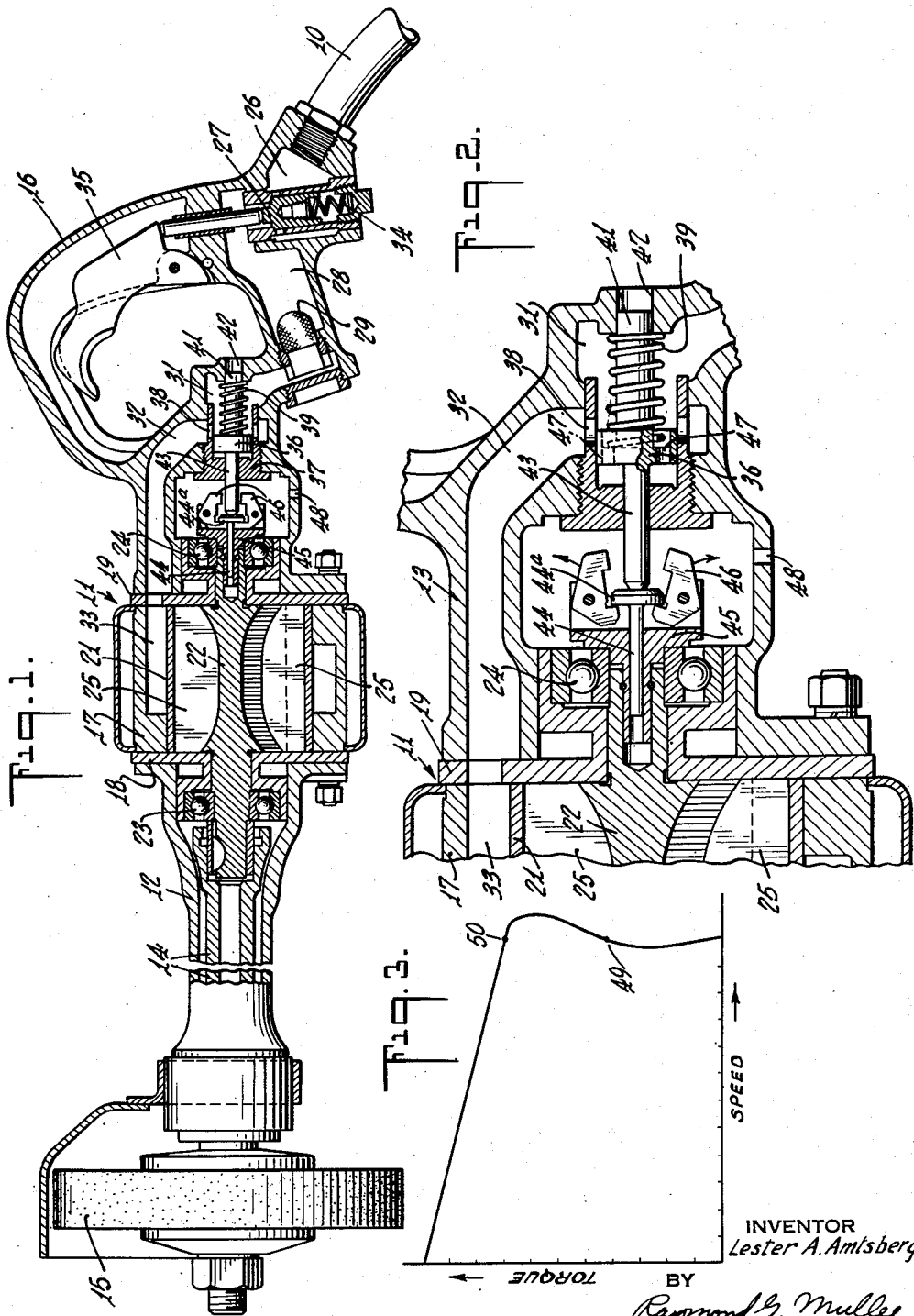


June 24, 1941.

L. A. AMTSBERG
OVERBALANCED GOVERNOR
Filed July 30, 1940

2,246,910



UNITED STATES PATENT OFFICE

2,246,910

OVERBALANCED GOVERNOR

Lester A. Amtsberg, Cleveland, Ohio, assignor to
Chicago Pneumatic Tool Company, New York,
N. Y., a corporation of New Jersey

Application July 30, 1940, Serial No. 348,503

17 Claims. (Cl. 121—34)

This invention relates generally to means for controlling automatically the speed of operation of a pressure fluid operated rotary motor, and relates more particularly to mechanism of this type exercising its control through a variable restriction of the supply of pressure fluid to the motor.

The principal object of the invention is to permit a pressure fluid operated rotary motor to attain a greater speed when operating under normal working loads than it is capable of attaining when idling or operating under a light load.

Another object of the invention is to control the supply of pressure fluid to a motor of the class described through means responsive in its action not only to the speed of the motor but also to the varying loads imposed upon the motor.

According to one contemplated embodiment of the invention the control means for carrying out the above objects takes the form of a governor mechanism including a governor valve urged from closed position by a spring, and urged toward closed position by a yielding pressure means which varies in intensity in inverse relation to the rise and fall of the load on the motor. Thus, the effective resultant force urging the governor valve toward wide-open position is at a minimum when the motor is idling and increases as the motor load increases.

Other objects and structural details of the invention will be more apparent from the following description when read in conjunction with the accompanying drawing, wherein:

Fig. 1 is a view in longitudinal section of a portable pneumatic tool embodying the device of the present invention;

Fig. 2 is a fragmentary enlarged view of a portion of Fig. 1, showing the governor mechanism in a position it may assume during operation of the tool; and

Fig. 3 is a graph showing the relation between torque and speed of a motor controlled by a typical embodiment of the invention.

The device of the invention has a general application to any machine or tool powered by a pressure fluid operated motor. It is however, particularly adapted for use in a pneumatic grinding or like tool and is disclosed as embodied in such a tool.

As shown in Fig. 1, the present tool is a relatively small and light unit which is connected by a flexible hose line 10 to a remote source of pressure fluid, and may be manually carried about and applied to the work anywhere within the

range of the hose line. The structure of the tool includes a motor housing assembly 11 and front and rear auxiliary housing sections 12 and 13 secured to the respective front and rear ends of the motor housing. A rotatable spindle 14 is supported within the front housing section 12 and has secured to its outer end a work performing implement; in this instance a grinding wheel 15. The rear housing section 13 is formed with a handle 16 and contains certain throttle control mechanism and pressure fluid supply passages later to be described. The motor housing assembly 11 includes a cylinder 17, end plates 18 and 19 closing the respective front and rear ends of the cylinder, and a replaceable lining strip 21 which acts as the inner surface of the cylinder. Within the cylinder 17 is a rotor 22, the opposite ends of which are supported by bearings 23 and 24 mounted in the respective end plates 18 and 19. The front end of the rotor 22 is keyed to the spindle 14 whereby a rotary motion of the rotor is caused to effect a corresponding movement of the spindle and grinding wheel 15. Following the usual construction of rotary air motors, the rotor 22 is provided with a plurality of radially extending vanes, or blades, 25 loosely positioned in slots extending longitudinally through the rotor between the side plates 18 and 19. During operation of the motor, the blades 25 are pressed outward into engagement with the lining strip 21 and form pockets into which live air is introduced to drive the rotor.

Pressure fluid for operating the rotor 22 is admitted to the tool through the hose line 10 which is connected to the lower end of handle 16. Air from the hose line is discharged into an inlet 26 and may then flow, under the control of a throttle valve 27 to a passage 28. An air filter 29 is positioned in the passage 28 and, after passing through the filter, the air is directed to a chamber 31 in the forward end of the handle 16. A passage 32, establishing communication between the chamber 31 and a groove 33 in motor cylinder 17, completes the path along which the pressure fluid travels between the inlet 26 and the motor. Groove 33 opens into the interior of the cylinder 17 and communicates with successive rotor pockets as the rotor turns about its axis. Before reaching the live air groove 33 each rotor pocket is momentarily connected to exhaust. The throttle valve 27 is normally held closed by a spring 34 and may be moved to open position by an actuating lever 35 pivotally mounted in the handle 16 and readily accessible for manual op-

eration. The valve 27 functions simply as an on and off control, either permitting or preventing the flow of air from the inlet 26 into the motor supply passages. It is not intended, nor is it necessary, for this valve to be variably adjusted in order to control operation of the motor by increasing and diminishing the supply of motive fluid thereto.

The means for controlling the flow of pressure fluid within the motor supply passages resides in a governor assembly including a governor valve 36 movable within the chamber 31. Referring also to Fig. 2, the valve 36 is slidably mounted within a bushing 37 positioned in the chamber 31 and having a set of ports 38 establishing communication between the chamber 31 and passage 32. The valve 36 normally stands in the open position of Fig. 1, with respect to the set of ports 38, and is movable to and beyond the position of Fig. 2 toward closed position, with respect to the ports 38. Thus the rate of flow of the pressure fluid from chamber 31 to passage 32 is determined by the position of the governor valve 36 relatively to the set of ports 38. Forward movement of the valve 36 (to the left, as viewed in Figs. 1 and 2) permits an increased flow of air into passage 32 and thereby to the motor, while rearward movement of the valve (to the right in Figs. 1 and 2) serves to reduce such flow.

The governor valve is urged toward the open position of Fig. 1 by a yielding means and is moved toward closed position, against the pressure of the opposing yielding means, by generally conventional speed responsive mechanism. The yielding means comprises a compression spring 39 surrounding a rearwardly extending stem 41 of the valve 36 and interposed between the rear wall of chamber 31 and the rear face of the valve. The outer end of the stem 41 is guided in an opening 42 in the housing 13 and is exposed to the atmosphere. The above-mentioned speed responsive mechanism actuates the governor valve 36 through a forwardly extending stem 43 thereof. The stem 43 extends through the closed outer end of the bushing 37 and engages the head 44a of an actuating plunger 44. The plunger 44 is movable coaxially of the stem 43 and rotor 22 and is supported within an extension 45 of the rotor shaft. The extension 45 turns with the rotor 22 and carries a pair of governor weights 46 having fingers engaging the inner face of plunger head 44a. The weights 46 are pivotally mounted in the slotted outer end of extension 45 and rock outward, in response to centrifugal force, to press the plunger 44, and thereby stem 43 and valve 36, rearwardly. Under the control of the spring 39 and weights 46, the governor valve 36 responds to each variation in speed of the rotor 22 by a movement toward or from closed position relatively to the ports 38. Thus as the speed of the rotor 22 increases, the valve 36 moves rearwardly to reduce the flow of air to the motor and so functions to prevent the rotor from exceeding a predetermined maximum speed. A reduction in speed of the rotor below the set maximum is reflected by a forward movement of the governor valve and a consequent increase in the flow of pressure fluid to the motor.

Variations in speed of the rotor 22 are occasioned by the varying resistance encountered by the grinding wheel 15. This resistance, or load, is at a minimum when the machine is idling and increases from that point proportionately with

the pressure with which the grinding wheel is forced into engagement with the work. It is desirable that the idling speed of the motor be established at the lowest possible level in order to minimize wear of the vanes 25 and lining strip 21, as well as to guard against breakage of the grinding wheel. In the conventional governor controlled motor, the idling speed represents the maximum speed permitted by the governor. Since it is necessary to set the maximum speed at a relatively high level to obtain efficient operation of the tool, under load, it may be said that the idling speed of the usual motor is excessively high.

In an effort to solve the problem thus presented, the conventional governor mechanism has been modified in order that it may function to permit the motor to attain one speed while idling, and to attain another and higher speed while under load. In effecting this modification advantage has been taken of the fact that the pressure in the chamber 31 decreases as the load on the motor increases, and increases as the load decreases. This condition is the result of the action of the governor in maintaining the motor speed within close limits. As the load is increased more air is required to operate the motor and the resulting increased flow of air causes a greater amount of fluid friction in the motor supply passages and a consequent drop of pressure therein. As is best shown in Fig. 2, the valve 36 is formed with a set of ports 47 which permit the live air in chamber 31 to pass through the valve and act on the front face of the valve with a pressure per unit area equal to that with which it presses on the rear face thereof. It will also be noted that the diameter of valve stem 41 is greater than the diameter of stem 43 so that the area at the front of valve 36 which is exposed to live air is greater than the corresponding area at the rear of the valve. The opposing air pressures on opposite sides of the valve 36 are therefore unbalanced, the greater force being exerted in a direction tending to move the valve rearwardly, or toward closed position. This pressure being opposed to that of the spring 39 the resultant actuating force urging the valve 36 leftward, toward open position, is equal to the spring pressure less the overbalanced air pressure. While the motor is idling or operating under a light load the overbalanced air pressure is at a maximum height and the resultant force opposing the actuating plunger 44 is at a minimum. At this time, therefore, the valve 36 may be moved toward closed position with comparative ease and the rotor 22 is held to a low maximum speed. As the motor load is increased the overbalanced air pressure drops and the resultant force opposing plunger 44 increases, with the result that the rotor 22 may reach and surpass its maximum idling speed without effecting a full operation of the governor valve. Stem 43, like stem 41, is exposed to atmospheric pressure at its free end, a vent port 48 being provided for this purpose.

The graph of Fig. 3 indicates by a diagrammatic curve the relation between torque (load) and speed in a tool embodying the present governor. The normal working range is generally between the points 49 and 50. Above the point 50 the curve is a straight line because the governor is fully open under these high torque conditions. For a considerable part of the normal working range, the speed drops as the torque de-

creases and the drop in speed continues as the tool is relieved of its load and approaches idling condition. In prior art devices, release of the load usually caused the motor to speed up, thereby wasting pressure fluid, and increasing the amount of wear and likelihood of breakage of movable parts.

What is claimed is:

1. In a device of the class described, the combination of a pressure fluid operated rotary motor, means for imposing a variable resistance to the operation of said motor, a governor mechanism controlling the speed of operation of said motor and including a governor control element exercising a variable restriction upon the supply of pressure fluid to said motor in response to variations in the speed of said motor, and means for causing said control element to respond to the speed of said motor with a degree of effectiveness varying inversely with the intensity of the resistance to operation of said motor.

2. In a device of the class described, the combination of a pressure fluid operated rotary motor, a pressure fluid supply passage leading to said motor, a control valve positioned in said passage and movable toward and from a closed position relatively thereto, speed responsive mechanism tending to move said control valve toward closed position as the speed of said motor increases, a yielding means urging said valve from closed position, additional yielding means urging said valve toward closed position, and means for increasing and reducing the pressure of said additional yielding means in inverse relation to the rise and fall of the load placed upon said motor.

3. In a device of the class described, the combination of a pressure fluid operated rotary motor, a pressure fluid supply passage leading to said motor, a control valve positioned in said passage and movable toward and from a closed position relatively thereto, said valve being exposed at each end thereof to the pressure fluid within said passage, means unbalancing the fluid pressures acting on said valve, the greater pressure being exerted in a direction tending to move said valve toward closed position, spring means urging said valve from closed position, and speed responsive mechanism tending to move said valve toward closed position.

4. In a device of the class described, the combination of a pressure fluid operated rotary motor, a pressure fluid supply passage leading to said motor, a control valve positioned in said passage and movable toward and from a closed position relatively thereto, a set of longitudinal ports in said control valve admitting pressure fluid to the opposite ends of said valve, and means for unbalancing the fluid pressures acting on said valve, the greater pressure being exerted in a direction tending to move said valve toward closed position.

5. In a device of the class described, the combination of a pressure fluid operated rotary motor, a pressure fluid supply passage leading to said motor, a governor mechanism for controlling the speed of operation of said motor and including a governor valve positioned in said pressure fluid supply passage and movable toward and from a closed position relatively thereto, said valve being exposed at each end thereof to the pressure fluid within said passage, and means for unbalancing the fluid pressures acting on said valve, the greater pressure being exerted in a direction tending to move said valve toward closed position.

6. A governor mechanism comprising a reciprocable governor valve, means for guiding said valve including a first valve stem projecting from one end of said valve and a second valve stem projecting from the opposite end of said valve, said second valve stem being greater in diameter than said first valve stem, spring means urging said valve in one direction, and speed responsive means for moving said valve in the opposite direction.

7. A governor mechanism comprising a reciprocable governor valve, means for guiding said valve including a first valve stem projecting from one end of said valve and a second valve stem projecting from the opposite end of said valve, said second valve stem being greater in diameter than said first valve stem, a set of longitudinal ports in said valve establishing communication between the areas at opposite ends of the valve, spring means urging said valve in one direction, and speed responsive means for moving said valve in the opposite direction.

8. A governor for fluid pressure rotary tools comprising a throttle valve, a passageway supplying pressure fluid to said throttle valve and offering resistance to the flow, centrifugal means tending to close the valve, spring means tending to open the valve, and fluid pressure means assisting the centrifugal means, said fluid pressure means having a pressure corresponding to the pressure at the discharge end of said passageway and thereby being adapted to drop as the flow of pressure fluid increases.

9. In a device of the class described, the combination of a pressure fluid operated rotary motor, a pressure fluid supply passage leading to said motor, a control valve positioned in said passage and movable toward and from a closed position relatively thereto, speed responsive mechanism tending to move said control valve toward closed position as the speed of said motor increases, means for imposing a variable resistance to operation of said motor, means resisting movement of said control valve toward closed position, and means supplementing the action of said speed responsive mechanism and opposing operation of said last named means with a force varying in intensity with changes in the resistance imposed on said motor.

10. In a rotary tool having a pressure fluid operated motor upon which a variable load is imposed in the operation of the tool, the combination of a throttle valve controlling the supply of pressure fluid to said motor, said valve being movable to increase and reduce the rate of flow of the fluid, speed responsive mechanism for moving said valve in one direction, opposed means of unequal pressures acting on said valve, the resultant force of said means being exerted in a direction to resist operation of said valve by said speed responsive mechanism, and means responsive to variations in the rate of flow of pressure fluid to said motor for increasing the pressure of the resultant force of said opposed means as the load imposed on said motor is increased.

11. A governor for pressure fluid operated rotary tools, comprising a throttle valve controlling the flow of pressure fluid through the tool, speed responsive mechanism for moving said valve in one direction, opposed means of unequal pressures acting on said valve, the resultant force of said means being exerted in a direction to resist operation of said valve by said speed responsive mechanism, and means for changing the degree of variance in the pressures of said opposed means to

increase and reduce the pressure of the resultant force thereof.

12. A governor for pressure fluid operated rotary tools, comprising a throttle valve controlling the flow of pressure fluid through the tool, said valve being movable toward and from a closed position to increase and reduce the rate of flow of pressure fluid thereby, means for controlling operation of said throttle valve including a first pressure means varying in intensity inversely with variations in the rate of flow of fluid past said valve and acting to move said valve toward closed position, and a second pressure means varying in effect in correspondence with variations in the rate of flow of fluid past said valve and acting to move said valve from closed position.

13. A governor for pressure fluid operated rotary tools, comprising a throttle valve controlling the flow of pressure fluid through the tool, said valve being movable toward and from a closed position to increase and reduce the rate of flow of pressure fluid thereby, first means responsive to variations in the rate of flow of fluid past said valve for pressing said valve toward closed position, the pressure of said first means tending to decrease in intensity as the rate of flow of fluid increases, and second means pressing said valve from closed position and variable in effect in response to changes in the intensity of the pressure of said first means.

14. A governor mechanism, comprising a gov-

ernor valve adapted for the control of a pressure fluid supply passage, means for directing pressure fluid to oppositely disposed faces of said valve, means for unbalancing the fluid pressures acting on said valve to set up a resultant force urging said valve in one direction, and additional pressure means acting on said valve in opposition to the resultant force of said fluid pressures.

15. A governor mechanism according to claim 14, characterized in that the fluid pressures acting on said valve are drawn from the fluid supply passage and have a pressure controlled by the rate of flow of fluid past said valve.

16. A governor mechanism, comprising a governor valve adapted for the control of a pressure fluid supply passage, speed responsive mechanism tending to move said valve in one direction, opposed pressures of the same intensity acting on said valve, means for unbalancing said opposed pressures to set up a resultant force aiding said speed responsive mechanism, and additional pressure means acting on said valve in a direction to resist the combined pressures of said speed responsive mechanism and the resultant force of said opposed pressures.

17. A governor mechanism according to claim 16, characterized in that the intensity of said opposed pressures is controlled by the rate of flow of pressure fluid past said valve.

LESTER A. AMTSBERG.