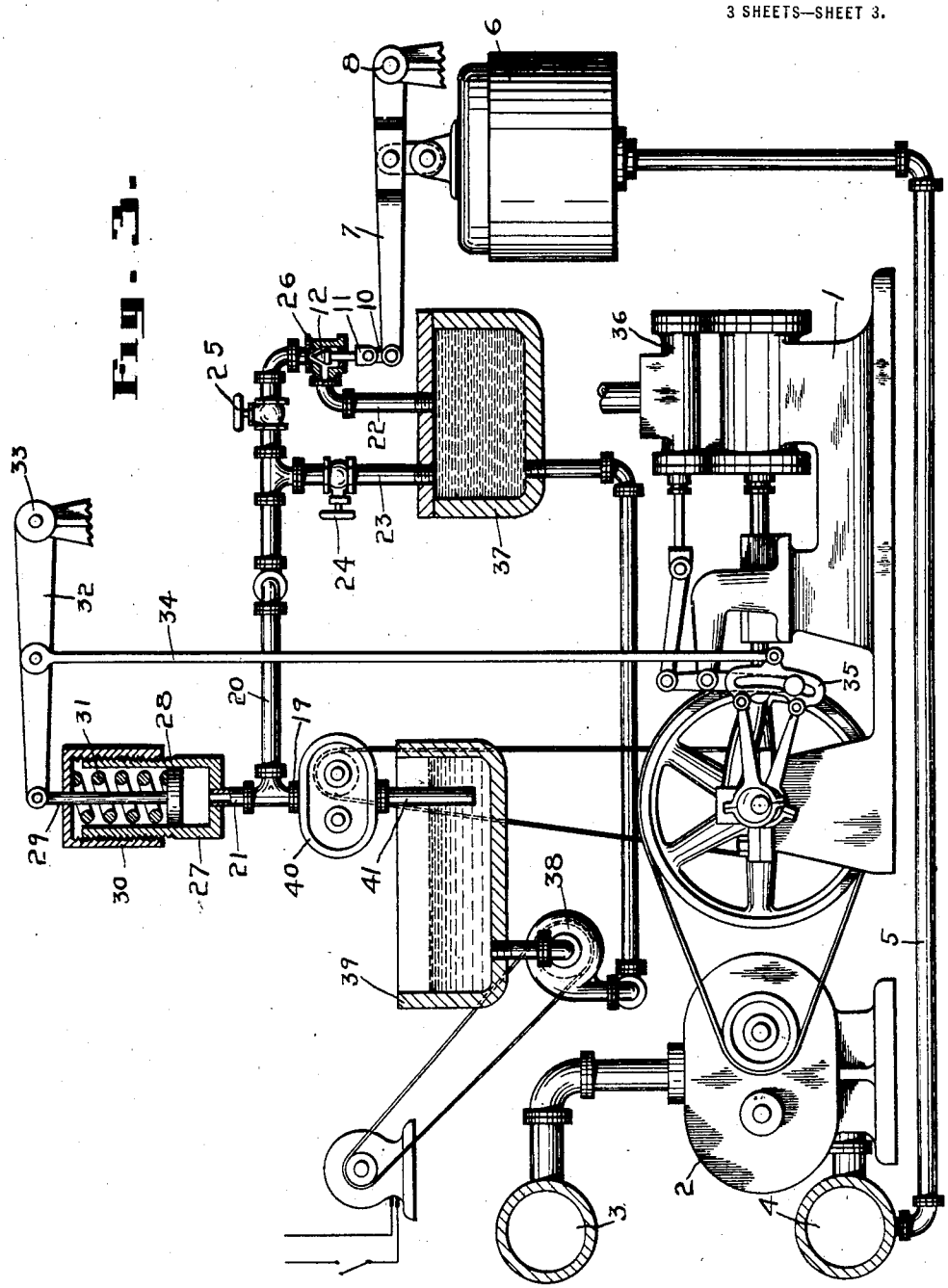
SPEED GOVERNING MECHANISM FOR PRIME MOVERS.

APPLICATION FILED OCT. 1, 1917.

1,381,512. Patented June 14, 1921.

3 SHEETS—SHEET 3.

Fig. 3.



Witnesses.
Edwin James.

Inventor.
Harry F. Smith

By Kerr, Page, Cooper Hayward.
Attorneys.

UNITED STATES PATENT OFFICE.

HARRY F. SMITH, OF LEXINGTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE GAS RESEARCH COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

SPEED-GOVERNING MECHANISM FOR PRIME MOVERS.

1,381,512. Specification of Letters Patent. Patented June 14, 1921.

Application filed October 1, 1917. Serial No. 194,165.

To all whom it may concern:

Be it known that I, HARRY F. SMITH, a citizen of the United States of America, residing at Lexington, Richland county, Ohio, have invented certain new and useful Improvements in Speed-Governing Mechanism for Prime Movers, of which the following is a full, clear, and exact description.

This invention relates to a system for regulating or governing engines, and more particularly to a system for controlling a plurality of engines so as to insure uniform operation thereof.

In systems for delivering liquids or gases under pressure it is quite common to employ a plurality of pumps for forcing the liquid or gas from a source of supply into the delivery main. In such systems it is very desirable that each pump furnish the same quantity to such main. Especially is this true where the pumps are functioning as exhausters for a multi-unit gas producer system or other analogous apparatus. In systems of this character it is essential that each unit thereof furnish a proportional part of the gas supplied to the main and the only way to insure this condition is to so govern the several pumps or exhausters that each one will operate at a definite rate of speed. It is also desirable that the speed of all of the pumps collectively, and consequently the quantity of gas delivered by them, be regulated according to conditions in the gas main. In other words, it is desirable that all of the pumps be kept at a uniform speed regardless of varying local conditions, and further, that all of the pumps collectively be driven at a speed dependent upon conditions in the main. Each of these pumps or exhausters is driven by a prime mover of some sort, generally a steam engine, and in order to insure a uniform speed thereof, it is only necessary that these driving engines be properly regulated.

In such regulation the regulating mechanism must be adapted not only for controlling all of the prime movers collectively and each unit thereof separately, but must also be adapted to prevent any variation of operating speed in either direction beyond a predetermined minimum and maximum. It has been found—where the prime mover is, for instance, a steam engine—that if for any reason any one of the prime movers slows down below a certain minimum speed there will not be sufficient momentum to turn the fly wheel over and thus keep it in operation. In such case the prime mover will stop. Immediately the gas will back up in the ash pit below the grate of the producer and cause dangerous explosions. Also the gas in the main being under pressure will cause the exhauster to function as a motor and reverse the driving engine. As a result gas will be pumped from instead of into the main, thus further increasing the danger from explosion in the ash pit. This will also cause a decrease of pressure in the main, the effect of which will be to cause the other engines to speed up to compensate for such decreased pressure. If this decrease is substantial, as it would be under generally existent conditions, the other engines will tend to race at a dangerous speed. It is, therefore, evidently necessary for the regulating mechanism to be so arranged that none of the prime movers may fall below a minimum or exceed a maximum speed of operation.

One object of this invention is to provide a system of regulation for controlling a plurality of engines adapted to insure a uniform and constant speed, *i. e.*, a constant number of revolutions per minute of all of the engines collectively, a constant speed of each individual engine, and at the same time to limit the maximum and minimum speed of operation of each and all of the engines.

Another object is to provide a control system for use in connection with a plurality of prime movers, and adapted to control the speed of operation of each prime mover separately, and of all the prime movers together.

Other objects and advantages of the present invention will be apparent from the description thereof set out below.

For purposes of description I make use of the apparatus shown in the drawing which has been worked out especially for use in connection with a multi-unit suction gas producer in which a separate exhauster is used with each unit of the producer.

In the drawing in which like characters of reference designate like parts:

Figure 1 is a view in elevation showing

my regulating mechanism applied to a plurality of steam engines for driving gas exhausters,

Fig. 2 is a view at right angles to Fig. 1 looking in the direction of the arrows, with parts of the structure shown in section to more clearly disclose the mechanical details thereof,

Fig. 3 is a view similar to Fig. 2 showing a modified form of regulating mechanism.

In the drawing 1 designates a plurality of steam engines adapted for driving the exhauster pumps 2. These exhausters are constant displacement gear pumps and when driven by the engines 1 withdraw gas from the main 3 and force this gas under pressure into the delivery main 4. The capacity of the exhausters 2 at any definite speed is, of course, constant, and variations in the amount of gas pumped thereby can be insured only by varying their speed of operation. And this speed of operation can be varied, when connected as shown in the drawing, only by varying the speed of the driving engines.

Leading from the delivery main 4 is a pipe 5 which opens into the lower end of a gasometer 6. Pivotally connected to the upper bell of the gasometer 6 is a lever 7, one end of which is fulcrumed to some stationary part of the apparatus as at 8. The other end of the lever 7 carries thereon a rigidly attached cross rod 9 the opposite ends of which have links 10 pivotally connected thereto. Pivotally attached to each of the links 10 is a socket 11 having a needle valve 12 adjustably mounted therein. Any variation in pressure within the delivery main 4 will cause a corresponding variation of pressure within the gasometer 6 with an ensuing rise or fall of the upper bell of the gasometer and a corresponding rise or fall in the free end of the lever 7.

Located above the engines 1, and driven thereby, are two constant displacement gear pumps 13. As shown each of these pumps is driven by means of a belt passing over a driving pulley 14, attached to the fly wheel of each engine 1 and a driven pulley 15, keyed to a shaft 16, which is operatively connected to the rotors of the pump. It is evident that variations in the speed of operation of any one of the engines will cause corresponding variations in the speed of operation of the pump driven thereby to vary the volume of fluid pumped by it. Leading from the tank 17 are pipes 18 opening into the casings of the pumps 13 and adapted to supply those pumps with the oil or analogous liquid stored in the tank 17.

Leading from each of the pumps 13 is an outlet pipe 19 divided into two branches 20 and 21. One of these branches, the pipe 20, leads to the tank 17. Each branch pipe 20 before reaching the tank 17 is itself divided into two branches 22 and 23. Located in each branch pipe 23 is a valve 24 for controlling the flow of fluid therethrough. Located in each branch pipe 22 is a valve 25, similar to the valve 24, for controlling the flow of fluid through that branch. Also located in each branch pipe 22 is a needle valve 12 which coöperates with a seat 26 to further regulate the flow of fluid through that pipe. Each of the valves 24 and 25 is a manually operated valve adapted to be so set as to limit to a permanent and desired quantity the flow of fluid through each of the branch pipes controlled thereby. The valves 12, however, are automatically operated by the lever 7, which, as described above, is itself automatically operated by the gasometer 6, such operation being dependent upon variations of pressure in the gasometer 6 caused by corresponding variations of pressure in the delivery pipe 4, so that variations in pressure in the gas main will cause corresponding variations in the amount of oil that may escape through the valves 12 from the branch pipes 22. The branch pipes 21 lead into the lower ends of the cylinders 27. Mounted in each cylinder 27 is a piston 28, having a stem 29 attached thereto. The top 30 of each cylinder 27 is adjustably connected thereto. In each cylinder between the top 27 and the piston 28 is a spring 31 adapted to force the piston toward the lower end of the cylinder. By means of the adjustable cap 30, the tension of spring 31 may be varied and the force tending to urge the piston 28 toward the lower end of the cylinder thus increased or decreased as desired. Each piston rod 29 is attached to one end of a lever 32, the other end of which is fulcrumed to some fixed part of the apparatus as at 33. Attached to each lever 32, between the fulcrum 33 and the point of attachment of the rod 29, is a rod 34. The other end of each rod 34 is connected to any conventional link mechanism for controlling the speed of the engines 1. As shown in the drawing, each of the engines 1 has the conventional Stephenson link mechanism 35 connected to the distributing valve 36 thereof for varying the cut-off of such valve and thus causing any desired variation in the speed of the engine. Each rod 34 is attached to the link mechanism 35 so that up or down motion thereof will cause such a change in the relative positions of the various elements of the link mechanism as to bring about a corresponding change in the cut-off of the distributing valve to thus bring about an increase or decrease in the speed of the engine controlled by such link mechanism. Upward movement of either piston 28 will cause a corresponding upward movement of the rod 34 connected thereto to cause a decrease in the speed of the particular en-

gine with which such rod 34 coöperates. Such upward movement of piston 28 will be caused by an increase in the speed of operation of pump 13, for such increase in speed of operation will result in the in-flow of an increased quantity of fluid to the lower end of cylinder 27 below the piston 28. And as an increase in speed of operation of pump 13 is solely dependent upon an increase in the speed of operation of the engine driving such pump, it is evident that increases in the speed of either of the engines 1 will, through its pump 13, cylinder 27, and rod 34 coöperating with that particular cylinder, cause such a change in the link mechanism 35 as will vary the cut-off of the valve 36 to decrease the speed of that engine 1 in such wise as to return it to normal conditions of operation. Likewise decrease in the speed of operation of any one of the engines 1 will result in a corresponding decrease in the speed of operation of pump 13 coöperating therewith to bring about such variation in the positioning of the link mechanism actuated thereby as will increase the speed of the engine thus governed to return it to normal conditions of operation.

The valves 24 and 25 are so set that, under normal conditions of operation, the pumps 13 will pump sufficient of the fluid in the tank 17 through the pipes 19 and the branches 20 and 21 to cause a definite pressure of such pumped fluid within the lower ends of cylinders 27. In other words the return of fluid through the valves 24, 25 and 12 is so fixed with relation to the speed of operation of the pumps 13 that under normal conditions a definite pressure will be maintained in the cylinders. Each valve 25 is adapted to so control the flow of liquid through the branch pipe 22 that undue pressure will not be exerted at the needle valves 12. As shown in the drawing it is clear that the valves 24 having once been set, the flow of liquid therethrough will be constant. The position of the valves 12, however, is dependent upon the pressure in the gasometer 6. If the pressure in the gasometer 6 remains constant, each valve 12 will maintain a definite opening therethrough, and the flow of fluid through the pipes 20 will be definite in quantity. If, however, pressure in the delivery main 4 varies, such variation will immediately be transmitted to the gasometer 6 to cause a corresponding variation in the opening of the valves 12. This variation in the opening of valves 12 will immediately permit a greater or less quantity of fluid to escape through the pipes 20 into the tank 17 with an ensuing increase or decrease in the pressure below the pistons in the cylinders 27. Such variation of pressure will, through the mechanism actuated by the pistons 28, cause an increase or decrease in the speed of the engines driving the exhausters 2, to compensate therefor. In this way the speed of both engines is regulated in unison to accord with variations of pressure in the delivery main 4.

If for any reason either engine has the speed thereof increased or decreased, and such variations might readily be caused by a number of different local causes, the speed of the pump connected with that particular engine will at once be affected so that the quantity of fluid pumped thereby will vary. Since the valve 24 has a definite opening therethrough at all times, and the opening through the valve 12 is constant except when the pressure in the delivery main 4 varies, the quantity of fluid escaping through the pipe 20 back into the tank 17, due to such increase or decrease in speed of operation, will be relatively greater or less than when the pump is operating at normal speed. Consequently the amount of fluid pumped to the cylinder 27 will be varied, the piston 28 will be urged toward or from the lower end of the cylinder, the rod 34 will be likewise moved, and, acting upon the link mechanism 35, will cause a variation in cut-off of the valve 36 to vary the speed of the engine until it is again operating at normal, predetermined speed.

In the modified form of my device, shown in Fig. 3, I substitute for the tank 17 of Fig. 1, a closed tank 37, supplied with oil or other fluid by the pump 38, which, as shown, is driven from an independent power source. As shown this independent power source consists of an electrically operated motor, but any desired source of power may be substituted therefor. The pump 38 is adapted to give a constant pressure in the tank 37. The pump 38 has inlet pipes thereto leading from open tanks 39. Driven by each engine 1 is a gear pump 40 having its inlet port connected to the pipe 19 and its outlet port connected to a pipe 41 which opens into the tank 39. The branch pipes 22 and 23 open into the tank 37, and are controlled by valves 24, 25 and 12 similar in location and operation to the corresponding valves shown in Figs. 1 and 2. The pumps 40 being driven by the engines 1 are of course subject to variations in speed of operation corresponding to variations in the speed of operation of the engines.

The mode of operation of this modified structure is as follows: The pump 38 being driven from an independent power source at a constant rate of speed, supplies oil to the tank 37 at a definite pressure and in a definite quantity, which quantity is such that some part thereof passes off through the branch pipes 22—23, into the cylinders 27, causing a rising or falling of the pistons in those cylinders, according to the quantity of oil supplied thereto. The pumps 40 during

operation remove, through the pipes 19, a part of the oil supplied through the pipes 22—23 and 20 to the cylinders 27, pumping the oil so removed into the tank 39. And the volume of liquid passing through the pumps 40 for any definite speed is constant despite variations of pressure in the cylinders 27. The oil thus pumped into the tank 39 furnishes a supply for the pump 38. There is thus a continuous flow of oil through the entire system, so that only a limited quantity is necessary in operating this regulating mechanism. Inasmuch as the speed of the pumps 40 is dependent upon the speed of operation of the engines with which those pumps are connected, it is evident that the amount of oil pumped out of the cylinders 27 will vary according to the speed of the individual engines connected thereto. Increase or decrease in the speed of operation of any one of the engines 1, therefore, will result in a corresponding variation of position of the piston 28 coöperating with that particular engine to thus cause a change in its distributing valve cut-off with a resulting variation in speed of operation. Also any variation of pressure in the gas main 4 will cause a corresponding variation of pressure in the gasometer 6 to bring about a corresponding change in the relative opening of valves 12. Such variation in the opening of valves 12 will result in a greater or less quantity of oil flowing into the cylinders 27 to bring about a greater or less speed of operation of the engines.

From the above description it is evident that since the opening of the valves 24 is fixed none of the engines can be slowed down sufficiently to cause stopping thereof, for even though the valves 12 be entirely closed, sufficient oil can always pass through valves 24 and branch pipes 23 to insure a definite minimum speed of operation. Likewise none of the engines can be made to race at a speed greater than the desired maximum, for while the opening of the valves 12 is variable, the effective maximum opening thereof can be limited as desired by means of the valves 25 regardless of the decrease in pressure of the gas main so that the maximum amount of oil that may pass through the valves 24 and 25 is limited, and the maximum speed of operation of the engines is thus also limited. It is evident too, from the above description, that my regulating mechanism is adapted to control each individual engine of a plurality of such engines so as to insure a constant speed of operation thereof despite varying local conditions tending to increase or decrease that speed of operation. It is also obvious that my regulating apparatus will in addition control all of these engines in unison so that the speed of operation of all of them will be governed to accord with conditions in the delivery main. It is further obvious that by my regulating mechanism each of the engines may be confined within a certain definite maximum and minimum speed of operation and thus prevented from stopping or racing unduly.

It is also quite obvious that my invention is by no means limited to the specific apparatus disclosed, inasmuch as the various mechanical details thereof may be varied as desired to meet conditions other than those present in such a system as disclosed. For my system of regulation can be readily adapted to control steam engines operating devices other than gas pumps and can also be adapted to control prime movers other than steam engines. I by no means limit myself therefore to the precise apparatus disclosed, but for a definition of the scope of my invention reference should be made to claims appended hereto.

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

1. A regulating device for a plurality of prime movers comprising in combination, pressure operated means actuated by each separate prime mover for insuring a predetermined speed thereof, and other pressure operated means coöperating with said first named means for insuring a uniform speed of operation of all the prime movers.

2. A regulating device comprising in combination, a plurality of prime movers, pressure operated pistons for varying the speed of said prime movers separately, means operated by said prime movers for actuating said pressure operated pistons, and means coöperating with said actuating means to vary the speed of operation of all said prime movers in unison.

3. A regulating device comprising in combination, a plurality of prime movers, pressure operated pistons for regulating the speed of operation of the prime movers separately, pumps operated by said prime movers for varying the pressure on said pistons and separate pressure operated means for varying the pressure on said pistons to vary the speed of operation of all said prime movers in unison.

4. A regulating device for pumps comprising in combination, a plurality of pumps, a plurality of prime movers for driving said pumps, means for regulating each prime mover to insure a definite speed of operation of the pump driven thereby, and pressure operated means to vary the speed of operation of all the pumps in unison.

5. A regulating device for pumps comprising in combination, a plurality of pumps, an engine for driving each pump, means actuated by each engine for regulating the speed of operation thereof, and pressure operated means coöperating with the said first named means to regulate the speed of operation of all the engines in unison.

6. A regulating device for pumps comprising in combination, a plurality of pumps, engines for driving the pumps, pressure operated means actuated by each engine for regulating the speed thereof, and pressure operated means coöperating with said first named means to regulate the speed of all the engines according to the pressure of the gas pumped.

7. A regulating device for a plurality of prime movers comprising in combination, means for regulating the speed of each prime mover separately, means for regulating the speed of all the prime movers in unison, and means coöperating with said first and second named means for insuring a definite possible maximum and minimum speed of operation for each prime mover.

8. In a regulating device for a plurality of prime movers, and in combination, pressure operated means for governing the speed of operation of each prime mover, pressure operated means for varying the speed of all of the prime movers in unison, and means coöperating with said two pressure operated means for insuring a definite possible maximum and minimum speed of operation for each prime mover.

9. A regulating device for pumps comprising in combination, a plurality of pumps, engines for driving the pumps, pressure means for regulating the speed of each engine, coöperative pressure operated means for regulating the speed of all the engines in unison according to the pressure of the fluid pumped, and means for insuring a definite possible maximum and minimum speed of operation of each engine.

10. A regulating device for pumps comprising in combination, a plurality of pumps, engines for driving the pumps, pressure means actuated by each separate engine for governing the speed thereof, coöperating separately actuated pressure operated means for regulating the speed of all of the engines in unison according to the pressure of the fluid pumped, and means for insuring a definite possible maximum and minimum speed of operation of each engine.

11. A speed regulating system for a plurality of pumps, blowers, or the like, comprising, in combination, a plurality of pumps; a prime mover for driving each pump; and speed controlling means associated with the prime movers: said means comprising a mechanism associated with each prime mover and variably actuated by its associated prime mover; other mechanism associated with all the prime movers and actuated uniformly from an independent power source; and still other mechanism, responsive to variable pressures in the delivery main leading from said pumps; the three said mechanisms, when acting in cooperative relation, controlling the speed of operation of each prime mover individually, the speed of operation of all the prime movers together, and the possible maximum and minimum speed of operation of all said prime movers.

12. A speed regulating mechanism for a plurality of prime movers; comprising in combination means constructed to automatically and positively control the speed of operation of each separate prime mover; and a second means coöperating with said first named means, said first and second named means being adapted when operating in cooperative relation to control the speed of all the prime movers in unison.

13. A regulating device for a plurality of prime movers; comprising in combination, governing mechanism for each prime mover, including a separate means operated by each prime mover and adapted to vary the functioning of the governing mechanism for such prime mover; and separately operated means coöperating with the first named means, the two said means when operating in coöperative relation being adapted to control the speed of each prime mover separately and of all the prime movers in unison.

14. A speed regulating mechanism for a plurality of prime movers; comprising in combination, a pressure operated governing mechanism for each prime mover, including means operated by each prime mover for varying the pressure operating the corresponding governing mechanism in accordance with variations in the speed of operation of the prime mover; and other means separately operated for varying the pressure operating all of the governing mechanisms, the operation of the two pressure varying means being so balanced as to control the speed of each prime mover separately and of all the prime movers in unison.

15. A speed regulating mechanism for a plurality of prime movers; comprising in combination, a pressure operated governing mechanism for each prime mover, a pump driven by each prime mover and tending to vary the pressure operating the corresponding governing mechanism in accordance with variations of the speed of operation of such prime mover; and a separately operated pump tending to uniformly vary the pressure operating all of the governing mechanisms, the relative operation of the two sets of pressure varying pumps being such that the resultant pressure operating each governing mechanism will tend to individually control the speed of operation of each separate prime mover to accord with the speed of operation of the other prime movers, and the speed of operation of all the prime movers in unison.

16. A speed regulating mechanism for a plurality of prime movers; comprising in

combination, a pressure operated governing mechanism for each prime mover; means tending to uniformly vary the operating pressure of all the governing mechanisms in unison; and a separate means operated by each prime mover, each such separate means tending to vary the operating pressure of its coöperating pressure operated governing mechanism according to the speed of operation of its coöperating prime mover.

17. A speed regulating mechanism for a plurality of prime movers, comprising in combination, means for automatically controlling the speed of each separate prime mover; and other controlling means coöperating with said first named means; the said means when operating in coöperative relation being adapted to maintain each prime mover at the same speed of operation as the other prime movers and to vary the speed of operation of all the prime movers in unison.

18. A speed regulating system for a plurality of prime movers; comprising, in combination, a pressure operated governing mechanism associated with each prime mover, and adapted to control the speed thereof; means actuated by each prime mover and constructed to cause variations in the operating pressure, affecting said pressure operated governing mechanism, to accord with variations in the speed of operation of the corresponding prime mover; a separate means associated with said pressure operated governing mechanism and said first named means and constructed to uniformly affect said operating pressure; and means associated with both said first-named means and said separate means adapted when functioning in conjunction with said two sets of means to affect the said operating pressure; all said means when operating coöperatively being adapted to control the speed of operation of each prime mover individually, and all of the prime movers together.

19. A speed regulating device for pumps, blowers, or the like, comprising, in combination, a plurality of pumps, blowers, or the like, having a common delivery main; a prime mover for driving each pump; and speed controlling means associated with the prime movers; said means comprising; a pressure actuated governor associated with each prime mover; pump mechanism driven from an independent power source and tending to maintain constant the pressure actuating each governor; a pump, associated with each prime mover, and variably actuated thereby, said last named pumps each tending to vary the pressure actuating its associated governor in accordance with variations in the speed of operation of its associated prime mover; and mechanism responsive to pressure conditions in the delivery main, tending to vary the pressure actuating all of the governors, said pressure responsive means tending to vary the actuating pressures in unison and in accordance with varying pressures within the delivery main; the two pump mechanisms and the pressure responsive mechanism when acting in coöperative relation controlling the speed of operation of each prime mover individually, the speed of operation of all the prime movers together, and the possible maximum and minimum speed of operation of all said prime movers.

In testimony whereof I affix my signature.

HARRY F. SMITH.