March 5, 1968 J. H. BICKFORD ET AL 3,371,863

FLUID-OPERATED COUNTING DEVICE

Filed June 17, 1966 3 Sheets-Sheet 1

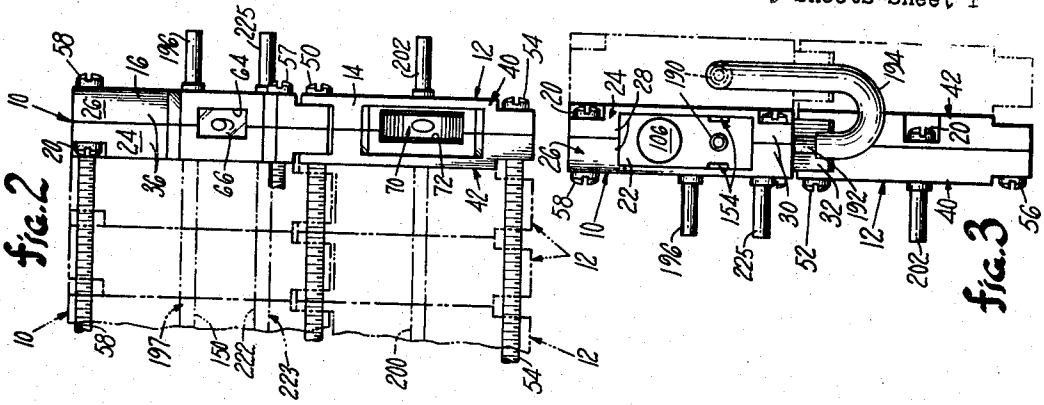


Fig. 2

Fig. 3

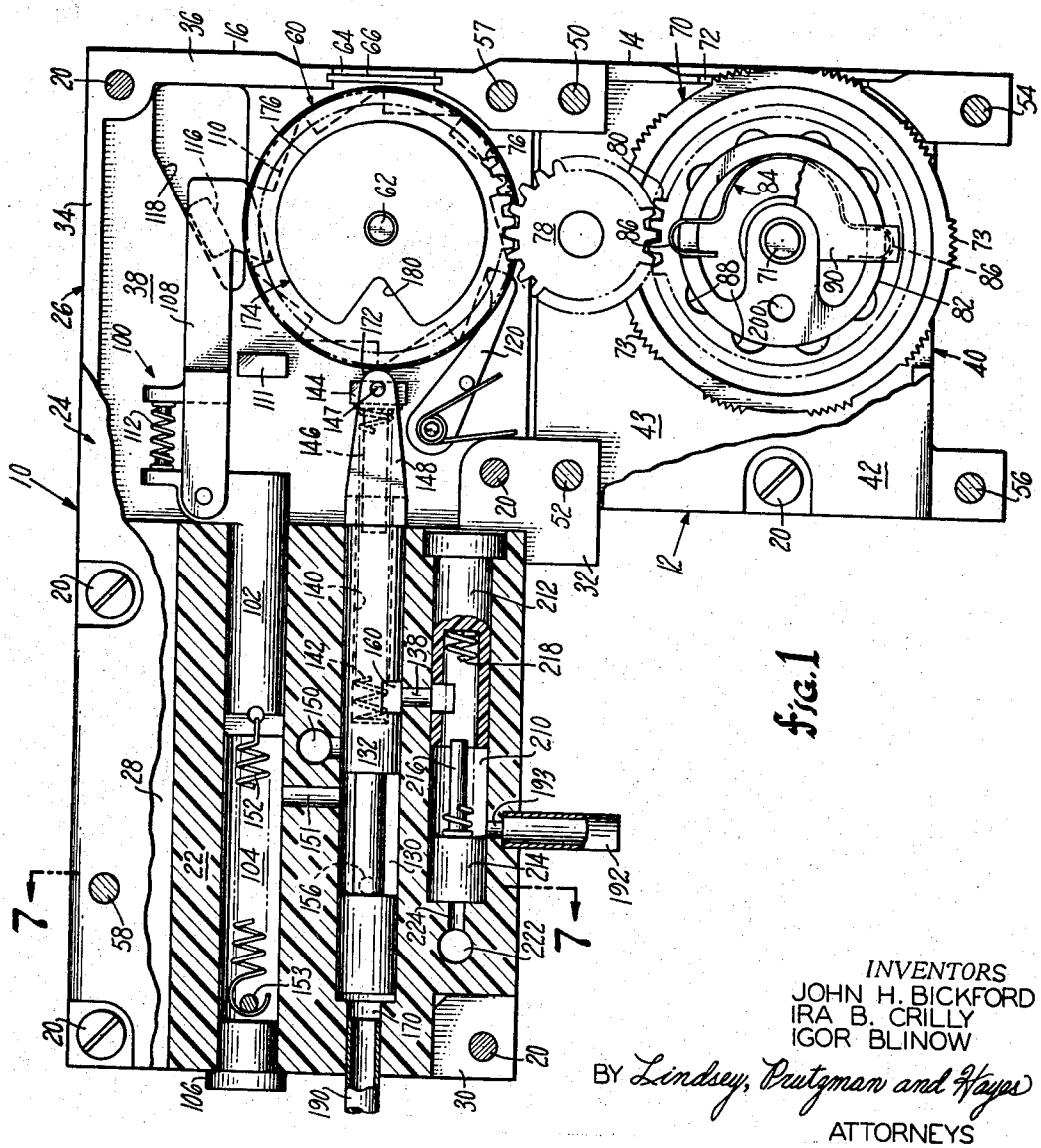


Fig. 1

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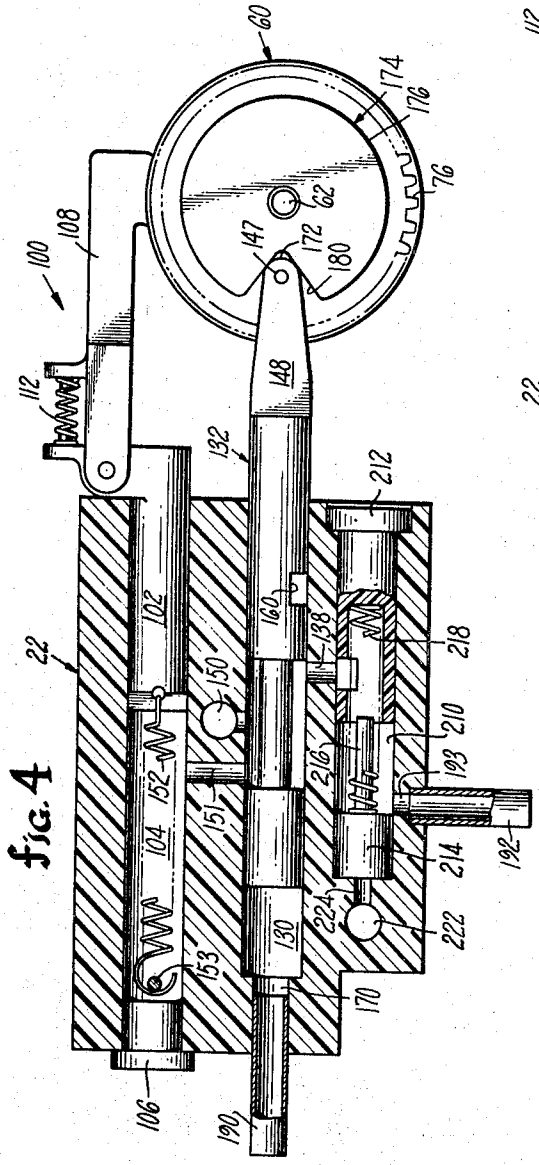


Fig. 4

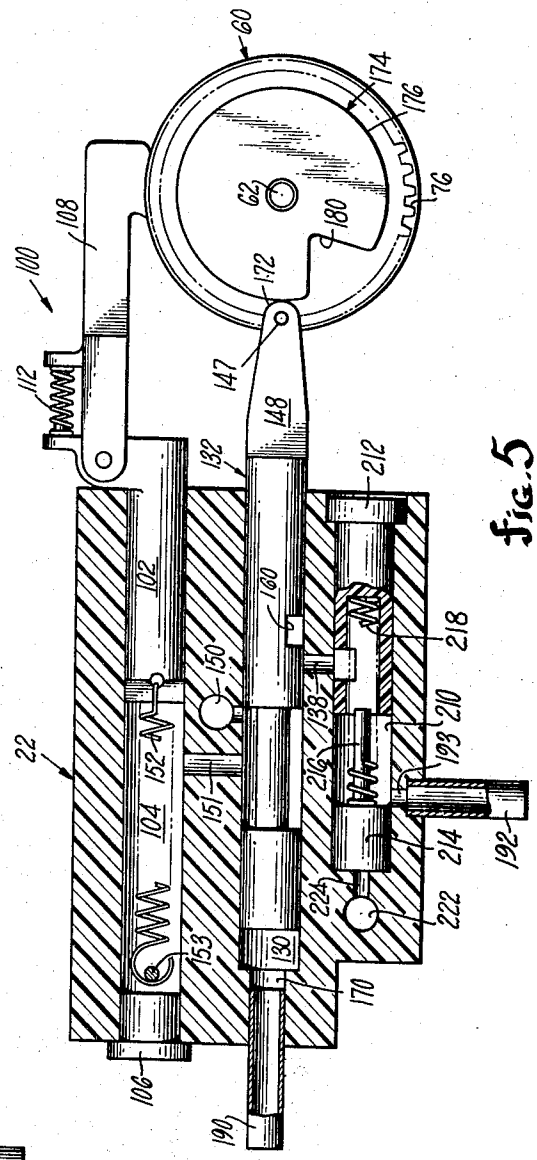


Fig. 5

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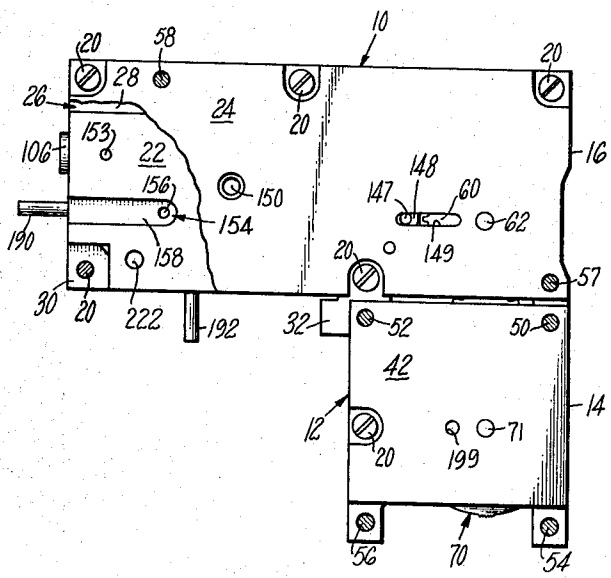
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Fig. 6



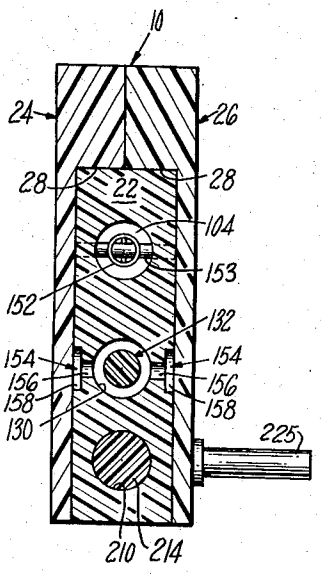


Fig. 7

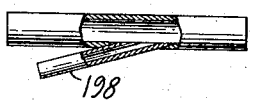


Fig. 8

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3,371,863

FLUID-OPERATED COUNTING DEVICE

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Filed June 17, 1966, Ser. No. 558,479
34 Claims. (Cl. 235—201)

ABSTRACT OF THE DISCLOSURE

A pneumatically operated single wheel predetermining counter adapted to be mounted in a bank thereof to provide a plurality of coaxial counter wheels and a plurality of coaxial predetermining wheels. A reciprocable pneumatic relay valve is adapted to be cycled by an air pulse to connect a transverse passage in the counter providing an air supply plenum to actuate a piston in one reciprocable direction against the bias of a return spring. The return spring, upon the cessation of the air pulse, returns the piston to index the counter wheel. A cam is provided on the counter wheel to control the reciprocable motion of the relay valve and to provide a transfer pulse to the adjacent higher order single wheel counter in the bank when the counter wheel is in its "9" position.

A reset valve is interposed in the transfer passage and is adapted to be pneumatically actuated against the bias of a return spring to close off this passage. For this purpose there is provided a second transverse passage in the counter providing a reset plenum, and the counter wheels are adapted to be reset by (1) connecting the reset plenum to a source of air pressure, (2) pneumatically actuating the relay valve of the lowest order single wheel counter of the bank and (3) supplying air pulses to the air supply plenum. The transfer cam on the counter wheel provides for retaining the counter wheel in its "9" position such that all of the counter wheels will then be indexed to "0" by the operating piston return springs when the reset operation is discontinued.

The predetermining section of the counter comprises a predetermining rotor with an axially extending passage which is adapted to be aligned with passage sections in the housing to provide an air pulse when the preselected count is reached.

The present invention relates generally to counting devices and more particularly to a counting device which is fluid operated.

It is a principal aim of the present invention to provide a new and improved counting device which is adapted to be operated by fluid pulses, for example, pneumatic pulses.

It is another aim of the present invention to provide a new and improved counting device which is adapted to be operated by fluid pulses of relatively low magnitude and duration and which is capable of being operated by the fluid pulses produced by conventional fluid logic circuits.

It is a further aim of the present invention to provide a new and improved counting device which is usable to count the number of cycles, etc., of associated equipment in accordance with the number of fluid pulses which are provided to give a measure of the operation of the equipment.

It is a further aim of the present invention to provide a new and improved single wheel counter module which is pneumatically operated and which is adapted to be employed in banks thereof to provide for multiple place counting.

It is another aim of the persent invention to provide a new and improved single wheel counter module which is entirely pneumatic.

It is another aim of the present invention to provide a new and improved single wheel counter which is adapted to be pneumatically operated, pneumatically actuated and pneumatically reset.

It is a still further aim of the present invention to provide a new and improved counting device having a predeterminer which provides a pneumatic response after a predetermined number of counts.

It is another aim if the present invention to provide a new and improved single wheel counter module having a compact and reliable assembly of parts providing a long service free life.

It is another aim of the present invention to provide a new and improved counting device which is pneumatically operated and which is adapted to count with a high degree of reliability at a relatively rapid rate.

It is another aim of the present invention to provide a new and improved counting device that is adapted for multiple entry operation.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a longitudinal side view, partly broken away, and partly in section of a single wheel counter module constructed in accordance with the present invention;

FIG. 2 is a reduced partial front end view, partly broken away, and partly shown in broken lines, of a bank of the single wheel counter modules of FIG. 1;

FIG. 3 is a partial rear end view, partly shown in broken lines, of the bank of single wheel counter modules of FIG. 2;

FIGS. 4 and 5 are partial longitudinal section views, partly broken away and partly in section, of the single wheel counter module of FIG. 1;

FIG. 6 is a reduced longitudinal side view, partly broken away and partly in section, of the single wheel counter module of FIG. 1;

FIG. 7 is a transverse section view, taken substantially along line 7—7 of FIG. 1; and

FIG. 8 is a longitudinal view of a modified connector for the single wheel counter module.

Referring now to the drawings in detail wherein like numbers represent like parts, a single wheel counter module incorporating the present invention is shown having a main housing **10** of generally box-like configuration and an accessory housing **12**, also of general box-like configuration, mounted below the forward end of the main housing with its front end or face **14** below and in alignment with the front end or face **16** of the main housing. The main and accessory housings **10**, **12** are of multipart construction with molded plastic parts secured together by fasteners **20** to provide integral housing assemblies. More particularly, the main housing **10** comprises a rear housing block **22** of generally box-like configuration and a pair of housing sides **24**, **26** having opposed lugs **28**, **30** providing for securely mounting the block **22** at the rear end of the main housing and opposed upper and forward flanges **34**, **36** providing for partially enclosing the generally rectangular chamber **38** formed between the sides **24**, **26** at the forward end of the housing. The left housing side **24** is provided with recesses for receiving the heads of the fasteners **20** and the aforementioned lugs and flanges of the right housing side **26** are provided with threaded apertures for receiving the fasteners **20**.

The accessory housing 12 is similarly formed with a pair of housing sides 40, 42 with opposed mating lugs and flanges to provide a partially enclosed chamber 43 directly below the chamber 38 of the main housing 10. The left housing side 42 is recessed to receive the head of a fastener 20 and the right housing side 40 is provided with a suitable threaded aperture for receiving the fastener. Also the housing sides 40, 42 are contoured at their upper ends to receive the lugs 32 and flanges 36 of the main housing and the accessory housing 12 is attached thereto by suitable fasteners 50, 52 in the aligned bores of the main and accessory housings.

As seen in FIGS. 2 and 3, the housings 10, 12 together form a narrow assembly with coplanar parallel side walls so that the modules can be assembled to provide a bank of modules as shown in FIGS. 2 and 3 and be secured together by the transversely extending fasteners 50, 52 and if desired, by additional fasteners 54, 56, 57 and 58 which may also be employed for mounting the counter assembly. The accessory housings 12 can be readily detached from or attached to the main housing with the fasteners 50, 52.

A number wheel 60 having a sequence of indicia of 0–9 on its cylindrical periphery is mounted within the chamber 38 of the main housing upon a laterally extending supporting shaft 62 suitably supported by the housing sides 24, 26. As seen in FIGS. 1 and 2, the forward flanges 36 are formed with an opening 64 adjacent the periphery of the number wheel 60 to provide for reading the counter. If desired, this opening may be provided with a suitable window 66.

A predeterminer number wheel 70 is similarly mounted on a supporting shaft 71 within the chamber 43. The housing sides 40, 42 are also provided with an opening 72 and the wheel 70 is dimensioned so that the front face 14 of the accessory housing is substantially tangential to the generally cylindrical periphery of the wheel 70. The number wheel 70 is provided on its cylindrical periphery with the sequence of indicia of 0–9 and with serrated sections 73 between the indicia for manually indexing or presetting the wheel.

The predeterminer number wheel 70 is shown connected to be angularly indexed in the counting direction opposite to the counting direction of the number wheel 60, in the shown embodiment in the subtracting direction. The number wheels 60, 70 are interconnected by a gear 76 integrally molded with the number wheel 60, an idler pinion 78 rotatably mounted within the chamber 43, a gear 80 rotatably mounted on the hub 82 of the number wheel 70, and a suitable detent arrangement which includes a spring detent finger 84 mounted within the hub 82. The detent finger 84 is provided with opposed detents 86 which are adapted to be received in the arcuate slots 88 formed on the inner generally cylindrical surface of the gear 80. A suitable plate 90 is also shown employed for axially retaining the spring finger 84 in position. Thus it can be seen that the number wheel 70 can be manually set independently of the number wheel 60.

The number wheel 60 is adapted to be indexed by an air motor 100 which includes a piston 102 reciprocably mounted in a longitudinally extending bore 104 in the block 22. A cap 106 is fixed within the rear end of the bore 104 and a ratchet pawl 108 is pivotally mounted on the enlarged forward end of the piston 102. The ratchet pawl 108 is shown mounted to cooperate with a ratchet wheel 110 integrally molded with the number wheel 60 for indexing the number wheel 60 in the adding direction (in the counterclockwise direction as viewed in FIGS. 1, 4 and 5) as the piston 102 is retracted from its forward or extended position in engagement with the stop or lug 111. Also the ratchet pawl 108 is adapted to engage the teeth of the ratchet wheel 110 along a line substantially lying on the axis of the piston 102 to minimize the lateral forces in the piston. The ratchet pawl 108 is

shown biased into engagement with the ratchet wheel by a compression spring 112 suitably mounted between upstanding lugs on the piston 102 and ratchet pawl 108. Also the ratchet pawl 108 is held in positive engagement with the ratchet wheel as the piston is being retracted by a guide lug 116 formed on the ratchet pawl and a guide cam 118 formed by a recess in the housing side 26. A holdback pawl 120 is provided for restraining the number wheel 60 against movement in the clockwise direction as viewed in FIGS. 1, 4 and 5.

A longitudinally extending bore 130 is provided in the block 22 in alignment with the axis of the number wheel 60. A spool valve 132 is mounted for reciprocable movement in the bore 130 between a retracted position shown in FIG. 1 and a fully extended position shown in FIG. 4. An intermediate position of the spool valve 132 is shown in FIG. 5. The valve 132 functions as a control valve for controlling the operation of the piston 102 and for supplying transfer pulses to a transfer conduit or bore 138. The control valve has a forwardly opening bore 140, and a light compression spring 142 received within the bore 140 and mounted between the control valve and an upstanding lug 144 integrally formed with the housing side 26 provides for returning the control valve to its fully retracted position. A support tube 146 with a forward end flange is mounted within the forward end of the compression spring 142 to maintain the spring in alignment with the bore 140. A guide pin 147 is mounted on a forward extension 148 of the control valve 132 which overlies the lug 144 for receipt within a guide slot 149 (FIG. 6) in the housing side 24.

With the control valve 132 in either its intermediate position shown in FIG. 5 or its fully extended position shown in FIG. 4, a laterally extending bore or supply conduit 150 provides for supplying air under pressure through the intermediate conduit 151 to the rear end of the bore 104. The piston 102 is thereby actuated into engagement with the forward stop 111 against the force of a return spring 152 shown connected between the piston 102 and a transverse pin 153.

With the control valve 132 in its retracted position shown in FIG. 1, the bore 104 is connected to exhaust through the exhaust conduits 154 provided by the laterally extending bores 156 and the longitudinally extending slots 158 in the block 22, to permit the return spring 152 to retract the piston 102 for indexing the number wheel 60 one count.

Also, with the control valve 132 in its retracted position, the transfer conduit 138 is connected to exhaust through the transverse slot 160 and the bore 140 in the valve 132. With the control valve 132 in its fully extended poistion shown in FIG. 4, the supply conduit 150 is connected to supply air under pressure to the transfer conduit 138. Thus as the control valve is cycled through its fully extended position a pulse of air is supplied to the transfer conduit 138.

A longitudinal control conduit or bore 170 is connected to the rear end of the bore 130 to provide for pneumatic actuation of the control valve 132 from its retracted position to its intermediate and fully extended positions. Accordingly an air pulse of appropriate pressure and duration supplied to the control conduit 170 would provide for indexing the counter wheel one count and for supplying an air pulse to the transfer conduit 138. Preferably, the inertia of the valve 132 and piston 102 and the force characteristics of the springs 142 and 152 are such that an air pulse of relatively low pressure and duration may be employed to permit the single wheel counter to be used with conventional fluid logic systems. Also, of course, the counter could be employed, for example, to count the fluid pulses which provide a measure of the operation, etc., of some associated equipment.

The forward extension 148 of the control valve 132 is provided with a rounded forward end or cam follower 172 which is engageable with a cam or stop 174 integrally

formed with the number wheel **60**. The cam or stop **174** is thereby adapted to control the amount of forward motion of the control valve in accordance with the angular position of the number wheel. More particularly, the cam or stop **174** is provided with a generally cylindrical peripheral portion **176** which limits the forward movement of the control valve to its intermediate position when the number wheel is positioned to display the indicia 0 through 8. The cam or stop **174** is, however, provided with a recessed or V-shaped peripheral portion **180** which permits the control valve **132** to be actuated to its fully extended position when the number wheel is in its "9" position. Thus an air pulse is supplied to the transfer conduit **138** when the control valve **132** is actuated to index the number wheel from 9 to 0.

Connectors **190** and **192** are shown mounted on the block **22** for connecting air supply hoses to the conduit **170** and to a transfer conduit **193**, respectively. Where the single wheel counter modules are employed in banks of two or more, a suitable hose **194** would be connected between the connectors **190** and **192** of the adjacent higher and lower order modules respectively as shown in FIG. 3, and the connector **190** of the lowest order module would be connected to a source of fluid pulses, for example to a fluid logic circuit. Also, if multiple entry into the bank of modules were desired one or more of the connectors **190** of the modules of the bank could also be connected to suitable additional pulse sources.

The connectors **190** may be modified as shown in FIG. 8 to include an auxiliary exhaust conduit **198** which is designed to function as a pneumatic diode or one-way valve and accordingly to provide for assisting in exhausting the valve bore **130** without seriously slowing the rate of actuation of the control valve **132**.

A connector **196** (FIGS. 2 and 3) is mounted in the supply conduit or bore **150** of the right housing side **26** of the lowest order module for connecting the supply conduits **150** of the bank of counters to a suitable air source. The aligned supply conduits **150** of the bank of modules thereby together provide an air plenum **197** for indexing the counter wheels. Of course, the bore **150** in the left side housing **24** of the highest order module would be suitably capped or also connected to the air source to maintain the air pressure of the plenum **197**.

Aligned laterally extending bores **199** are shown provided in the housing sides **40**, **42** of the accessory housing and the hub or rotor **82** of the predeterminer number wheel **70** is provided with a laterally extending bore **200** which is adapted for alignment with the bores **199**, in the described embodiment when the number wheel **70** is in its "0" position. A connector **202** is mounted in the bore **199** of the right housing side **40** for connecting the bore to a suitable air source. Accordingly, when two or more of the modules are mounted in a bank and when all of the wheels **70** have been indexed to their "0" positions, all of the bores **199**, **200** of the bank of counters will be aligned to connect the air source to the left end of the bank of modules. Thus, the number wheels **70** can be preset to provide an air pulse after a given number of counts. This pulse can, for example, be used to shut off some associated equipment after a given number of cycles of the equipment, etc.

A third longitudinally extending bore **210** is provided in the block **22** below the bore **130** and between the transfer conduits **138** and **193**. A cap or plug **212** is suitably fixed within the forward end of the bore **210** and a reset valve **214** having a forwardly projecting pin **216** is mounted for reciprocable movement within the rear end of the bore **210**. A compression spring **218** encircling the pin **216** and received with an elongated bore in the cap **212** provides a bias urging the reset valve **214** to its withdrawn position shown in FIGS. 1, 4 and 5, at which position the conduits **138** and **193** are connected for supplying an air pulse to the connector **192**. A lateral reset bore or conduit **222** in the housing **10** provides for supplying air through

the intermediate conduit **224** to the rear end of the bore **210** to actuate the valve **214** forwardly against the bias of the compression spring **218**. In its fully forward or extended position in engagement with the cap **212**, the valve **214** closes off the transfer conduit **138** and connects the transfer conduit **193** with the reset bore **222**. The lateral bores **222** of the bank of modules provide an air plenum **223**, and a suitable connector **225** is mounted in the right side housing **26** of the lowest order module, for connecting the plenum **223** to a suitable air source. The bore **222** in the left side housing **24** of the highest order module would normally be provided with a suitable cap (not shown) to maintain the air pressure of the plenum **223**.

The bank of modules are adapted to be reset by connecting the plenum **223** and the conduit **170** of the lowest order single wheel counter to a source of steady air pressure, and by supplying air pulses to the plenum **197**. As a result the reset valves **214** and the control valves **132** will be shifted to the right. The air pulses supplied by the plenum **197** will provide for indexing the counter wheels in stepwise fashion until they reach their "9" position at which point the forward end or nose of the corresponding control valve **132** will restrain the counter wheel against further rotation and the corresponding piston **102** from being retracted

When all of the counter wheels have been indexed to their "9" position, the air plenums **197** and **223** and the conduit **170** of the lowest order module can be connected to exhaust to permit the pistons to be withdrawn to index the number wheels from their "9" to their "0" positions. The predeterminer number wheels **70**, will, of course, be indexed to their original settings as the number wheels **60** are zeroized.

Thus it can be seen that the fluid-operated counting device of the present invention is adapted to be operated by fluid pulses, to be indexed in stepwise fashion by fluid pressure, to be reset by fluid pulses, and to provide a fluid pulse after a given number of counts. Additionally the single wheel counter module incorporating the present invention is adapted to be mounted in banks having multiple entry operation and providing transfer fluid pulses for indexing the higher order modules. Further the single wheel counter module incorporating the present invention has a compact and reliable assembly of parts which are responsive to fluid pulses having a relatively low magnitude and duration and which are adapted for counting at a relatively high rate over a long service free life.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

We claim:

1. A pneumatic counting device comprising a plurality of counter wheels of ascending order, pneumatic motor means for each of the counter wheels adapted to be operated by pneumatic pulses for angularly indexing the respective counter wheel in stepwise fashion, and transfer means associated with each adjacent lower order counter wheel for providing pneumatic transfer pulses in accordance with the angular position of the respective lower order counter wheel for operating the pneumatic motor means of an adjacent higher order counter wheel.

2. The pneumatic counting device of claim **1** wherein the motor means is adapted to index the respective counter wheel one step for each pneumatic pulse and wherein the transfer means associated with each adjacent lower order counter wheel provides a single pneumatic transfer pulse for each revolution of the respective lower order counter wheel.

3. The pneumatic counting device of claim **1** wherein the transfer means associated with each adjacent lower order counter wheel comprises control means on the respective lower order counter wheel for providing a single

pneumatic transfer pulse for each revolution of the counter wheel.

4. A pneumatic counting device comprising a counter wheel, pneumatic motor means adapted to be actuated by pneumatic pulses for angularly indexing the counter wheel in stepwise fashion, and transfer means for providing pneumatic transfer pulses in accordance with the angular position of the counter wheel, the motor means being connected for angularly indexing the counter wheel at the end of the pneumatic pulse, and the transfer means being controlled in accordance with the operation of the motor means to provide the pneumatic transfer pulse before the counter wheel is indexed.

5. A pneumatic counting device comprising a counter wheel, pneumatic motor means adapted to be actuated by pneumatic pulses for angularly indexing the counter wheel in stepwise fashion, transfer means for providing pneumatic transfer pulses in accordance with the angular position of the counter wheel, and control means including said transfer means comprising a pneumatic relay valve adapted to be actuated by a pneumatic pulse to operate the motor means for indexing the counter wheel and to selectively provide pneumatic transfer pulses in accordance with the angular position of the counter wheel.

6. The pneumatic counting device of claim 5 wherein the control means comprises a pneumatic supply conduit and a pneumatic transfer conduit; and wherein the relay valve is adapted to be pneumatically actuated to connect the supply conduit to the motor means for indexing the counter wheel and to selectively connect the supply conduit to the transfer conduit for supplying a pneumatic transfer pulse in accordance with said angular position of the counter wheel.

7. The pneumatic counting device of claim 6 further comprising a pneumatic reset conduit, and pneumatic reset control means connected to the reset conduit to be pneumatically actuated to connect the reset conduit to the transfer conduit.

8. The pneumatic counting device of claim 6 wherein the control means is adapted to hold the counter wheel in said angular position with the relay valve pneumatically actuated to connect the supply conduit to the transfer conduit.

9. A fluid-operated counting device comprising a counter wheel, a pneumatic motor operable for angularly indexing the counter wheel in stepwise fashion, the pneumatic motor comprising a cylinder and a piston reciprocable within the cylinder connected to index the counter wheel in response to reciprocable movement thereof, and control means including an air supply conduit for supplying air to the cylinder for actuating the piston in at least one reciprocable direction and pneumatically operated operator means comprising a reciprocable relay valve adapted to be pneumatically actuated in one reciprocable direction by a pulse of air pressure for selectively connecting the air supply conduit to the cylinder for pneumatic actuation of the piston in one reciprocable direction, and a return spring for actuating the relay valve in the opposite direction for disconnecting the air supply conduit from the cylinder and for returning the piston in the opposite reciprocable direction.

10. A fluid-operated counting device comprising a counter wheel, fluid motor means operable for angularly indexing the counter wheel in stepwise fashion, a fluid supply conduit for supplying fluid to the motor means, a transfer conduit for supplying a transfer pulse of fluid pressure, and control means including a fluid operated control valve adapted to be actuated by a pulse of fluid pressure for selectively connecting the fluid supply conduit to the fluid motor means and operable to connect the fluid supply conduit to the transfer conduit, and transfer control means for selective operation of the control valve to connect the supply conduit to the transfer conduit in accordance with the angular position of the counter wheel.

11. The fluid-operated counting device of claim 10 wherein the transfer control means comprises cam means rotatable with the counter wheel and cam follower means on the control valve engageable with the cam means for controlling the valve in accordance with the angular position of the counter wheel.

12. A fluid-operated counting device comprising a counter wheel, motor means operable for angularly indexing the counter wheel in stepwise fashion, and control means including fluid operated operator means adapted to be actuated by a pulse of fluid pressure to operate the motor means for indexing the counter, the motor means comprising a pneumatic motor adapted to be pneumatically actuated for indexing the counter wheel; the operator means comprising a pneumatic relay valve adapted to be cycled by a pulse of air for operation of the pneumatic motor, the relay valve being adapted to be selectively operated to provide a pneumatic transfer pulse, and the control means comprising transfer control means for selective operation of the relay valve to provide a pneumatic transfer pulse in accordance with the angular position of the counter wheel.

13. A fluid-operated counting device comprising a counter wheel, motor means operable for angularly indexing the counter wheel in stepwise fashion, and control means including fluid-operated operator means adapted to be actuated by a pulse of fluid pressure to operate the motor means for indexing the counter, the operator means being reciprocably mounted to be actuated in one reciprocable direction by a pulse of fluid to operate the motor means, the control means comprising spring means biasing the operator means in the other reciprocable direction, a fluid supply conduit, and a fluid transfer conduit; the operator means being selectively operable to connect the fluid supply conduit to the transfer conduit, and the control means comprising transfer control means for selective operation of the operator means to connect the supply conduit to the transfer conduit in accordance with the angular position of the counter wheel.

14. A fluid-operated counting device comprising a counter wheel, motor means operable for angularly indexing the counter wheel in stepwise fashion, control means including fluid-operated operator means adapted to be actuated by a pulse of fluid pressure to operate the motor means for indexing the counter, and fluid predeterminer means adapted to be preset to provide a fluid pulse after a given number of counts of the counter wheel, the predeterminer means comprising a predetermining rotor, drive means for rotating the predetermining rotor with the counter wheel, and predeterminer fluid conduit means, said predetermining rotor having a laterally extending bore adapted to be angularly aligned with the predeterminer fluid conduit means for transmitting a fluid pulse after said given number of counts.

15. A fluid-operated counting device comprising a counter wheel, motor means operable for angularly indexing the counter wheel in stepwise fashion, control means including fluid-operated operator means adapted to be actuated by a pulse of fluid pressure to operate the motor means for indexing the counter, the operator means being adapted to be actuated by a pneumatic pulse for operating the motor means for indexing the counter wheel, the control means further including a control conduit for supplying a pneumatic pulse for actuating the operator means and an exhaust conduit means connected to the control conduit, said exhaust conduit means being directly connected to the control conduit and being responsive for effecting timely discharge of the pneumatic pulse after the operator means has been pneumatically actuated for indexing the counter wheel.

16. The fluid-operated counting device of claim 15 wherein the control conduit has a generally straight portion, and wherein the exhaust conduit means comprises

a generally straight open ended stub conduit connected to said straight portion and inclined at an acute angle toward the upstream end of said straight portion of the control conduit.

17. A pneumatic single wheel counter adapted to be mounted in a bank thereof to provide a counting device with a plurality of aligned counter wheels of increasing order, comprising a counter wheel, and control means operated by pneumatic pulses for angularly indexing the counter wheel in step-by-step fashion in accordance with the number of pneumatic pulses and for providing a pneumatic transfer pulse for indexing a succeeding higher order single wheel counter of the bank in accordance with the angular position of said counter wheel.

18. The pneumatic single wheel counter of claim 17 wherein the control means comprises an air supply conduit extending generally parallel to the axis of the counter wheel and adapted to form an air plenum with the supply conduits of the other single wheel counters of the bank, a pneumatically operable motor, a pneumatically operable control valve for connecting the air plenum to the pneumatically operable motor for angularly indexing the counter wheel, a transfer conduit for providing said transfer pulse, said control valve being selectively operable to connect the air plenum to the transfer conduit, and transfer control means for selective operation of the control valve in accordance with the angular position of said counter wheel.

19. The pneumatic single wheel counter of claim 18 wherein the transfer control means comprises first means rotatable with the counter wheel and second means on the control valve cooperable with said first means to control the operation of the control valve in accordance with the angular position of said counter wheel.

20. The pneumatic single wheel counter of claim 17 wherein the control means comprises a pneumatic supply conduit, a pneumatic transfer conduit, a pneumatically operable motor connected for indexing the counter wheel in step-by-step fashion, and pneumatically operable relay means for selectively connecting the supply conduit to the pneumatically operable motor for indexing the counter wheel in response to a pneumatic pulse and for selectively connecting the supply conduit to the transfer conduit to provide a pneumatic transfer pulse in accordance with the angular position of the counter wheel.

21. The pneumatic single wheel counter of claim 20 wherein the control means includes relay control means on the counter wheel for permitting selective connection of the supply conduit to the transfer conduit in accordance with the angular position of the counter wheel.

22. A pneumatically operated counter comprising a counter wheel, a pneumatically actuated motor connected for angularly indexing the wheel in response to a pneumatic pulse, a pneumatic supply conduit, a control conduit for supplying a pneumatic control pulse, control valve means connected to the control conduit and operable by the pneumatic control pulse to momentarily connect the supply conduit to the motor for indexing the counter wheel, and a transfer conduit for supplying a pneumatic transfer pulse, the control valve means being adapted to be operated by the control pulse to momentarily connect the supply conduit to the transfer conduit, and transfer control means for controlling the operation of the control valve means to connect the supply conduit to the transfer conduit in accordance with the angular position of the counter wheel.

23. The pneumatically operated counter of claim 22 wherein the control valve means and the transfer control means cooperate to hold the counter wheel against rotation with the control valve means operated to connect the supply conduit to the transfer conduit.

24. The pneumatically operated counter of claim 23 wherein the transfer control means comprises a control cam rotatable with the counter wheel engageable by the control valve means and having a relatively large annular cam surface portion coaxial with the number wheel and a generally V-shaped cam surface portion permitting movement of the control valve means to connect the supply conduit to the transfer conduit.

25. A single wheel pneumatic counter module comprising an elongated narrow housing with generally parallel external sidewalls, a number wheel mounted in the forward end of the housing with its axis perpendicular to said sidewalls for displaying a number at the forward end thereof, transfer control means on the number wheel, a first longitudinally extending bore in the rear of the housing, a piston longitudinally reciprocable in the first bore between a withdrawn rearward position and an extended forward position, first spring means biasing the piston to its withdrawn position, a ratchet wheel on the number wheel, a ratchet pawl connected to the forward end of the piston for indexing the number wheel as the piston is returned to its withdrawn position, a second longitudinally extending bore in the housing in communication with the first bore, a control valve reciprocable in the second bore, second spring means biasing the control valve rearwardly in its bore, the control valve having a forward end engageable with the transfer control means for controlling the forward movement of the control valve, a supply conduit in the housing connected to the second bore, a control conduit connected to the second bore for supplying a pneumatic pulse for actuating the control valve forwardly against the bias of the second spring means, and a transfer conduit connected to the second bore, said control valve having a forward position connecting the supply conduit to the transfer conduit and first bore and an intermediate position connecting the supply conduit to the first bore only, said transfer control means being adapted to permit movement of the control valve to its said forward position in accordance with the angular position of the number wheel.

26. The pneumatic counter module of claim 25 wherein the number wheel is provided with a sequence of indicia of 0–9 and wherein the transfer control means is adapted to permit movement of the control valve to its said forward position when the number wheel is positioned to display the number 9 at the forward end of the housing.

27. The pneumatic counter module of claim 25 further comprising a third bore intermediate the second bore and the transfer conduit, a pneumatic reset conduit in the housing connected to the third bore, a reset valve reciprocable in the third bore between a retracted position providing a fluid connection between the second bore and the transfer conduit and an extended position providing a fluid connection between the reset and transfer conduits, spring means urging the reset valve to its retracted position, and said reset conduit being connected to the third bore to provide for pneumatic actuation of the reset valve to its extended position.

28. The pneumatic counter module of claim 25 wherein the elongated narrow housing comprises a rear housing block with the first and second longitudinally extending bores, and a pair of longitudinally extending sides on opposite sides of the rear housing block providing the parallel external sidewalls.

29. The pneumatic counter module of claim 28 wherein said block and sides are of separate molded plastic construction, and wherein the sides are formed with locating lugs for locating the block at the rear end of the housing.

30. A pneumatic single wheel counter module comprising an elongated narrow housing with generally parallel external sidewalls, a number wheel mounted in the forward end of the housing with its axis perpendicular to the sidewalls of the housing for displaying a number at the forward end thereof, said counter module being adapted to be mounted in a bank thereof with the parallel external sidewalls of the modules of the bank in aligned engagement and with the number wheels in coaxial alignment, a laterally extending pneumatic supply conduit

through the housing adapted for communication with the supply conduits of the other modules of the bank to provide a pneumatic supply plenum, pneumatically actuated motor means for indexing the number wheel, and control means including relay means adapted to be actuated by a pneumatic pulse for connecting the motor means with the pneumatic supply plenum for indexing the number wheel.

31. The pneumatic single wheel counter module of claim **30** further comprising a laterally extending pneumatic reset conduit through the housing adapted for communication with the reset conduits of the other modules of the bank to provide a pneumatic reset plenum, and a transfer conduit adapted to be connected to a succeeding counter module of the bank; wherein the control means provides for selectively connecting the pneumatic supply plenum to the transfer conduit in accordance with the angular position of the number wheel; and wherein the counter module comprises pneumatically actuated reset control means connected to the reset plenum to be pneumatically actuated to connect the reset plenum to the transfer conduit.

32. A fluid predetermining counter comprising a plurality of rotary coaxial counter wheels of ascending order, a control bore extending substantially parallel to the axis of the counter wheels formed by bore sections in the counter wheels adapted to be in alignment with the number wheels in predetermined relative angular positions, said control bore being thereby adapted to provide a fluid pulse with the number wheels in said predetermined relative angular positions.

33. The fluid predetermining counter of claim **32** wherein the counter wheels bear a sequence of indicia of 0 through 9, and wherein the control bore further comprises fixed bore sections adapted for alignment with the bore sections in the counter wheels with the counter wheels in their 0 angular positions.

34. The fluid predetermining counter of claim **32** wherein the counter comprises a plurality of single wheel predetermining counters each having a narrow housing with housing sides having generally parallel external sidewalls, and a counter wheel rotatably mounted therebetween, and wherein the control bore comprises aligned bore sections in the housing sides and a bore section in the counter wheel adapted for alignment therewith at a predetermined angular position of the counter wheel.

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