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G. E. RAYMAN ETAL
TORQUE TIMING SYSTEM

3,033,236

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2 Sheets-Sheet 1

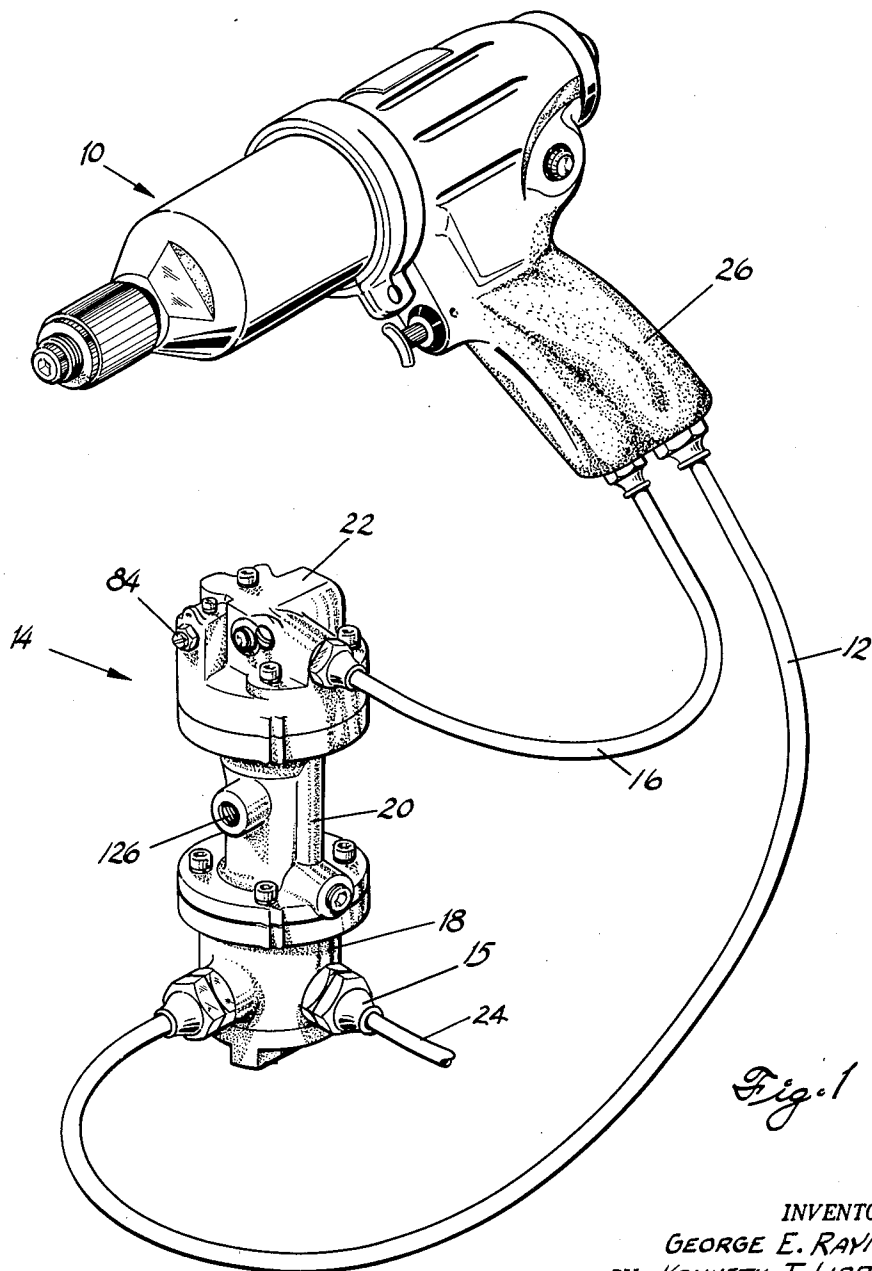


Fig. 1

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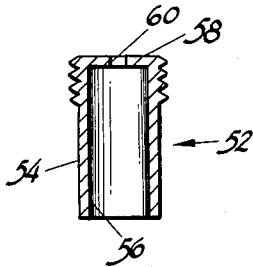


Fig. 5

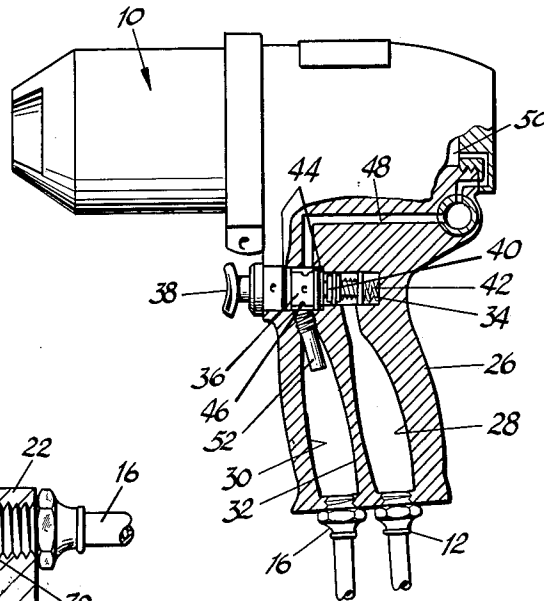


Fig. 2

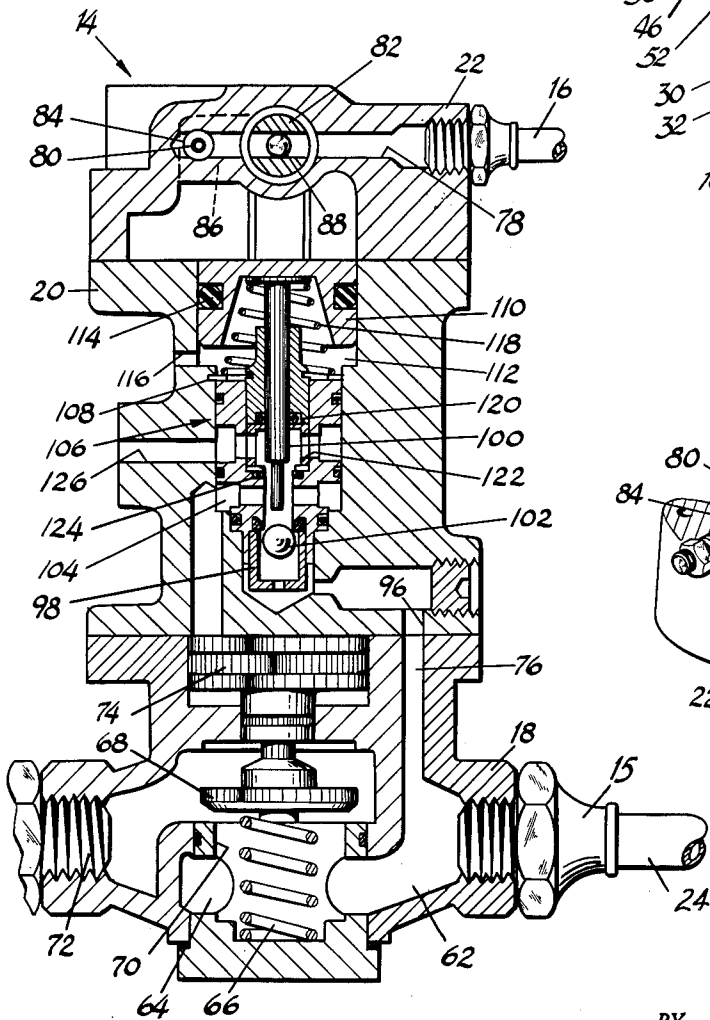


Fig. 3

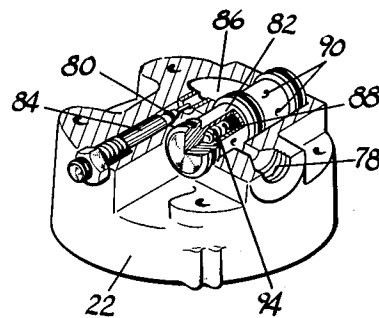


Fig. 4

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TORQUE TIMING SYSTEM

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This invention relates to timing controls for pneumatic tools, in general, and more particularly to timing controls for pneumatic impact and stall type power tools.

Pneumatic impact wrenches and the like normally have a source of pneumatic power connected directly thereto and under the control of the tool operating trigger mechanism. When the operating trigger is activated the tool commences operation and continues until the trigger is released and the air supply to the tool is closed.

Stall tools are operated in the same manner as the impact wrenches except that there is a tendency for the tool to throw itself from the operators hands when a predetermined torque reaction is obtained. This instinctively advises the operator to release the tool trigger and shut off the power supply source thereto.

Dependence upon an operator releasing the trigger mechanism of a pneumatic tool, even with the forewarning of a stall reaction, is not a suitable control for such tools. Delayed reactions, momentary diversions, inattention to the job, etc. can and do cause serious consequences as regards both the work and the work tool.

It is an object of this invention to disclose an automatic timing control for pneumatic power tools.

It is an object of this invention to disclose an apparatus for timing pneumatic power tools which is essentially independent of operator reaction time and/or attention to the job.

It is also an object of this invention to disclose a timing control system for pneumatic power tools which may be incorporated with such tools as are presently in use as well as with new tools.

Another object of this invention is to disclose a timing control system particularly suited to pneumatic torque tools to prevent and minimize torque reaction damage to the tool and/or the work being performed.

Still another object of this invention is to disclose a torque timing system for torque tools operated by pneumatic power and such as is capable of a wide range of torque applications.

A further object of this invention is to disclose a torque control system readily variable for different torque requirements without extensive adjustment or revision thereto.

A still further object of this invention is to disclose, suggest and teach improvements and modifications of apparatus to incorporate the principle of this system of control therein.

These and other objects and advantages obtained and attainable in the practice of this invention will be more apparent upon a reading of the following specification, in regard to a working embodiment of this invention, and a study of the accompanying drawings.

In the drawings:

FIGURE 1 is a pictorial illustration of one accepted form of this invention with parts thereof shown in perspective.

FIGURE 2 is a plan view of a pneumatic power tool with parts broken away and shown in cross-section.

FIGURE 3 is an enlarged cross-sectional view of a part of the regulatory control of the proposed system.

FIGURE 4 is perspective and cut-away view of one of the parts of the disclosed regulatory control means.

FIGURE 5 is an enlarged cross-sectional plan view of

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another one of the parts of the regulatory control means of the disclosed timing control system.

Briefly, the illustrated and described embodiment of this invention is with regard to an impact wrench having the tool operating time controlled to obtain a given torque load. The tool is operated by pneumatic power received through a normally open valve. A bleed air line is connected between the power tool and a regulatory control operatively connected to the normally open supply valve. By the use of restrictive means within the bleed line control, in this particular instance, the sequential operation of the supply valve between closed and opened position is controlled within sufficiently close limits to enable torque load regulation of the torque tool itself.

Referring to FIGURE 1 there is shown an impact wrench 10; hereinafter generally referred to as the pneumatically operated torque tool. The torque tool 10 is connected by an air supply line 12 to a regulatory device 14. The tool also includes a bleed line 16 connected to the regulatory member 14.

The regulatory member 14 is inclusive of an air supply valve part 18, a valve control part 20, and a flow restrictive part 22. A source of compressed air is connected by a flow conduit 24 to the inlet side of the valve part 18 to provide the pneumatic power for operating the tool 10.

The power tool 10 has its handle 26 formed to provide two flow passages 28 and 30, separated by a dividing wall 32. The air supply line 12 is connected to the passage 28 and the bleed line 16 is connected to the passage 30. Both of the passages 28 and 30 are in communication with a trigger assembly passage 34.

The trigger assembly of the power tool 10 includes a bushing part 36 located in passage 34 in the vicinity of the bleed line passage 30. A trigger member 38 is accessibly disposed and is operatively connected through the bushing 36 to a valve part 40 reciprocal relative to the end of the bushing member. The valve part 40 is backed up by a spring 42 which normally keeps the valve closed when the trigger 38 is not depressed. The valve part 40 has sufficient travel to open the air supply passage 28 and permit air flow into the end of bushing 36.

The trigger assembly bushing 36 is sealed in passage 34 at both ends by O-rings 44 so that air cannot pass other than through the bushing. However, the bushing is inherent and provided with air flow holes 46 so that the tool operating air can gain access to the supply passage 48 formed in the shank of the tool. The supply passage 48 communicates with other passageways to deliver tool operating air to the tool motor chamber 50.

The tool operating air is to be understood as exhausting therethrough to the atmosphere. Accordingly, when the supply passage 48 is cut off from the air supply passage 28 in the handle of the tool, the pressure condition therein is substantially atmospheric.

Within the bleed passage 30 is disposed a flow restrictor 52. Such restrictor 52 may be an oiler body part of the normal wick type air line lubricator modified to serve as a flow restrictor. As shown by FIGURE 5, in this instance it is simply a cylindrical body 54 open at its lower end 56 and partially closed at its upper end by a closure wall 58 with a flow restrictive opening 60 therethrough.

The air supply valve 18, of the regulatory assembly 14, is a normally open valve adapted to permit air flow therethrough. A source of compressed air is connected by flow line 15 to the inlet passage 62. The inlet passage 62 is in open communication with a valve spring passage 64 wherein the spring 66 tends to hold the overhead valve 68 open and off the valve seat 70. The outlet flow passage 72 on the other side of the valve seat 70 is connected by the flow line 12 to the power tool 10.

The valve 68 includes a piston head 74 within a separate chamber part of the valve housing 18. Suitable pressure applied to such piston head 74 is adapted to close the valve 68 on seat 70 and shut off the air supply to the supply line 12.

The valve housing 18 will also be noted to include a passage 76 formed therethrough from the inlet passage 62. This passage serves to by-pass inlet air through a check valve and onto the piston head 74 for operation of the valve 68, as will be subsequently described.

Such tool operating air as bleeds through the bleed passage 30 is delivered via the bleed line 16 to the flow restrictive part 22. The flow restrictive part 22 is best shown by FIGURE 4 to include an inlet passage 78 leading to a needle valve controlled flow passageway 80. A poppet valve assembly 82 is interposed in the inlet passage 78 but offers no restriction to bleed air delivered to the needle valve passageway.

An adjustable needle valve assembly 84 regulates the passage of bleed air from passageway 80 to a chamber 86. Chamber 86 is in open communication with the top of the valve control part 20 which is secured immediately thereunder. The chamber is also in open communication with the other side of the poppet valve assembly 82. Accordingly, a favorable differential of pressure between the chamber 86 and inlet passage 78 will unseat the ball check 88 of the poppet valve (via holes 90 in the poppet valve body 82), against the resistance of the closing spring 94, and will dump air from the chamber instead of requiring it to bleed back through the needle valve passageway 80.

The valve control part 20 includes a flow passage 96 aligned with the by-pass passage 76 of the valve part 18. Such flow passage 96 terminates at a check valve assembly 98. A check valve operating member 100 is provided to open the ball check 102 of the passage closing valve and permit the full air supply pressure to flow through an operating passage 104 in communication with the piston head 74 of the air supply valve 68.

The check valve operating member 100 is reciprocal within a capsule assembly 106 held by a retainer ring 108 within the housing 20. It includes a piston head 110 disposed within a chamber area 112 and exposed to the chamber area 86 of the restrictive part 22 immediately thereover. The piston head includes a sealing ring 114 to prevent air pressure passing thereby and the chamber 112 is inclusive of a breather hole 116 to enable ready depression of the head and actuation of the valve operating member 100.

The valve operating member 100 is raised out of check valve engagement by a spring 118. The stem part thereof extends through a sealing ring 120, to prevent pressure loss thereby, and past exhaust ports 122 in the capsule assembly 106. Its lower end is formed for engagement with another sealing ring 124 just over the operating passage 104. Thus, when the check ball 102 is unseated the operating passage 104 is shut off from the exhaust ports 122, but when the valve is closed the operating passage may vent itself through the exhaust ports 122 and via the exhaust passage 126 to the atmosphere.

Operation

With an installation such as described, air pressure is admitted directly to the power tool 10 via the supply line 15, from the air power source, through the normally open air valve 18, and through flow line 12. The air is received within the passage 28 in the handle 26 of the tool and behind the air valve 40 in the trigger assembly passage 34 of the work tool.

Trigger 38 is activated to open valve 40 and enable air flow through bushing 36, out the holes 46 therein, and to the supply passage 48 in the tool shank. As soon as the operating air reaches the motor chamber 50 the tool commences its intended function.

While the trigger or throttle control 38 is held, air

pressure builds up in the flow passages to the tool motor and begins to build up within the bleed passage 30 of the tool handle. The air flow to the bleed passage 30 is through the restrictor 52 and is accordingly regulated or metered to an extent dependent upon the restricting opening 60 provided therein.

The restricted air flow passes from the bleed passage 30 through the bleed line 16 to the restrictor head 22. It flows through the inlet passage 78 and across the poppet valve assembly 82 into the needle valve passageway 80. The spring loaded ball check valve 88 precludes air flow through the poppet valve and requires the air to pass through the needle valve metering passage into the chamber area 86. The ball check valve 88 remains seated because of the greater pressure on the closing side thereof.

The air flow received in chamber 86 of the restrictor head 22 has been retarded by the restrictor member 52 in the tool handle and by the needle valve 84 therein. Accordingly, it takes a predeterminable time to build up sufficient pressure to have an affect upon the exposed piston head 110 of the valve operating member 100 in the control member 20.

As pressure builds up in chamber 86, the piston head 110 is depressed against the resistance of the spring member 118. The lower end of the valve operating member 100 engages and unseats the ball check valve 102 to open passage 96 to passageway 104. The passage 96 is charged with full line pressure due to its communication with the passages 76 and 62 of the air valve 18. Because passageway 104 is exposed to the piston head 74 of the valve 68, the air pressure immediately acts to close the valve 68 and shut off the air supply to tool 10.

Flow line 12, and passages 28, 34, and 48 immediately exhaust to the atmosphere through the work tool 10. This assumes that the trigger 38 remains depressed to hold valve 40 open; and such would be the case in normal tool operation.

Because of the restrictor 52, the bleed line 16 cannot exhaust as rapidly. However, as the pressure drops in the bleed line 16 the differential of pressure within the restrictor chamber 86 and the restrictor passage 78 causes the ball check 88 to open and enables air to be "dumped" from behind the needle valve 84 rather than requiring its reverse flow therepast. Thus the restrictor 52 is the principal deterrent to a rapid depletion of air pressure in the bleed lines.

A reduction of pressure on the piston head 110 of the valve control member 100 enables the spring 118 to gradually take over and raise the operating member out of engagement with the ball check 102. As the shank of the operating stem 100 passes the seal 124, air trapped in passageways 104 is vented through exhaust ports 122 and 126 to atmosphere. Air pressure in passageways 96 immediately takes over to seat and hold the ball check 102 closed. At the same time the relief of air pressure on piston head 74 of valve 68 enables the valve opening spring 66 to take over and open the air supply valve 68 once more. Accordingly air is again available to the work tool 10.

The delay effected is sufficient to advise the operator of the work tool 10 to release the trigger 38. Accordingly, when air pressure is again available to the work tool, it is stopped by the valve 40 unless the tool has been relocated to another work station and the trigger is again depressed.

The torque obtainable by use of the tool 10 is a factor of its operating time. Thus, by allowing the tool to operate for only a given period of time, the torque obtainable can be predetermined.

As a safety factor, the work tool 10 should be used for torque applications less than its maximum capacity. This assures tool safety if, for example, the operator holds the trigger 38 depressed and does not relocate the tool as he should before it recycles.

In such instances, the resistance to air flow through

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the torque locked tool motor will cause the air pressures in the bleed lines to build up faster, and to remain partially charged, and the normally open valve 68 will be closed quicker than in the usual instance.

The operating time of the tool 10, and accordingly its torque application, is dependent upon the impedance to air flow caused by the restrictor 52, the setting of the adjustable needle valve 84, and any resistance in the intermediate bleed lines and passages. It is also dependent upon the extent of pressure required to be built up to overcome the operator spring 118, the valve spring 66, and any frictional resistance of the piston heads 110 and 74, and the operating stem 100, to movement.

The recycling time is principally dependent upon the restrictor 52 in the tool handle. However, the other factors have their affect on the recycling time. A larger opening 60 in the restrictor 52 will cause a faster recycling. Without the restrictor the poppet valve 80 would dump the air pressure too fast. With the poppet valve inoperative the recycling would be as slow as the timed torque application.

The disclosed system of utilizing air pressure differentials to shut off an air operated tool within prescribed time limits, to obtain a given torque load, has been found highly successful. The system may be regulated to operate from approximately one-half second to 60 seconds or more. Each installation requires different adjustments, one to different variables for different jobs. However, such adjustments are readily made by changing the restrictor 52 to one having a larger or smaller opening 60 and by adjusting the needle valve 84.

Obviously, the disclosed system is applicable to stall tools, right angle or straight, as well as any other air powered tool. With stall tools, the tool is shut off just before the operator is required to take a violent torque reaction. However, if he is inattentive to the job and doesn't release the trigger when the tool cuts off, he will get a torque reaction on the second cycle.

The disclosed system may be used in conjunction with multiple as well as single spindle tools.

While one particular embodiment of this invention has been described, it will be appreciated that modifications and improvements may be made thereto. Such of these modifications and improvements as incorporate the principle of this invention are to be considered as included in the hereinafter appended claims unless expressly stated otherwise by the language of such claims.

We claim:

1. A control device for use with pneumatic power tools and other air operated mechanisms to regulate the recyclic operating time thereof, and comprising; means for connecting a source of air pressure to an air operated mechanism and including a normally open check valve, means for exhausting said source to atmosphere from the downstream side of said check valve, means for bleeding air from said connected source between said valve and the atmospheric exhaust therefor, means operatively connecting said bleed air to said valve for actuation thereof, means restricting the flow of said bleed air to said valve for delayed closing actuation thereof, and means for by-passing at least in part said restricting means upon the closing of said valve and the venting of the downstream side of said connected source to the atmosphere.

2. A control device for use with pneumatic power tools and other air operated mechanisms to regulate the recyclic operating time thereof, and comprising; means for connecting a source of air pressure to an air operated mechanism and including a normally open check valve, means for exhausting said source to atmosphere from the downstream side of said check valve, means for bleeding air from said connected source between said valve and the atmospheric exhaust therefor and operatively connected to said valve for pressure accumulating actuation thereof, means restricting the accumulation of bleed air to delay the closing actuation of said valve, and means for by-

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passing part of said restricting means upon the closing of said valve and the reverse flow of said bleed air for more rapid opening than closing of said valve.

3. A control device for use with pneumatic power tools and other air operated mechanisms to regulate the recyclic operating time thereof, and comprising; means for connecting a source of air pressure to an air operated mechanism and including a normally open check valve, means for exhausting said source to atmosphere from the downstream side of said check valve, means for bleeding air from said connected source between said valve and the atmospheric exhaust therefor and operatively connected to said valve for actuation thereof, means imposing at least two separate restrictions to the flow of air to said valve for delayed closing thereof, and means for by-passing at least one of said restrictions in the reverse flow of said air upon the closing of said valve and the venting of the downstream side of said connected source to the atmosphere.

4. A timing and recycling control for pneumatically operated torque tools and other air operated mechanisms having a pressure responsive shut-off valve in the air supply line thereto, and comprising; a bleed line connection from the downstream side of said valve back to said valve, a pair of restrictions interposed in said bleed line for delaying the accumulation of sufficient air pressure to actuate said valve and to close said supply line, at least one of said restrictions being adjustable to regulate the delay time in accord with torque requirements for said tool, and means for by-passing at least one of said restrictions in the reverse flow of air in said bleed line upon the closing of said supply line for quicker opening than closing of said valve.

5. A timing and recycling control for pneumatically operated mechanisms, comprising; an air supply connection for use between a source of air under pressure and an air operated mechanism, a normally open pressure responsive shut-off valve provided in said air supply connection, an air bleed connection provided between said shut-off valve and the downstream side of said valve, exhaust means provided in said air supply connection downstream of said air bleed connection, air flow restrictive means provided within said air bleed connection for retarding the build-up of air pressure at the valve end thereof sufficient to close said valve, and means for by-passing said flow restrictive means at least in part during the reverse flow of air through said bleed connection upon the closing of said valve and the exhaust of air from the downstream side of said air supply connection.

6. A device for controlling the automatic recycling operation of an air operated mechanism, comprising; an air supply connection for the operative connection of a source of air under pressure to an air operated mechanism, a pressure responsive normally open shut-off valve provided in said air supply connection, means of exhausting the downstream side of said air supply connection through said air operated mechanism, an air bleed connection in communication with said exhaust means and the downstream side of said air supply connection, said air bleed connection being operatively connected to said pressure responsive shut-off valve, a series of air flow restrictions provided in said air bleed line for time controlled delay of the pressure accumulation at the end thereof and operation of said shut-off valve, and means of by-passing at least one of said restrictions in the reverse flow of air through said bleed line upon the closing of said shut-off valve and the venting of said bleed line via said exhaust means, said exhaust flow being more rapid than said pressure accumulation for faster recyclic operation.

7. A device for controlling the automatic recycling operation of an air operated mechanism, comprising; an air supply connection for the operative connection of a source of air under pressure to an air operated mechanism, a pressure responsive normally open shut-off valve

provided in said air supply connection, means of exhausting the downstream side of said air supply connection through said air operated mechanism, a throttle valve operatively disposed for opening said exhaust means, an air bleed connection in throttle valve connected communication with said exhaust means and the downstream side of said air supply connection, said air bleed connection being operatively connected to said pressure responsive shut-off valve, a pair of air flow restrictions provided in said air bleed line for time controlled delay of the pressure accumulation at the end thereof and operation of said shut-off valve, at least one of said restrictions being variable, and means of by-passing said one of said restrictions in the reverse flow of air through said bleed line

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upon the closing of said shut-off valve and the venting of said bleed line via said exhaust means, said exhaust flow being more rapid than said pressure accumulation for faster recyclic operation.

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