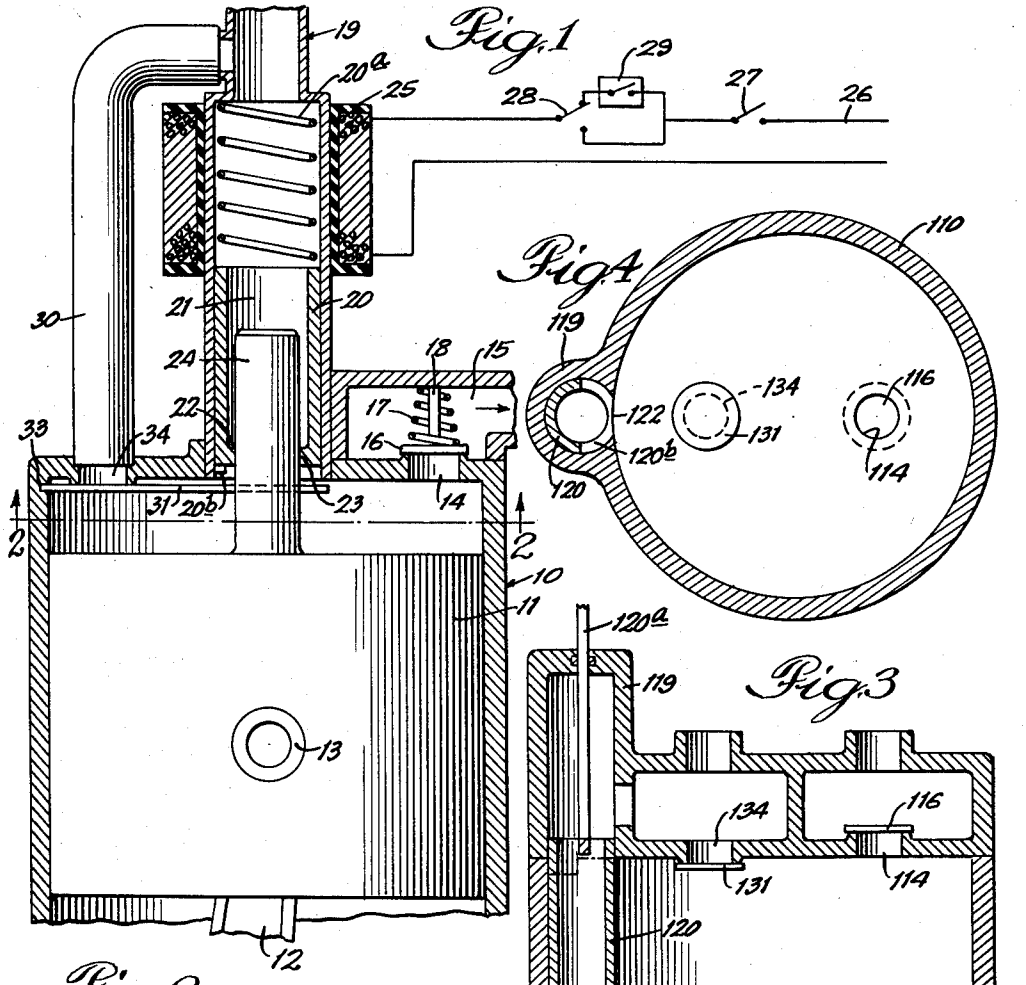
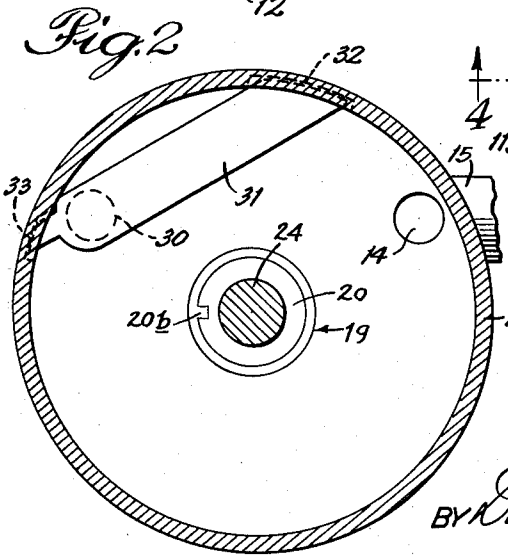
Feb. 5, 1963 A. B. NEWTON 3,076,593

FLOW REGULATOR FOR PISTON-EQUIPPED CYLINDER

Filed Sept. 15, 1958 2 Sheets-Sheet 1





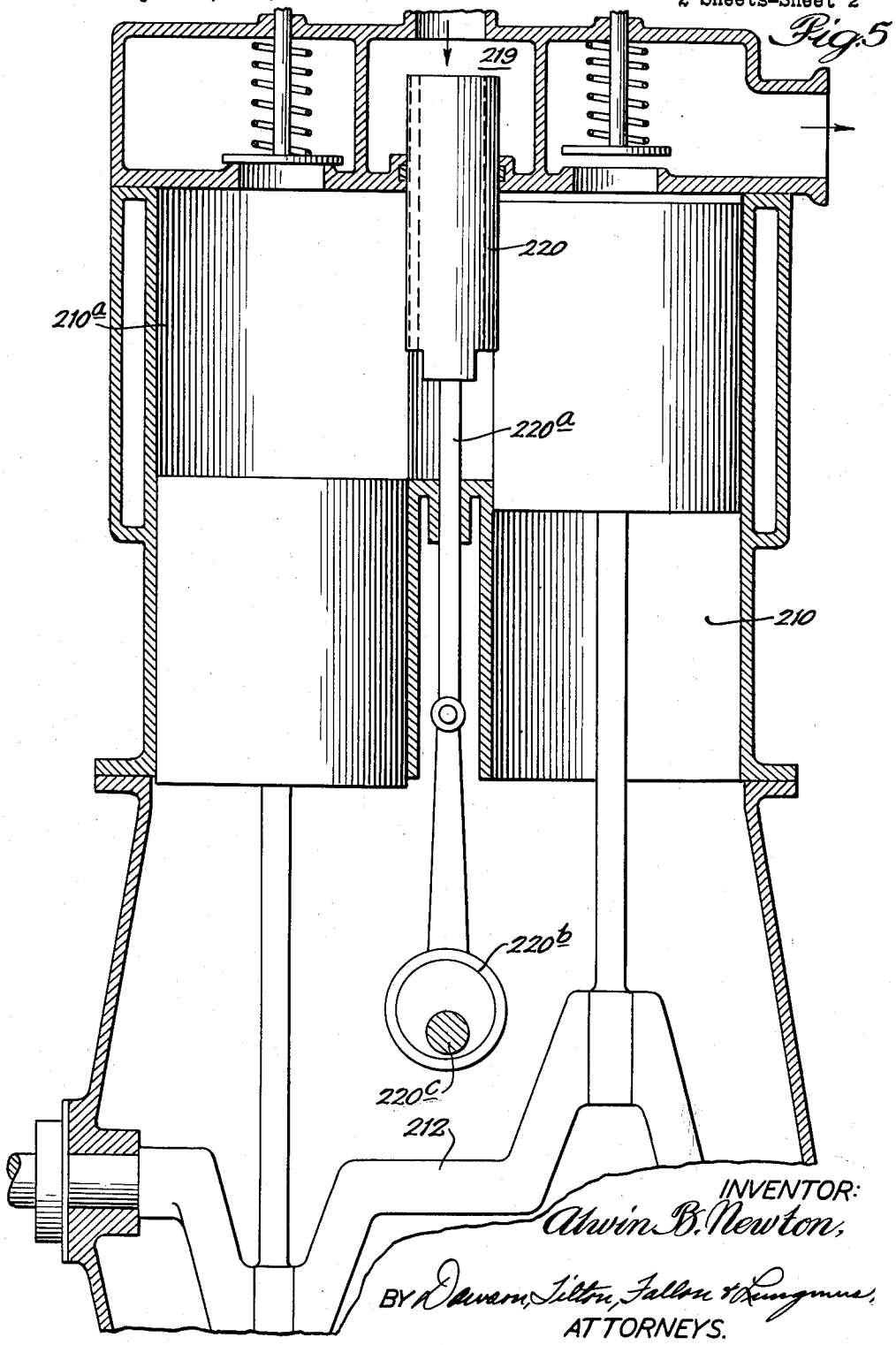
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Fig. 5



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FLOW REGULATOR FOR PISTON-EQUIPPED CYLINDER

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This invention relates to a flow regulator for a piston-equipped cylinder, and, more particularly, to a flow regulator for the fluid intake line for such a cylinder.

This invention finds utility in the field of refrigeration compressors, but has application also to other operations in which a fluid is pressurized in a piston-equipped cylinder.

In certain applications of air conditioning, the compressor is operated irrespective of whether refrigeration is called for. One prime example is in automotive refrigeration. There, the compressor piston is directly coupled to the crankshaft and reciprocates whether refrigeration is needed or not. This operation is currently justified, since automobiles are overpowered and the power utilized in the refrigeration compressor does not seriously affect the engine performance. It would be desirable, however, to provide means which would regulate the amount of compression effected by the compressor as a function of the refrigeration load. It would further be desirable to provide means to reduce the capacity of the compressor during periods when little or no compression is required. These, then, form some of the objectives of this invention.

Another objective is to provide a novel flow regulator for a piston-equipped cylinder. Still another object is to provide means in the fluid intake to a piston-equipped cylinder that regulates the flow of fluid thereto. Yet another object is to provide means cooperating with the piston of a piston-equipped cylinder that regulates the degree of capacity or unloading of the cylinder and thereby correlates the compression developed by the cylinder to the load requirements.

A further object of the invention is to provide a novel structure of the character indicated in which a flow fitting or port member is sealingly and positionably mounted in a fluid intake to a piston-equipped cylinder with the piston being movable into engagement with the fitting or port to close the same. A still further object is to provide in the apparatus described in the object immediately preceding, means for positioning the fitting or port member which is responsive to a thermal signal. A yet further object is to provide, in the apparatus just described, time delay means which postpones the imposition of all or part of the load on the compressor until it has started up. Other objects and advantages of this invention can be seen as this specification proceeds.

This invention will be described in conjunction with the accompanying drawing, in which—

FIG. 1 is an elevational view, partly in section and partly diagrammatic, of apparatus embodying the teachings of this invention; FIG. 2 is a cross-sectional view, taken along the line 2—2 of FIG. 1; FIG. 3 is a view similar to FIG. 1 but showing a modified form of the invention; FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 3; and FIG. 5 is a view similar to FIG. 3 but showing a plurality of cylinders in a compressor.

In the illustration of the invention given in FIG. 1, the numeral **10** designates generally a cylinder which has a piston **11** slidably mounted therein and which is reciprocated by a piston rod **12** coupled to piston **11** through a wristpin **13** in a conventional fashion.

Cylinder **10** is equipped with an outlet port **14** communicating with an outlet manifold **15**, the manifold

supporting an exhaust check valve **16**. The foregoing arrangement is well known, so that the details given are shown in the particular form they are merely for the sake of completeness of illustration. For example, valve **16** is equipped with a spring **17** mounted about a post **18**, so that upon the development of a predetermined pressure within cylinder **10**, the valve **16** will open until it abuts post **18** to permit outflow of the compressed fluid through manifold **15**.

Fluid is delivered to cylinder **10** through an intake conduit designated generally by the numeral **19** and which is equipped with a slidable flow fitting generally designated **20**. Flow fitting **20**, which may be generally tubular in nature, provides a flow passage **21** therein, the fitting **20** being in sealing engagement with the interior walls of conduit **19**. The inner end of fitting **20** is equipped with a constricted port or orifice **22** provided by an inwardly-extending flange **23**. Shown in sealing engagement therewith and slidably mounted therein is a piston extension **24**.

Mounted within conduit **19** and bearing against one end of fitting **20** is a coiled spring **20***a* which is operative to urge fitting **20** against stop **20***b* and into the position shown in FIG. 1. The spring **20***a* supplies a downward force against fitting **20** urging it into engagement with stop **20***b*, the downward force exerted being slightly in excess of the maximum desired difference in pressure between suction and discharge multiplied by the projected area of the annulus formed by the opening at **23** and the outer diameter at **20**. This then provides an internal load limitation on the device.

The intake conduit is equipped with a solenoid **25** which is energized through an electrical connection **26**. Interposed in the electrical circuit delivering current to solenoid **25** is a manual or safety switch **27**, a thermostatic switch **28**, and a time delay switch **29**, the functions of which, as well as the operation of the apparatus just described, can be appreciated from the following description:

Operation

It is believed that the operation of the apparatus just described can be readily appreciated when the apparatus is considered as a part of an automobile refrigeration system. In such a case, the manifold would be communicated with a condenser, expansion valve, and evaporator. The evaporator in turn would be communicated with the suction intake conduit **19**. The piston **11** could be energized from the engine crankshaft through the piston rod **12**. The manual or safety switch could be provided as part of the ignition switch, while the thermostat **28** would be responsive to the temperature within the passenger space of the automobile.

When the car is started, switch **27** is closed, along with the time delay switch **29**. If the thermostatic switch **28** is in the position shown, this will energize solenoid **25** to raise fitting **20** to a position above extension **24** during the entire piston cycle.

Thus, no compression is provided and the refrigerant merely is drawn into and forced out of cylinder **10** through the intake opening **22**. The cylinder **10** now acts as a compressor in a completely unloaded condition (i.e., with its capacity to pump reduced to zero). A short time after the start-up time delay switch **29** will open, breaking the supply of electrical current to solenoid **25**, and spring **20***a* will force fitting **20** to the position shown. The compressor then will be loaded, and once each cycle extension **24** moves downwardly a sufficient distance to become disengaged from fitting **20** and permit the inflow of refrigerant fluid. Shortly thereafter, the upward stroke of piston **11** again causes extension **24** to engage the fitting **20** and seal it against further flow of

fluid therethrough, permitting the cylinder to develop compression on the refrigerant fluid which is finally discharged through valve **16**. Under the operation just discussed, the thermostatic switch **28** is in the position in which refrigeration is called for. Should the switch be in the alternative position, corresponding to no demand for refrigeration, the solenoid **25** will be continuously energized and the cylinder **10** will remain in an unloaded condition.

For automotive application, it is possible to combine the functions of switches **27** and **29** into a single switch which is closed during the cranking cycle and which therefore may be the same switch which energizes the starting solenoid of the engine. In such an event, the combined switch could be disposed in parallel to switch **28**.

For the sake of clearness of illustration, only one cylinder has been shown, but it is to be appreciated that the invention can be satisfactorily employed in apparatus where a plurality of cylinders are present.

It is also to be appreciated that by varying the strength of spring **20***a*, a small degree of loading can be achieved even when solenoid **25** is energized. This may be desirable in some cases even though refrigeration is not called for in the evaporator, since the slight refrigeration developed under very small loading could be dissipated in merely cooling the engine block or, more specifically, the cylinder **10** in which piston **11** is continuously reciprocated. However, excellent results can be obtained for automotive purposes when the fitting **20** has a limited range of movement in which at the extreme upper limit it is spaced from extension **24** during the entire cycle of operation of piston **11**, while at the lower limit of its range of movement it is engaged by extension **24** for a major portion of the cycle.

Full capacity reduction is possible in automotive work because the compressor heat is dissipated by the flow of air (even though relatively warm) over the compressor. This may not always be the case in motor-driven stationary units.

Ordinarily, no additional suction line is needed for applications where power input is not a critical factor, however, power can be reduced by adding a conventional suction valve in parallel to the flow fitting **20**. This is illustrated in FIG. 1 and designated by the numeral **30**. The by-pass intake conduit **30** is connected at one end to cylinder **10**, and at the other end to intake conduit **19** up-stream of the flow fitting **20**. The conventional intake **30** is equipped with an inlet check valve **31**, which may take the form of a resilient metal member supported in recesses **32** and **33** in the side walls of cylinder **10** and which closes the inlet port **34** whenever no suction is applied by piston **11**.

An alternative form of the invention is seen in FIGS. 3 and 4, in which numerals are employed that correspond to the numerals employed in FIGS. 1 and 2 but which have been increased by 100. Thus, the numeral **110** designates a cylinder, **111** a piston, **112** a piston rod, and **113** the wristpin. An exhaust port is designated by the numeral **114**, being closed by valve **116**, while a conventional suction port is designated by the numeral **134**, being closed by a valve **131**. An intake conduit in this form of the invention is designated by the numeral **119** communicating with the evaporator by means that are not shown. A tubular port member **120** is slidably, sealingly mounted in intake conduit **119** and is adapted to be positioned by means of rod **120***a*.

The intake conduit **119** is provided as part of the cylinder wall, as can be best appreciated from FIG. 4. The intake conduit **119** communicates with the interior of cylinder **110** through an elongated slot **122**, which is adapted to be closed by the port member **120**. Port member **120** is notched as at **120***b*, so that even in the extreme down position as shown, it does not completely isolate conduit

119 from cylinder **110**. In the uppermost position of port member **120**, the conduit **119** and the cylinder **110** are in continuous communcation, so that the compressor is completely unloaded. It is to be appreciated that member **120** can be positioned intermediate two adjoining cylinders, thus varying the capacity of each—or a plurality of such members can be employed, each operated from a common shaft, so that each cylinder is "unloaded" to the same degree. A form of the invention where one port member serves two adjoining cylinders can be seen in FIG. 5, where member **220** is slidably mounted in the intake conduit **219** common to both cylinders **210** and **210***a*. Port member **220** is positioned by rod **220***a* connected to an eccentric **220***b*. For individual port members for each cylinder, the shaft **220***c* to which the eccentric **220***b* is attached may be arranged parallel to the crankshaft **212** instead of transverse as shown. In this manner each of a number of positioning rods such as **220***a* can be simultaneously positioned.

In this illustration given in FIGS. 3 and 4, any intermediate degree of effective stroke of the piston **111** can be obtained by positioning the port member **120** by moving rod **120***a*. Alternatively, rod **120***a* may extend inward, i.e., through the bottom wall of conduit **119**, which has been designated **119***a*, for control from within the crankcase of the compressor. It is also to be appreciated that a solenoid and spring structure can be employed with rod **120***a* to provide the operation described in connection with FIG. 1.

This invention provides a number of advantages over prior art structures employed for the same purposes. The invention here, when employed in conjunction with a compressor, does more than merely "unload" the compressor, as was the case with prior art devices. Here, it is possible to reduce the capacity of the compressor cylinder. In a multi-cylinder compressor, it is possible to reduce the capacity of all cylinders an equal amount. In contrast to this, many conventional unloading means for cylinders permit only complete unloading, one by one. This results in unequal torque in some of the drive means. Such a conventional unloader is described in my prior Patent No. 2,761,616, issued September 4, 1956. In contrast to this, the invention here permits a smooth reduction of capacity. Furthermore, in conventional systems, it is usual to unload all but 20–30% of the cylinders in a multi-cylinder compressor, as to unload all of them would result in cessation of flow of gas and therefore of cylinder cooling. By keeping at least one or two cylinders cool by continuing their flow, it was hoped that the rest would be cool, also. In the inventive device, at least a minimum flow can be provided for each cylinder, irrespective of the number, thereby attaining cooling of each.

While, in the foregoing specification, a detailed description of the invention has been given for clearness of understanding, those skilled in the art will perceive many variations in those details without departing from the spirit and scope of the invention.

I claim:

1. In a gas compressor,

A. a cylinder having interior top and side walls, said cylinder being equipped with an opening in said interior top wall, means containing a gas communicating with said opening,

B. a piston mounted in said cylinder for reciprocal movement defining intake and compression strokes,

C. a tubular element mounted in said opening for movement therein parallel to the piston movement and independent of the movement of said piston, said piston being equipped with a projection extending upwardly therefrom for sealing receipt in said tubular element, and means for positioning said element in said opening to provide gas flow therethrough during selected initial portions of the piston compression stroke up to and including substantially all of the piston compression stroke.

2. The structure of claim 1 in which said projection is located on the axis of said piston.

3. The structure of claim 1 in which means are associated with said tubular element for restricting upward movement of said element to necessarily engage said element and projection just prior to the completion of said compression stroke.

4. The structure of claim 1 in which said means is adapted to position said element to provide gas flow therethrough during all of said piston compression stroke.

5. In refrigeration apparatus,

A. a cylinder having top and side walls defining a compression chamber,

i. said cylinder being equipped with an opening in said top wall,

ii. means containing refrigerant gas communicating with said opening,

iii. port means in said cylinder for introducing and removing refrigerant gas,

B. a piston mounted in said cylinder chamber for reciprocal movement defining intake and compression strokes,

C. a tubular element mounted in said opening for movement therein parallel to the piston movement and independent of the movement of said piston,

i. said piston being equipped with a projection extending upwardly therefrom for sealing receipt in said tubular element,

ii. and means for positioning said element in said opening to provide gas flow therethrough during selected initial portions of the piston compression stroke up to and including substantially all of the piston compression stroke.

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