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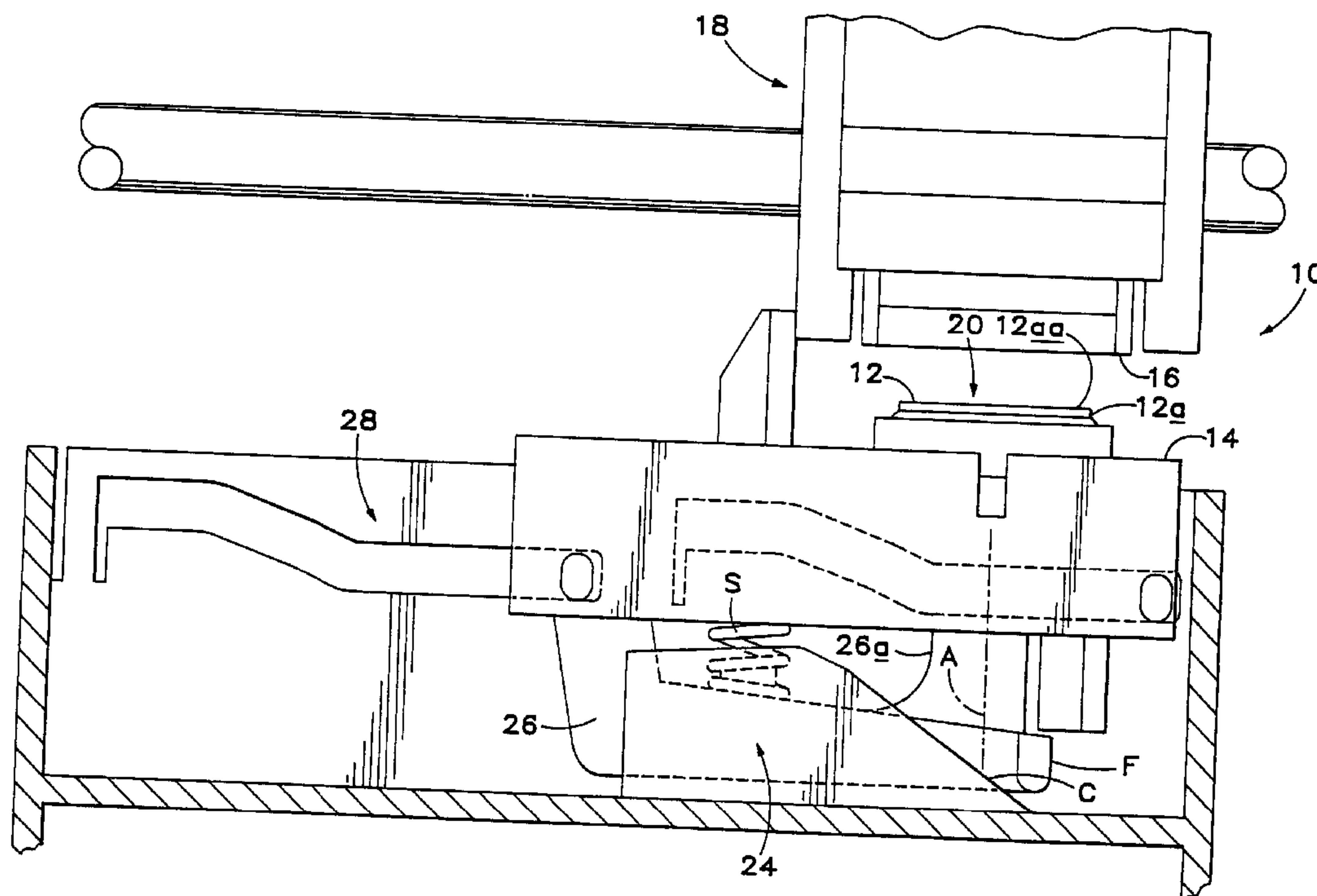
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(54) Titre : COMPRISE ET SYSTEME D'AMORCAGE POUR IMPRIMANTE A JET D'ENCRE SANS TUBES

(54) Title: TUBELESS INK-JET PRINTER PRIMING CAP AND SYSTEM



(57) Abrégé/Abstract:

An ink jet printhead-priming cap includes a first expanse having a peripheral lip region for sealingly engaging an ink jet printhead. The first expanse has formed therein an aperture through which ink can be drawn. Flexible sidewalls are connected in a first region thereof with and extend from the first expanse. The sidewalls extend continuously around a perimeter of the first expanse. A second expanse is connected with a second region of the sidewalls to form a substantially sealed chamber of nominal volume into which ink can be drawn. The second expanse has generally centrally located structure therein for matingly engaging a piston. The flexible sidewalls enable the volume of the chamber alternately to be decreased and increased by piston action thereby to prime the printhead by producing relatively reduced pressure in the chamber to draw ink thereinto from the printhead with the printhead sealingly engaged by the lip region.

ABSTRACT

An ink-jet printhead-priming cap includes a first expanse having a peripheral lip region for sealingly engaging an ink-jet printhead. The first expanse has formed therein an aperture through which ink can be drawn. Flexible sidewalls are connected in a first region thereof with and extend from the first expanse. The sidewalls extend continuously around a perimeter of the first expanse. A second expanse is connected with a second region of the sidewalls to form a substantially sealed chamber of nominal volume into which ink can be drawn. The second expanse has generally centrally located structure therein for matingly engaging a piston. The flexible sidewalls enable the volume of the chamber alternately to be decreased and increased by piston action thereby to prime the printhead by producing relatively reduced pressure in the chamber to draw ink thereinto from the printhead with the printhead sealingly engaged by the lip region.

TUBELESS INK-JET PRINTER PRIMING CAP AND SYSTEM

Technical Field

The present invention relates generally to priming ink-jet printer printheads. More particularly, the invention concerns a tubeless system that includes a priming cap having integrally formed therewith a pump diaphragm automatically actuated by printhead carriage movement to draw ink droplets from a sealed printhead into a chamber formed between the cap's upper and lower expanses.

Background Art

Rolling diaphragm assemblies are known to have been used in flow control metering valves in automotive applications, e.g. internal combustion engines, while printing applications that utilize diaphragms conventionally have used disk-shaped diaphragms and valves to pump small quantities of ink from reservoirs to printers via flexible tubes and conduits. Recent advances in ink-jet printhead priming and flushing are described in my co-pending U.S. Patent Application Serial No. 07/949,318, filed September 21, 1992 entitled "Automatic Failure Recovery Method and System for Ink-jet Printheads", which is subject to common ownership herewith. The system described therein requires a vacuum-and-flush tube, a rotating cam, and a tube pinch-off follower member per printhead, as well as a common diaphragm-type pump, drive motor clutch mechanism and firmware for synchronously controlling a drive motor's forward and reverse rotation. The system is effective in priming and flushing ink from plural printheads, thus to avoid clogging of the printheads' nozzles, but it involves many moving parts and their attendant cost of production and maintenance and it is subject to accumulation of ink and particulate in the tubes. The system also requires a relatively long, e.g. twenty second or more, cycle time during which the ink-jet printer is out of service.

Disclosure of the Invention

The invented system requires fewer parts, involves lower cost and achieves higher reliability than previous ink-jet printhead-priming systems. It is preferably implemented, using the existing printer carriage drive motor, by integrally

molding a rolling diaphragm into a lower region of a printhead-sealing cap, with the diaphragm being reciprocated by a spring-returned lever in synchronism with lateral and differential vertical movement of a cap-carrying sled, wherein priming is accomplished uni-directionally to avoid reverse priming of the printhead. There are no tubes subject to becoming clogged with ink or other particulate. Out-of-service printhead-priming cycle time is reduced to under five seconds, thus increasing long-term printer throughput. The invented system may be integrated with printhead capping systems, as in a rotatable, multi-service station equipped with an ink blotter.

10 In accordance with one aspect of the present invention there is provided an ink-jet printhead-priming cap comprising:

 a first expanse including a peripheral lip region for sealingly engaging an ink-jet printhead, said first expanse having formed therein an aperture through which ink can be drawn;

15 flexible sidewalls connected in a first region thereof with and extending from said first expanse, said sidewalls extending continuously about said first expanse; and

 a second expanse connected with a second region of said sidewalls to form a substantially sealed chamber having sufficient volume into which ink can be drawn, said second expanse having generally centrally located therein structure for matingly engaging a piston, said flexible sidewalls enabling the volume of said chamber alternately to be decreased and increased by piston action, thereby to prime the printhead by producing relatively reduced pressure in said chamber to draw ink thereinto from the printhead with the printhead sealingly engaged by said lip region.

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 These and additional objects and advantages of the present invention will be more readily understood after a consideration of the drawings and the detailed description of the preferred embodiment.

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Brief Description of the Drawings

Embodiments of the present invention will now be described more fully with reference to the accompanying drawings in which:

Fig. 1 is a front elevation of the invented priming cap and system made in accordance with their preferred embodiments.

Fig. 2 is a side elevation of the cap and system corresponding generally with Fig. 1, but showing the system in a different phase of its operation.

Figs. 3A through 3F are sectional illustrations corresponding generally with Fig. 1 and showing various phases of the operation of the invented priming cap and system.

Fig. 4 is an alternative embodiment of the invention featuring a dual printhead capping and priming system in a rotatable, multi-service station.

Detailed Description of the Preferred Embodiments and Best Mode of Carrying Out the Invention

Fig. 1 is a front elevation of the invented priming system in its preferred embodiment, indicated at 10. In a first preferred embodiment, system 10 includes an ink-jet printhead-priming cap 12 mounted for vertical reciprocation on a sled 14 beneath an ink-jet printhead 16 that typically is mounted for horizontal reciprocation on a carriage including a carriage rod, indicated generally at 18.

Referring collectively to Figs. 1, 2 and 3A, cap 12 preferably includes a first, e.g. upper, expanse 12a including a peripheral lip region 12aa for sealingly engaging the ink-jet printhead, with first expanse 12a also preferably having formed therein an aperture 12b through which ink can be drawn. Cap 12 also preferably includes flexible sidewalls such as rectilinearly extending sidewalls 12c, 12d, 12e, 12f connected in a first, e.g. upper, region thereof with, and extending from, first expanse 12a, with the sidewalls extending at least substantially continuously around a perimeter of the first expanse, as shown in Fig. 1. Cap 12 also preferably includes a second, e.g. lower, expanse 12g connected with a second, e.g. lower, region of sidewalls 12c, 12d, 12e, 12f to form a substantially sealed chamber of nominal volume into which ink can be drawn, such chamber being indicated in Fig. 1 generally at 20.

Preferably, second exppanse 12g has generally centrally located therein structure, e.g. a thickened central region 12ga having a hole 12gaa formed therein, for matingly, e.g. yieldably conformingly, engaging a piston, or piston member, 22. Those of skill will appreciate that, within the spirit and scope of the invention, alternative means for engaging piston 22 and first exppanse 12a of cap 12 may be used. Those skilled in the art also will appreciate that flexible sidewalls 12c, 12d, 12e, 12f enable the volume of chamber 20 alternately to be decreased and increased by piston action, thereby to prime printhead 16 by producing relatively reduced pressure in the chamber to draw ink thereinto from the printhead with the printhead sealingly engaged by lip region 12aa of first exppanse 12a. Thus, flexible sidewalls 12c, 12d, 12e, 12f collectively will be referred to herein as a diaphragm, and more specifically in the context of the preferred embodiment of the invention as a rolling diaphragm, for reasons that will be apparent to persons skilled in the art.

First and second expspaces 12a, 12g, as well as flexible sidewalls 12c, 12d, 12e, 12f preferably are integrally molded from any suitable material, e.g. a pliable polymeric or other elastomeric material. As may be seen from Fig. 1, central region 12ga of second exppanse 12g is generally congruent with the piston member-mating structure described above is thicker than a peripheral, or annular, region 12gb therearound. As also may be seen from Fig. 1, the thickness of the second region of sidewalls 12c, 12d, 12e, 12f preferably is substantially the same as the thickness of second exppanse 12g in such peripheral region 12gb, and the inner surfaces of the sidewalls preferably continuously smoothly connect with this peripheral region of the second exppanse. In order to make second exppanse 12g and sidewalls 12c, 12d, 12e, 12f of cap 12 form what is referred to herein as a rolling diaphragm, one of the first and second expspaces is of lesser extent in its two dimensions than the other in its two corresponding dimensions such that connecting sidewalls 12c, 12d, 12e, 12f are inclined therebetween.

It will be understood that, in operation, sidewalls 12c, 12d, 12e, 12f “roll” and “unroll” smoothly in response to reciprocal movement of second exppanse 12g, such as that produced by piston member 22, generally along a reciprocation axis A. Preferably, a region of second exppanse 12g around the inside of hole 12gaa formed therein that forms the above-described piston member-mating structure includes a

recessed annular shoulder for seating an enlarged terminal region 22a of a terminal end 22b of piston 22 that extends at least partway through hole 12gaa.

Referring still to Fig. 1, invented tubeless ink-jet carriage-mounted printhead priming system 10 may be described as including 1) piston member 22 having
5 distal end 22b; 2) a first drive mechanism, indicated generally at 24, for reciprocating distal end 22b of piston member 22 generally along a predefined axis such as axis A; and 3) a generally vertically reciprocable cap 12, cap 12 having an upper region 12a, preferably including lip region 12aa, located along axis A for sealingly engaging
10 printhead 16 in a first predefined position of cap 12 relative to a horizontally reciprocal carriage 18 that mounts such printhead 16 (e.g. a position such as that shown in Fig. 1). Preferably cap 12 has a receptacle, also generally indicated at 20, formed therewith for receiving ink droplets introduced thereinto from the printhead.

Referring collectively to Figs. 1 and 2, first drive mechanism 24 in accordance with the first preferred embodiment of the invention takes the form of a
15 pivotal member, or lever, or rocker arm, 26 having operatively connected on a distal end 26a thereof piston member 22, with a pinned second end 26b defining an axis for pivotal reciprocation of arm 26 thereabout by any suitable drive mechanism (such as a lifter, which in a first preferred embodiment takes the form of a cam C and a cam follower F
20 arrangement of a cap-mounting sled and a sled mounting base, and a return spring S) to produce generally vertical reciprocation of piston member 22 in synchronization with horizontal reciprocation of the printer's carriage. Those of skill in the art will appreciate that, within the spirit and scope of the invention, any suitable means for producing reciprocation of piston member 22 may be used.

As is suggested by Fig. 1, receptacle 20 preferably has a diaphragm
25 located along axis A defining a lower region of the receptacle, with the diaphragm having on a lower surface thereof structure operatively engaging piston member 22.

The diaphragm is flexed by generally vertical reciprocation of piston member 22 in predefined synchronization with carriage 18, with cap 12 in sealing

engagement with the printhead to prime the same, thereby to cause ink droplets to exit the printhead and to be collected in the receptacle.

Preferably, a second drive mechanism indicated generally at 28, is provided for lowering cap 12 to a second predefined position below the first predefined position in predefined synchronization with reciprocation of piston member 22 such that cap 12 sealingly engages printhead 16 only during a downstroke of the piston member. Preferably, operatively coupled with second drive mechanism 28 is moveable sled 14 mounting invented cap 12, wherein sled 14 is vertically reciprocated in predetermined synchronism with lateral reciprocation of carriage 18. In this embodiment of invented system 10, lowering of sled 14 effects lowering of cap 12 to such second predefined position.

It will be appreciated that second drive mechanism in the first preferred embodiment described and illustrated herein may take the form of the cam and cam follower arrangement suggested in Figs. 1 and 3A through 3F constructed, for example, in accordance with the teachings of U.S. Patent No. 5,563,638 entitled "Ink-jet Printhead Capping and Wiping Method and Apparatus", which is commonly owned herewith. Alternatively, second drive mechanism 28 may take the form of a stepper motor capable of alternately raising and lowering sled 14 responsive to drive signals produced by the printer's controller. Those skilled in the art will appreciate that sled 14 may be reciprocally raised and lowered by any suitable means.

Fig. 2 corresponds with Fig. 1, but represents invented system 10 in side elevational view. Clearly from comparing Figs. 1, 2 and 3C, chamber or receptacle 20 is reduced from a maximum to a minimum volume, and sidewalls 12c, 12d, 12e, 12f are rolled, or substantially and smoothly folded back on themselves, such that the sealing engagement of lip region 12aa of expanse 12a with printhead 16 during a downstroke of piston 22 produces a vacuum within chamber 20. Those of skill will appreciate that, as piston 22 returns from its position shown in Fig. 3C, for example, to its position shown in Fig. 1, the one or more pens of ink-jet printhead 16 will be primed, and ink droplets will be forced to exit the pens' orifices, to pass through hole 12ab in expanse 12a and to

drop into chamber or receptacle 20. In this way, then, ink-jet printhead 16 is primed without the need for a tube for each included pen leading from a corresponding priming structure to a common receptacle located remote therefrom, as heretofore have been required.

5 Figs. 3A through 3F illustrate the operation of system 10 in various phases of its operation, in somewhat simplified form. Fig. 3A shows system 10 in an initial, or start, phase of operation in which sled 14 is lowered and invented priming cap 12 is uncompressed such that its chamber is of maximum volume. Fig. 3B shows system 10 in a later phase of operation in which sled 14 remains in its lowered position
10 and in which compression of cap 12 begins. Fig. 3C shows system 10 in a still later phase of operation in which sled 14 yet is lowered (and has been moved to the left by carriage 18, and the second end 26b of lever 26 has climbed the sled's ramped cam surface) and in which cap 12 is fully compressed such that its chamber is of minimal volume. Fig. 3D shows system 10 in a yet later phase of operation in which capping
15 begins by raising sled 14 with cap 12 yet fully compressed but without contact between its lip region 12aa and printhead 16. Fig. 3E shows system 10 in a priming phase of operation in which previously fully compressed cap 12 sealingly engages printhead 16 and during which ink is drawn from ink-jet printhead 16 by progressive decompression of the cap. It is noted that lever 26 controllably is returning piston 22 to its initial,
20 unelevated position by the cooperative action of spring S, cam C and follower F.

Those skilled in the art will appreciate that, as described herein "capping" refers to the sealing engagement with printhead 16 of lip region 12aa of cap 12, rather than to conventional capping of a printhead when it is net in use, which conventional capping requires printhead venting to ambient pressure. As will be seen by later
25 reference to Fig. 4, invented priming cap and system are compatible with such conventional capping of printheads for such purpose, while also providing the unique printhead-priming advantages described herein.

Finally, Fig. 3F shows system 10 in a final phase of operation in which priming by cap 12 is complete. It is noted that lever 26 has returned fully to its initial
30 position, representing completion of a downstroke of first end 22a of operatively

connected piston member 22 and decompression of cap 12. Importantly, it will be appreciated by contrasting Figs. 3D, 3E and 3F that printhead 16 is not capped during an upstroke of piston member 22 during which cap 12 is compressed, but instead is capped preferably simultaneously with, or slightly after, the beginning of the downstroke of piston member 22. In this way, no head is produced in printhead 16 and only a vacuum is produced therein at the beginning of the priming step facilitated by invented priming cap 12 and system 10 described herein. This avoids undesirable production of a positive pressurization of printhead 16 that might damage the printhead.

Fig. 4 illustrates an alternative embodiment of invented system 10 in which a priming cap is mounted for rotation on a multi-service station including an ink blotter for removing accumulated ink therefrom. In this also preferred embodiment of invented system 10, a rotatable member 30 mounts cap 12 for selective sealing engagement of printhead 16 thereby when member 30 is rotated to a first predefined position of proximity between cap 12 and printhead 16 (e.g. the position shown in Fig. 4). Other service stations, including, for example, a conventional cap 32 and a conventional wiper 34, may be provided on member 30. Shown also in Fig. 4 is a blotter 36 disposed adjacent the periphery of rotatable member 30 in arcuately spaced relationship with printhead 16 for blotting ink collected in receptacle 20 when rotatable member 30 is rotated to a predefined second position of proximity between cap 12 and such blotter 36. It will be appreciated that this second predefined position corresponds to the location of blotter 36 shown in Fig. 4, and that rotatable member 30 may of course be rotated, either unidirectionally or bidirectionally, by any suitable means such as a stepper motor under the control of the ink-jet printer's controller. Preferably, although the capacity of invented priming cap 12 is 500-1000 typical priming cycles, it is convenient to blot priming cap 12 after each priming cycle, as by use of blotter 36 of the alternative Fig. 4 embodiment.

Other services may of course be performed by rotatable member 30 by equipping it with various service positions, e.g. it also may provide for wiping, spitting, capping and/or other desirable servicing of printhead 16. Skilled persons will appreciate that, by providing for any needed venting of the printhead during capping thereof for prolonged printer non-use, it may be possible at lower cost to integrate the priming and

capping structures within one service station position. In other words, priming cap 12 may be designed at somewhat greater complexity to provide a vacuum seal with printhead during the relatively short-term priming cycle, as taught herein, and to provide a vent to ambient of the printhead during the relatively long-term capping cycle, as is
5 known.

Industrial Applicability

It now may be appreciated that the invented priming cap and system eliminate the need for tubes extending between a common diaphragm pump and one or more primer mechanisms corresponding with one or more printheads, and between such
10 one or more primer mechanisms and a common ink receptacle. In accordance with the invention, ink-jet printhead priming is accomplished for one or more printheads without tubes and without a multiplicity of complex priming assemblies for the one or more printheads. The invented priming cap and system are relatively easily and inexpensively manufactured and maintained in singular or plural ink-jet printhead printers, with the
15 simplest of drive mechanisms including, for example, a cam and cam follower arrangement of a sled driven by the printer's existing carriage motor, a lever and a spring. The cap itself inexpensively may be manufactured by the use of relatively inexpensive tools such as injection molds. In operation, the priming of one or more printheads is accomplished in a short cycle time, thus taking the printer off-line for
20 priming only minimally.

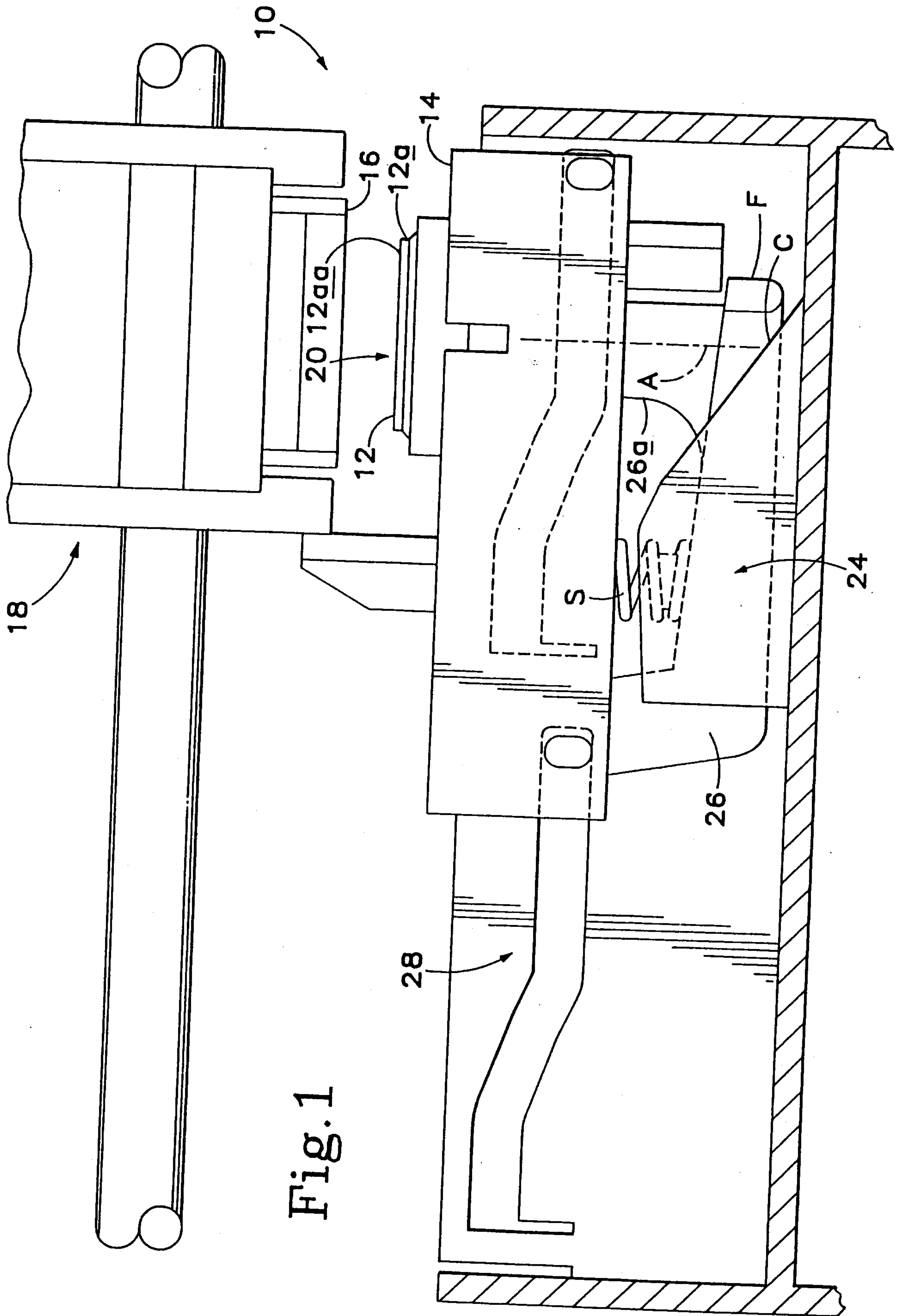
While the present invention has been shown and described with reference to the foregoing operational principles and preferred embodiment, it will be apparent to those skilled in the art that other changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An ink-jet printhead-priming cap comprising:
a first expanse including a peripheral lip region for sealingly engaging
an ink-jet printhead, said first expanse having formed therein an aperture through
5 which ink can be drawn;
flexible sidewalls connected in a first region thereof with and
extending from said first expanse, said sidewalls extending continuously about said
first expanse; and
a second expanse connected with a second region of said sidewalls to
10 form a substantially sealed chamber having sufficient volume into which ink can be
drawn, said second expanse having generally centrally located therein structure for
matingly engaging a piston, said flexible sidewalls enabling the volume of said
chamber alternately to be decreased and increased by piston action, thereby to prime
the printhead by producing relatively reduced pressure in said chamber to draw ink
15 thereinto from the printhead with the printhead sealingly engaged by said lip region.
2. The ink-jet printhead-priming cap of claim 1, wherein said first and
second expanses and said sidewalls are integrally molded from a pliable polymeric
material.
3. The ink-jet printhead-priming cap of claim 2, wherein a central region
20 of said second expanse generally congruent with said structure is thicker than a
peripheral region therearound.
4. The ink-jet printhead-priming cap of claim 3, wherein the thickness of
said second region of said sidewalls is substantially the same as the thickness of said
second expanse in said peripheral region and wherein inner surfaces of said sidewalls
25 continuously smoothly connect with said peripheral region of said second expanse.

5. The ink-jet printhead-priming cap of claim 4, wherein one of said first and second expanses is of lesser extent in two dimensions than the other and wherein said sidewalls are inclined therebetween to form a rolling diaphragm.

6. The ink-jet printhead-priming cap of claim 4, wherein said structure of
5 said second expanse includes a hole formed therein with a region around the inside of the hole including a recessed annular shoulder for seating an enlarged terminal region of said piston that extends at least partway through said hole.



Fin.

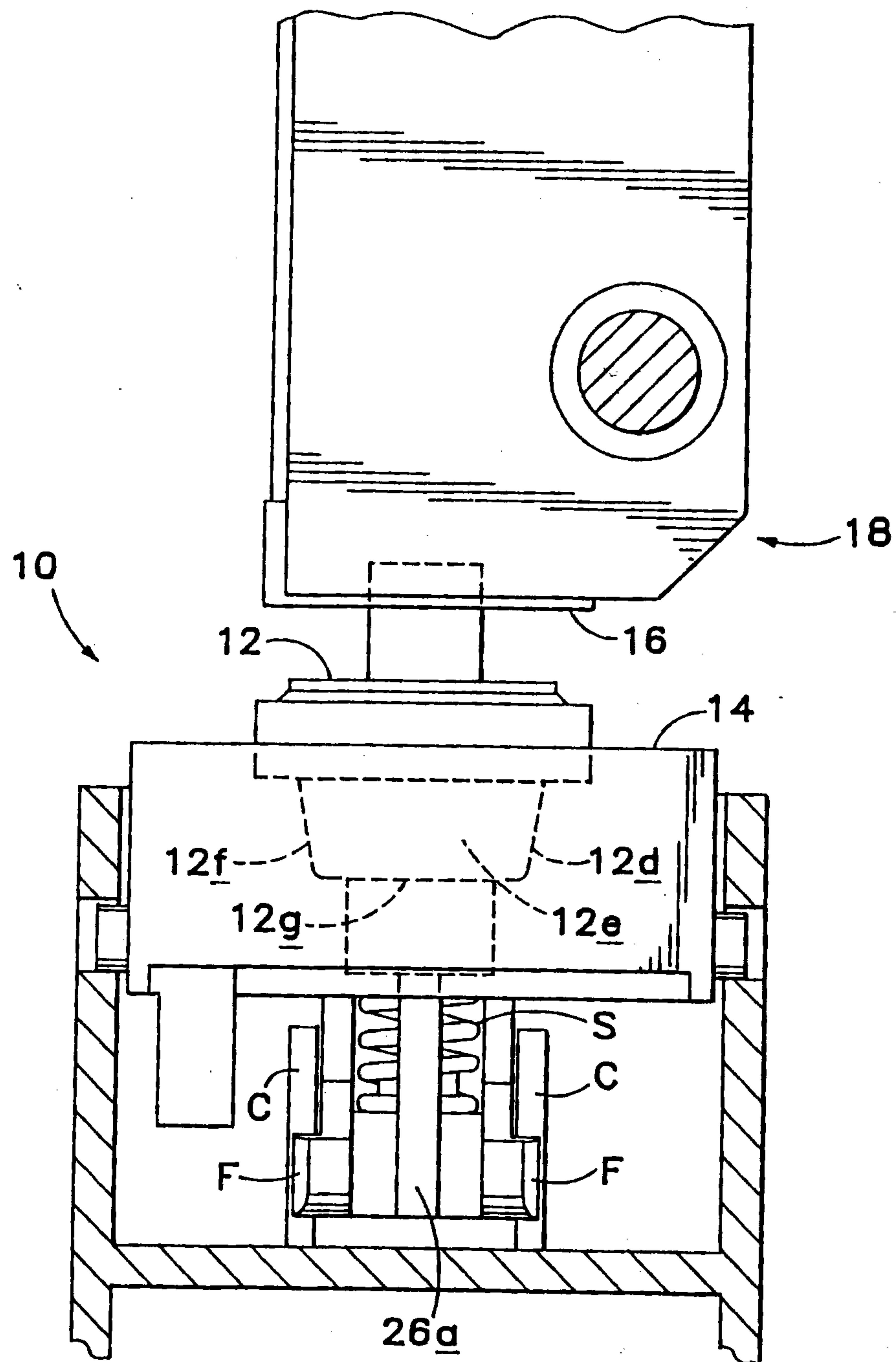


Fig. 2

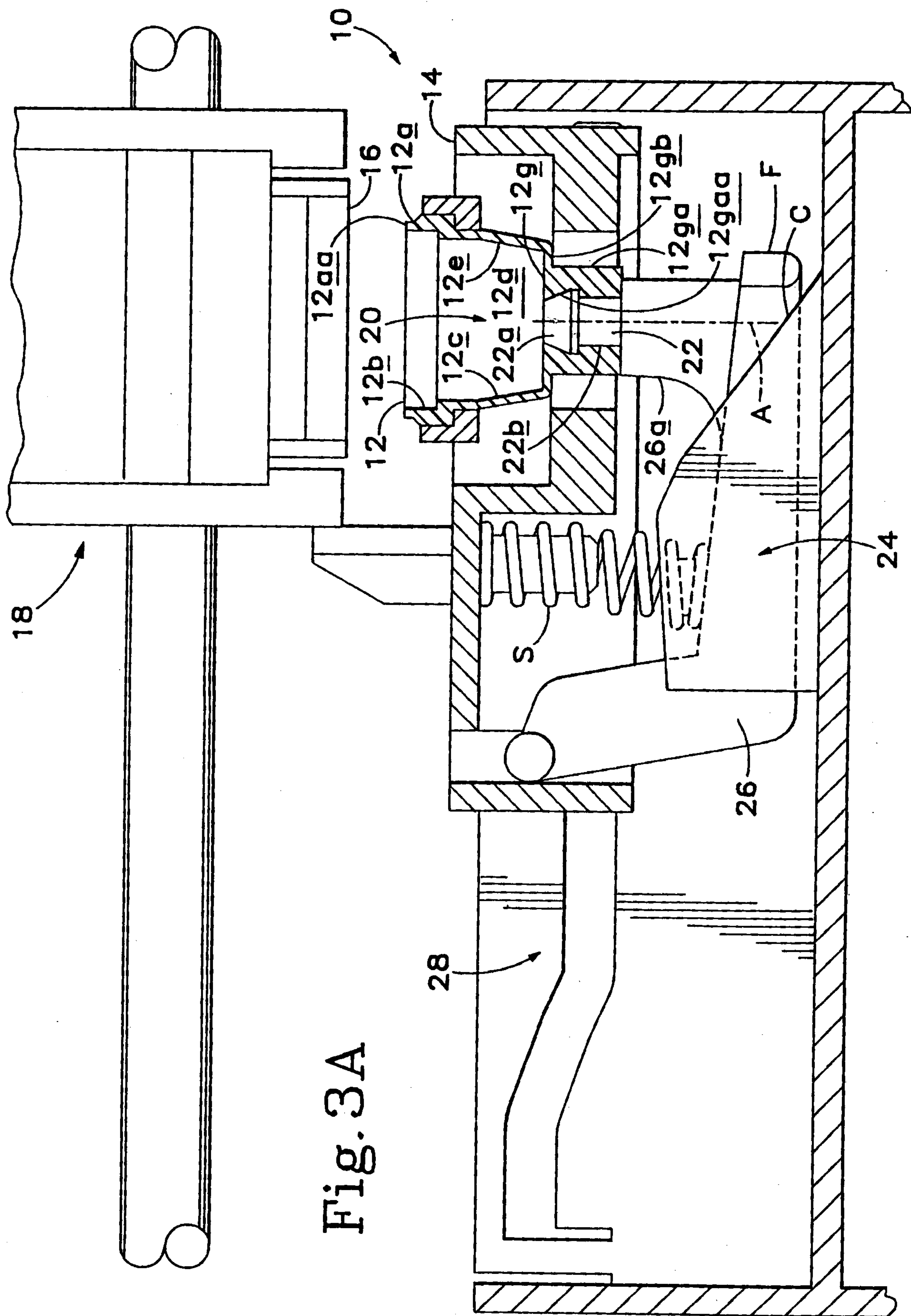
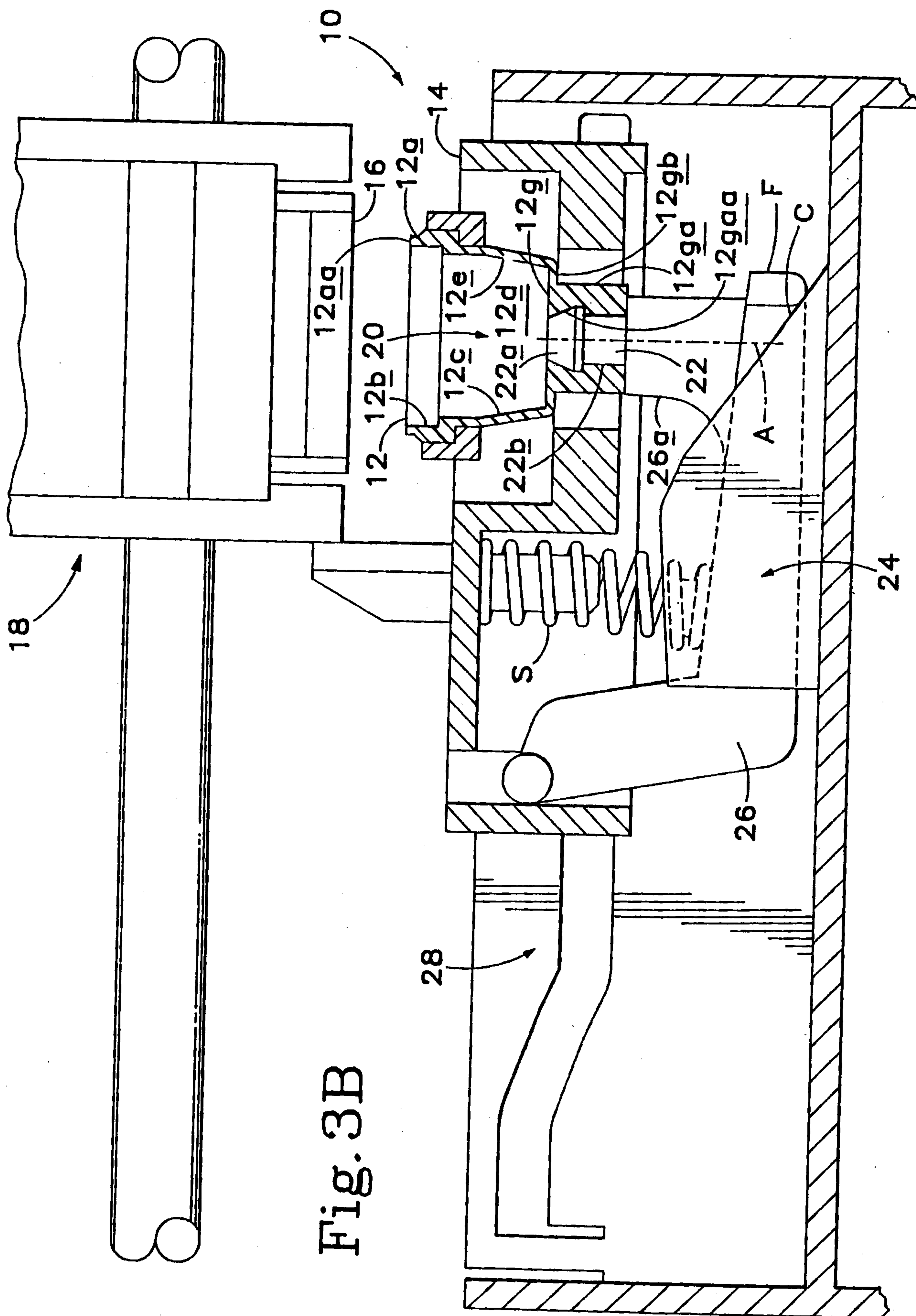


Fig. 3A



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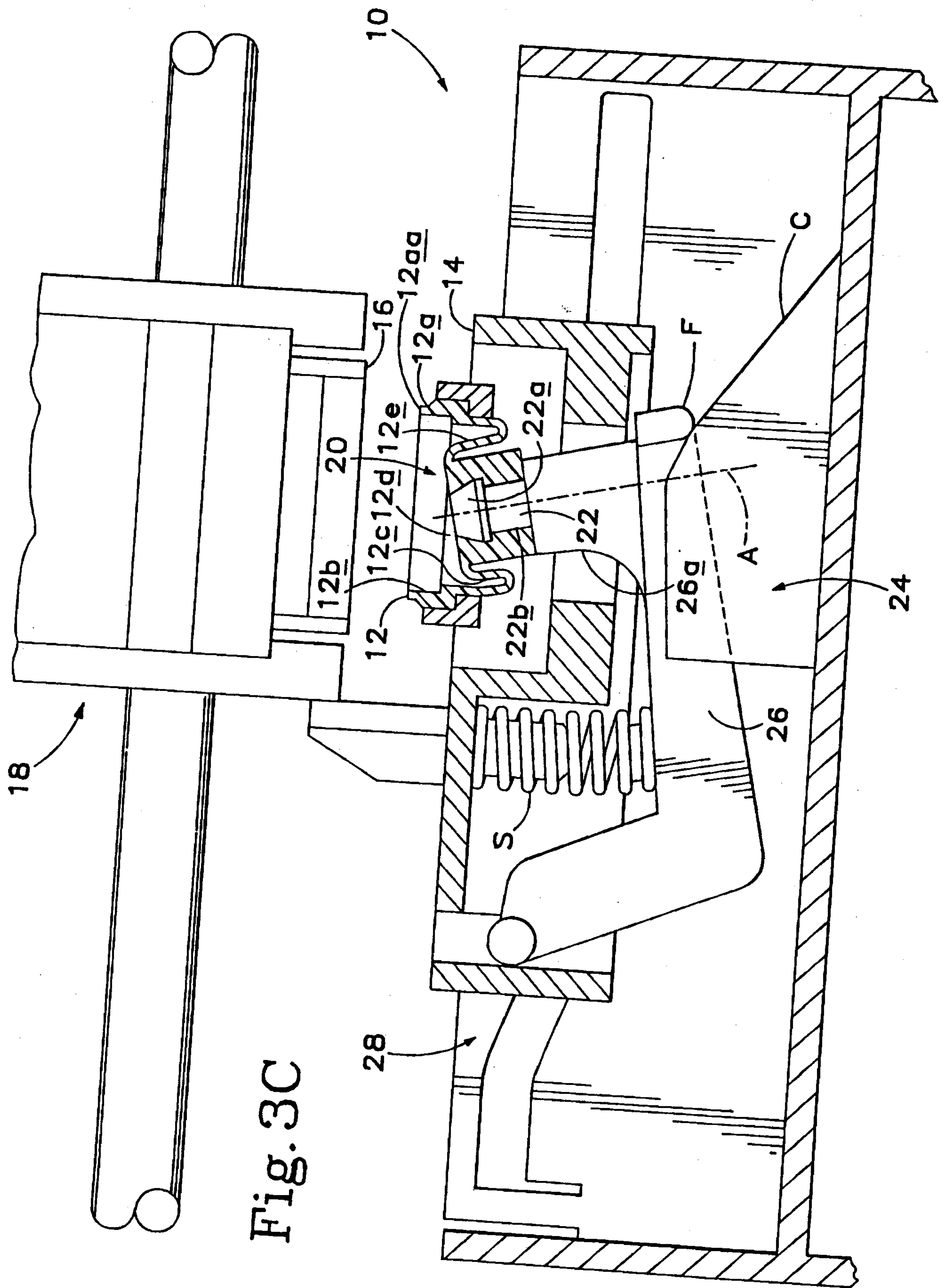


Fig. 3C

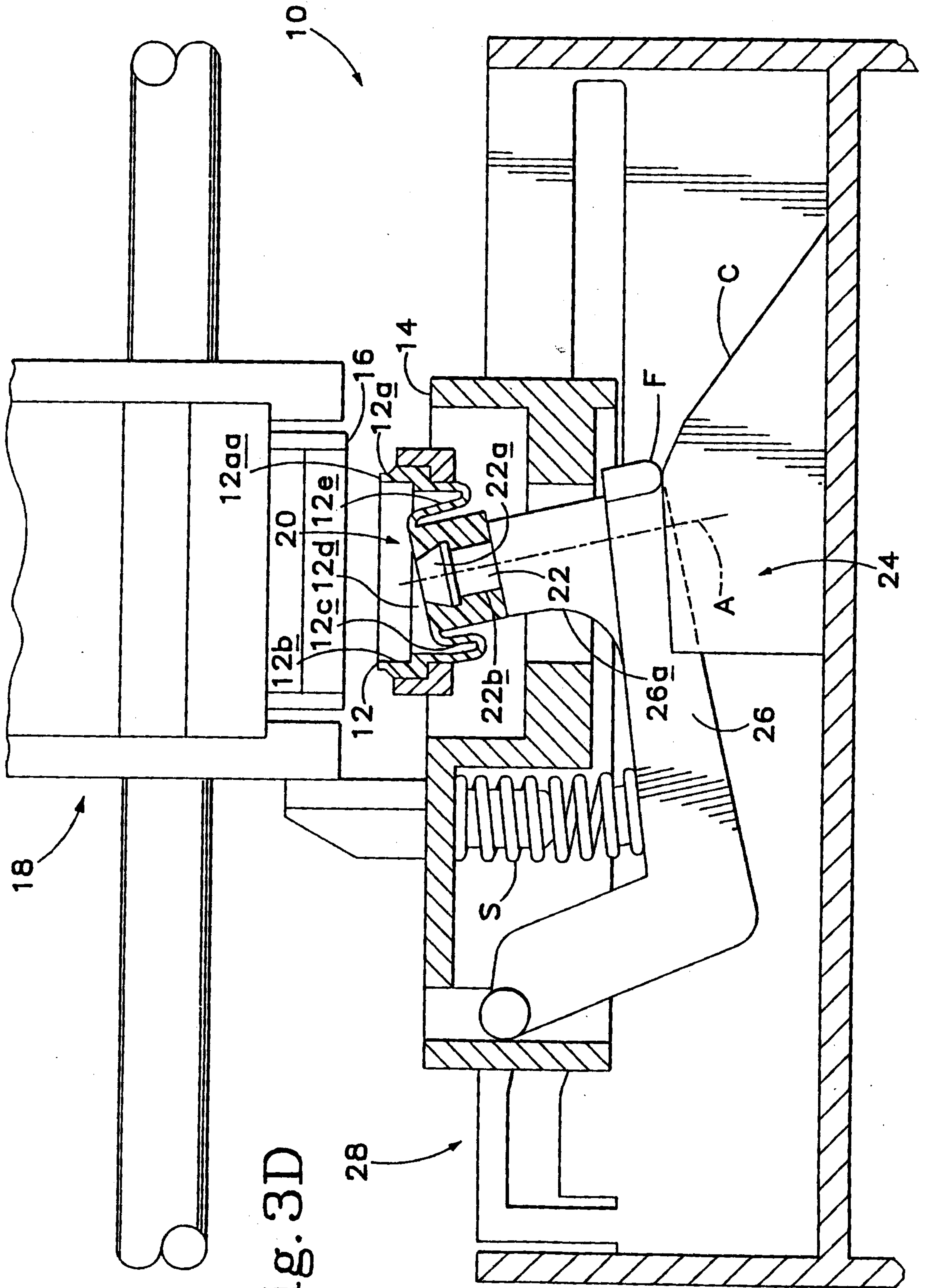
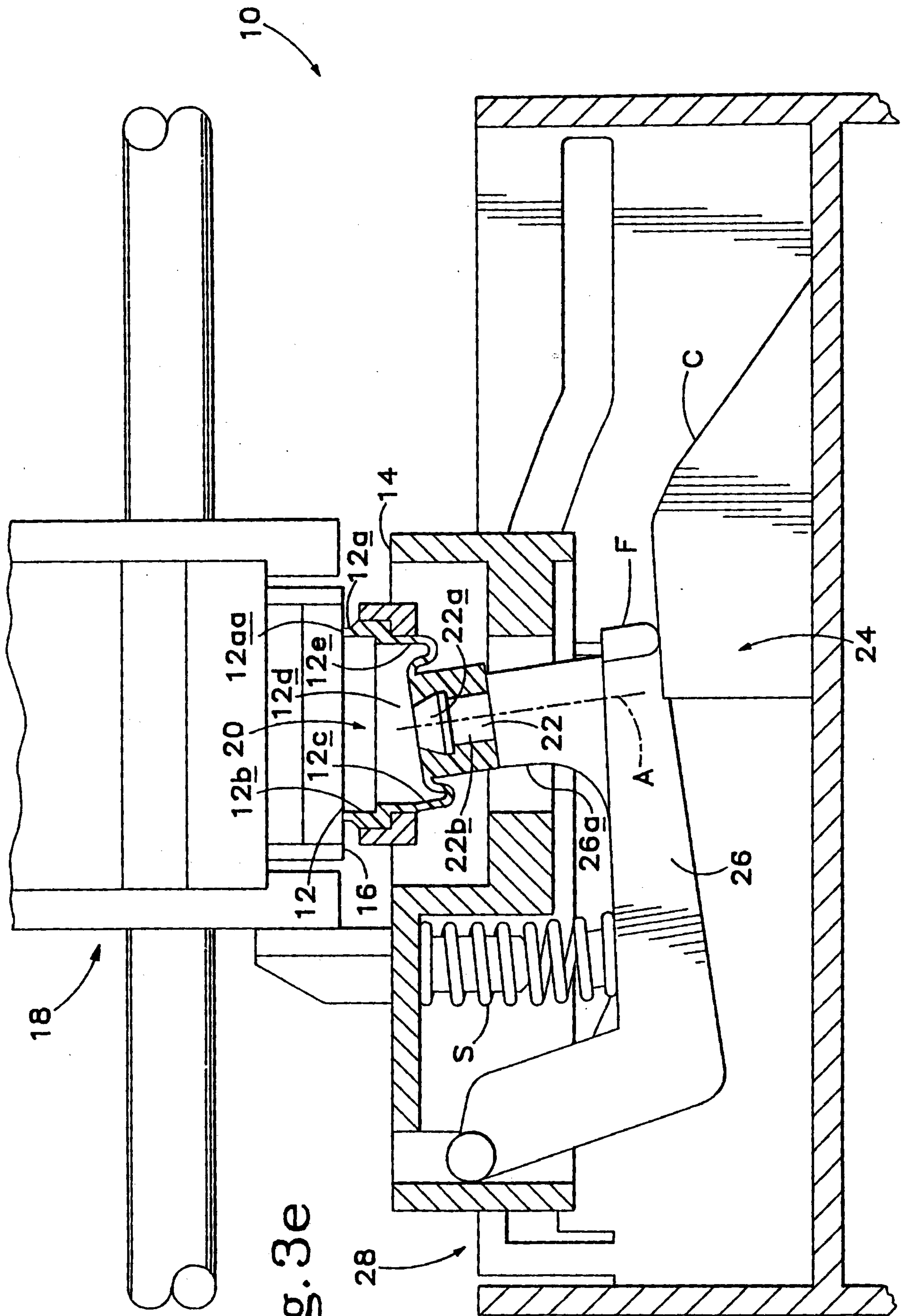
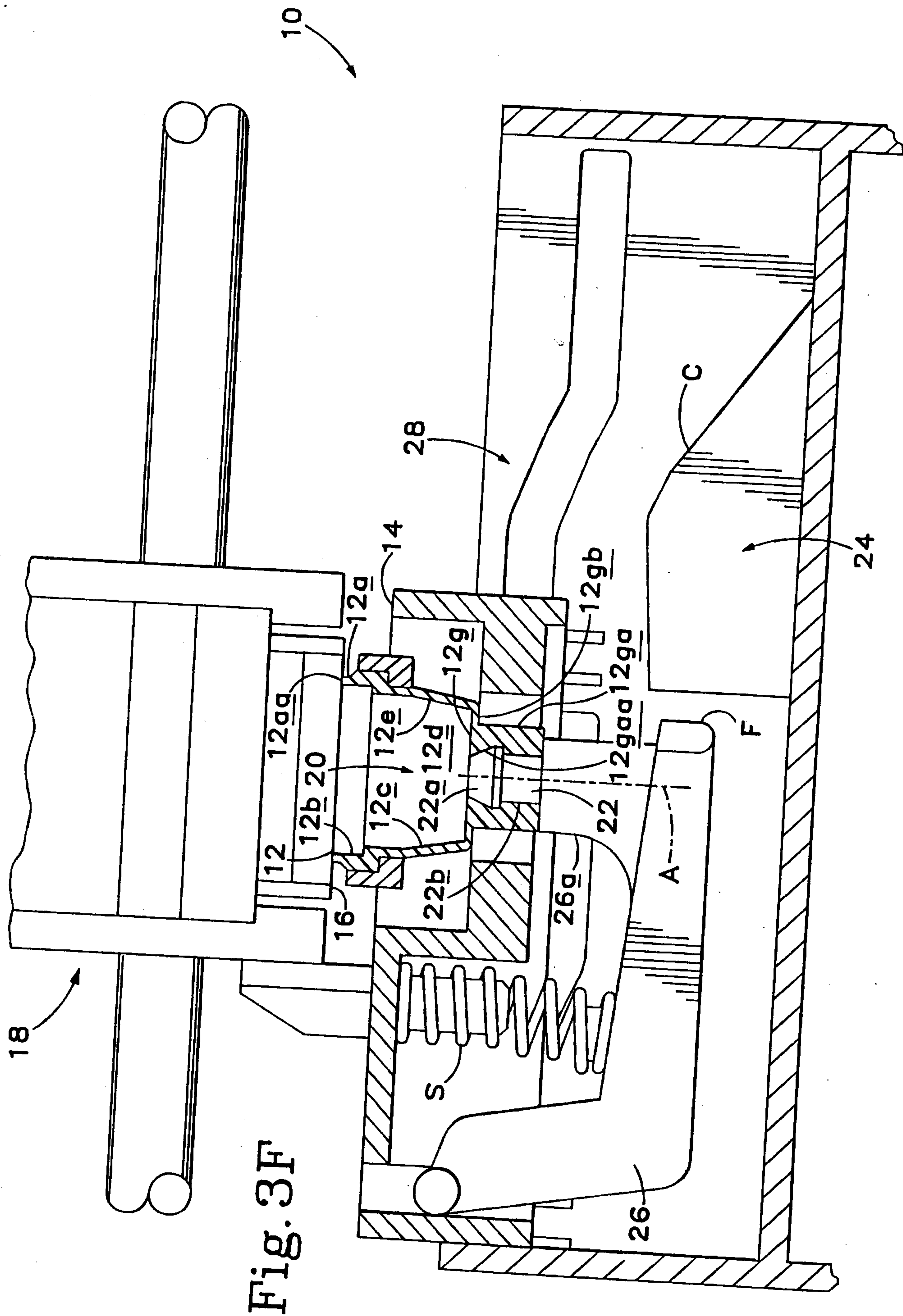


Fig. 3D



File 3e



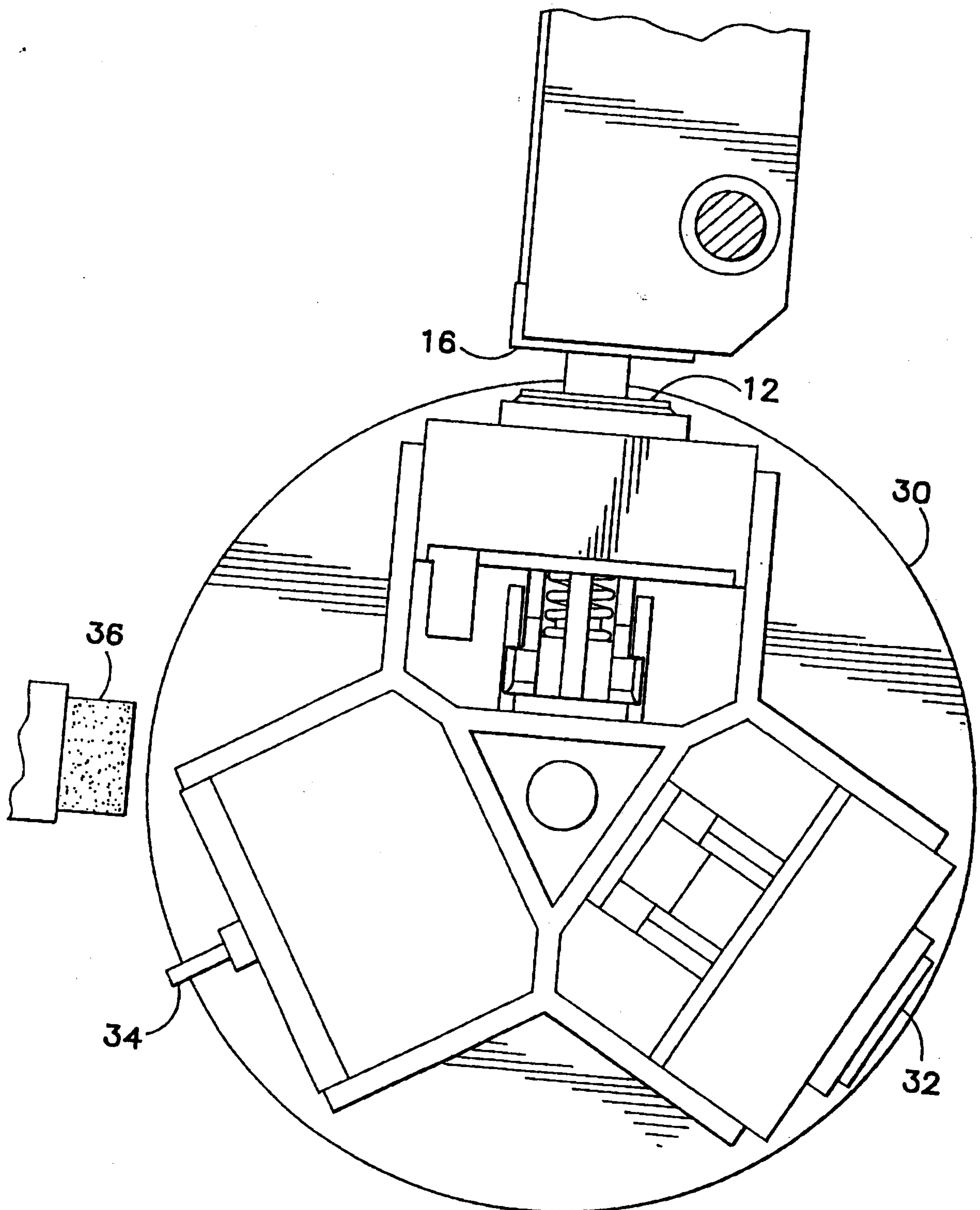


Fig. 4

