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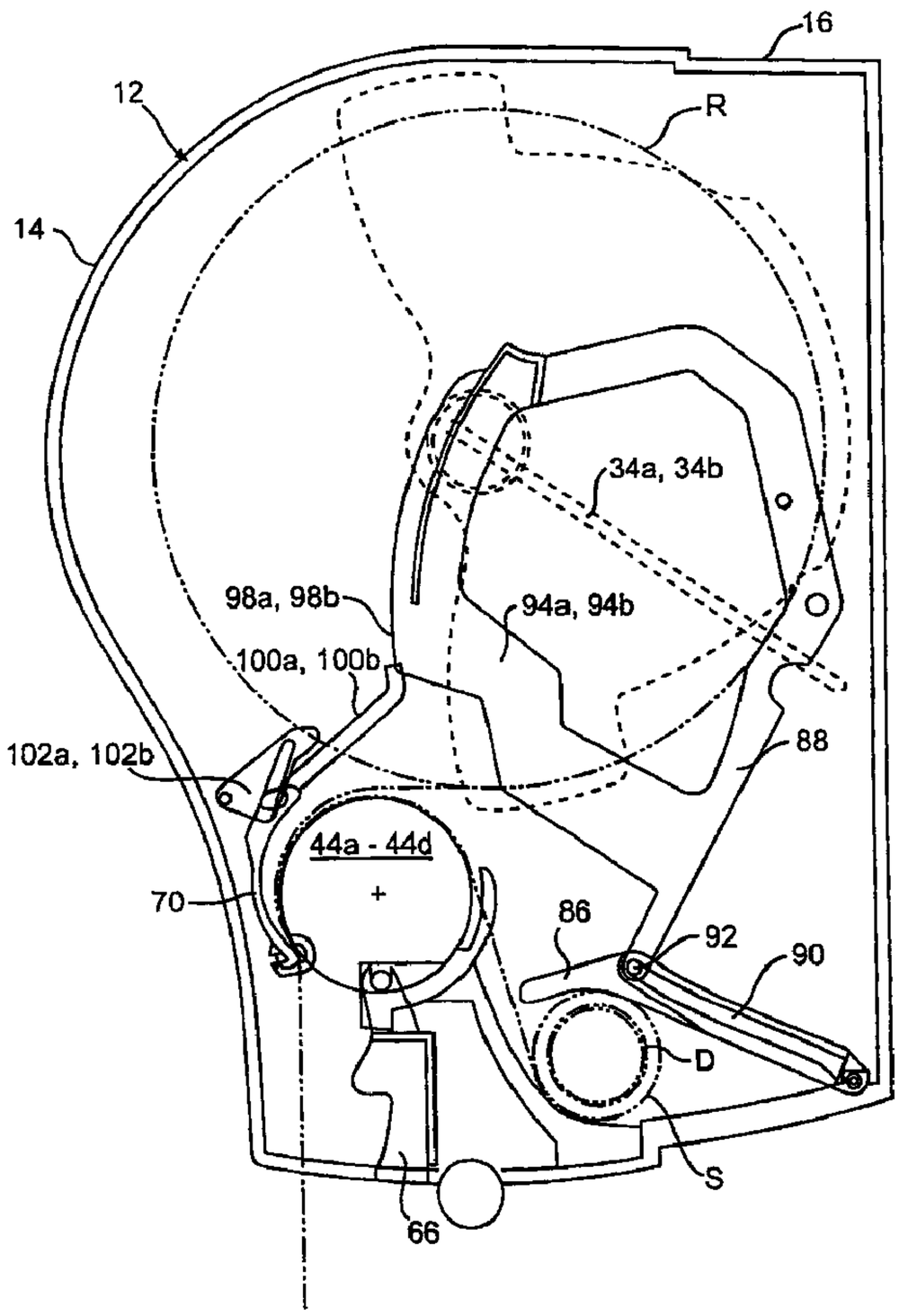

(57) Abrégé/Abstract:
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roll. An isolating element is provided to lift the reserve roll out of contact with dispensing rollers during dispensing of sheet material from the stub roll, and a nipping element is provided to nip sheet material of the reserve roll when dispensing is transferred from the stub roll to the reserve roll. A camming mechanism controls movement of both the lifting mechanism and the nipping element. Structure is also provided for sensing the diameter of the reserve roll of sheet material and providing an indication when the reserve roll is a predetermined diameter. The dispenser is quite and capacity efficient.

ABSTRACT

A dispensing apparatus and method are disclosed for dispensing sheet material from at least one roll of the sheet material. Dispensing is transferred from a stub roll to a reserve roll automatically in response to sensing a predetermined quantity of the stub roll. An isolating element is provided to lift the reserve roll out of contact with dispensing rollers during dispensing of sheet material from the stub roll, and a nipping element is provided to nip sheet material of the reserve roll when dispensing is transferred from the stub roll to the reserve roll. A camming mechanism controls movement of both the lifting mechanism and the nipping element. Structure is also provided for sensing the diameter of the reserve roll of sheet material and providing an indication when the reserve roll is a predetermined diameter. The dispenser is quite and capacity efficient.

SHEET MATERIAL DISPENSING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a sheet material dispensing apparatus and method. More particularly, the present invention relates to an apparatus and method for dispensing sheet material from at least one source of sheet material.

Description of Related Art

A number of different types of sheet materials are dispensed from dispensers. Typically they are wound into a roll either with or without a core to provide a maximum amount of material in a relatively small amount of space. Some examples of these materials include paper towels, toilet tissue, wrapping paper, aluminum foil, wax paper, and plastic wrap. Rolled sheet materials are typically dispensed from dispensers having structure for allowing the roll of sheet material to rotate while the material is removed from the roll. Although these dispensers have been in existence for a long period of time, some of them have many drawbacks and disadvantages.

In many conventional dispensers for sheet material, a user must rotate a crank or move a lever each time the user desires to remove material from the dispenser. This crank or lever typically rotates a roller mechanism for feeding the sheet material from the dispenser. Although these types of dispensers are effective at dispensing sheets of material, a user must make physical contact with the crank or lever each time the user desires to dispense the sheet material from the dispenser. For example, during a single day in an extremely busy washroom, hundreds or even thousands of users may physically contact a dispenser to dispense paper toweling therefrom. This leads to possible transfer of germs and a host of other health concerns associated with the spread of various contaminants from one user to another.

Another problem associated with conventional dispensers is that of maintaining an adequate supply of the rolled sheet material in the dispenser. In one type of dispensing system, a housing contains a single roll of material during

dispensing. This type of dispenser requires frequent monitoring by a service attendant to determine when substantially all of the material has been dispensed so that a new roll of material may be loaded in the dispenser. When the new roll is loaded, the partially consumed roll is often discarded in place of the new roll, resulting in the waste of a significant amount of usable material left on the partially consumed roll.

In an attempt at solving the problem of maintaining an adequate supply of sheet material, some conventional dispensers have a transfer mechanism allowing for subsequent dispensing from multiple rolls of sheet material. Although these types of dispensers are sometimes effective at dispensing substantially all of the material from each of the rolls, they are often very complex, leading to increased cost and reduced reliability.

Lack of control of the length of material dispensed is another problem associated with some conventional dispensers. For example, some conventional dispensers include a cutter allowing a user to select a particular length of sheet material before cutting it away from the remainder of the roll of material. Because a continuous sheet of material can be rapidly removed from these types of dispensers, more material than is necessary may be removed from the dispenser, resulting in waste. Due to their design, dispensers of these types are often noisy and bulky.

Attempts have been made to limit the amount of sheet material continuously dispensed. For example, U.S. Patent No. 5,630,526 to Moody discloses a system for dispensing individual segments of sheet material from a roll of sheet material having perforated tear lines separating the individual segments. Pulling an end-most segment of the sheet material tears the end-most segment away from the remaining material along a perforated tear line separating the end-most segment from the remainder of the material. Although this type of dispenser is effective, additional features such as multiple roll capacity are lacking.

In light of the foregoing, there is a need in the art for an improved dispenser and method for dispensing sheet material.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a sheet material dispensing apparatus and method that substantially obviate one or more of the limitations of the related art.

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, the invention includes an apparatus for dispensing sheet material from at least one source of sheet material. The apparatus includes a housing defining an interior including a first section for a first source of sheet material and a second section for a second source of sheet material, and an outlet though which an end portion of sheet material is dispensed from at least one of the sources. At least one nipping surface is disposed in the housing. A nipping element is pivotally mounted in the housing so that the nipping element pivots between a first position in which a first portion of the nipping element and the nipping surface form a nip for the end portion of sheet material, and a second position in which at least a second portion of the nipping element and the nipping surface form a nip for the end portion of sheet material.

In another aspect, the apparatus includes a sensor for sensing the amount of sheet material of the first source of sheet material, the sensor includes at least one cam surface moving in response to a change in size of the first source of sheet material. At least one cam follower cooperates with the nipping element. The cam follower contacts the cam surface and the cam surface moves with respect to the cam follower to control movement of the nipping element.

In an additional aspect, the apparatus includes at least one isolating element movably mounted in the housing. The isolating element moves between a second source isolating position in which the isolating element positions the second source away from the nipping surface and a second source dispensing position placing the second source on the nipping surface.

In another aspect, the apparatus includes a housing defining an interior for accommodating a quantity of sheet material therein and an outlet through which the sheet material is dispensed. The housing includes a first housing

member, a second housing member, and at least one hinge member allowing the first housing member to pivot with respect to the second housing member between a closed position limiting access to the interior of the housing and an open position allowing access to the interior of the housing. A latch is provided on the housing for selectively retaining the first housing member in the closed position. At least one biasing element cooperates with the first and second housing members. The biasing element biases the first housing member toward the closed position when the first housing member moves to the open position so as to limit free movement of the first housing member to the open position.

In yet another aspect of the invention, the apparatus includes a housing defining an interior for including a first section for a source of sheet material and a second section for the source of sheet material, the second section being larger than the first section, and an outlet through which the sheet material is dispensed. A sensor is disposed in the housing for sensing the size of the source while the source is in the second section. An indicator cooperates with the sensor to provide an indication when the size of the source is small enough to place the source of sheet material in the first section of the housing.

In a further aspect, the apparatus includes a lever pivotally coupled to the housing and cooperating with a roller so that pivoting of the lever rotates the roller, the lever being located with respect to the outlet so that sheet material dispensed through the outlet passes substantially over the lever.

In another aspect, the present invention includes a method of dispensing sheet material, including dispensing sheet material from the first source, the dispensing including passing an end portion of sheet material from the first source through a nip formed between the nipping element and the nipping surface and through the outlet. The nipping element is moved with respect to the nipping surface to place an end portion of sheet material from the second source in the nip formed between the nipping element and the nipping surface. The method also includes dispensing sheet material from the second source, the dispensing of sheet material from the second

source including passing the end portion of the sheet material from the second source through the nip and through the outlet.

In another aspect, the method includes the steps of positioning the second source away from the nipping surface and dispensing sheet material from the first source, the dispensing including passing an end portion of sheet material from the first source through a nip formed between the nipping element and the nipping surface and through the outlet. The size of the first source is sensed and the second source is placed on the nipping surface when a predetermined size of the first source is sensed. The method also includes dispensing sheet material from the second source, the dispensing of sheet material from the second source including passing an end portion of sheet material from the second source through the nip and through the outlet.

In another aspect, the method includes the steps of sensing the size of a source of sheet material and providing an indication when the size of the source is small enough to place the source in the first section of the housing interior.

In a further aspect, the method includes placing a first roll of sheet material in the first section of the housing, and placing a second roll of sheet material in the second section of the housing so that the second roll of sheet material is on the roller. A terminal end of sheet material from the first roll is positioned in a nip formed between the roller and the nipping element, and a terminal end of sheet material from the second roll is positioned between the roller and the nipping element at a location outside of the nip. Sheet material from the first roll is dispensed by passing the terminal end portion of sheet material from the first roll through the outlet, and sheet material from the second roll is dispensed by passing the terminal end portion of sheet material from the second roll through the outlet.

In an even further aspect of the invention, the apparatus includes a contacting element for contacting an outer surface of a first roll to apply a force capable of resisting rotational movement of the first roll and preventing translational movement of the first roll throughout the dispensing of sheet material from the first roll.

In an even further aspect of the invention, there is provided a system for dispensing sheet material from at least one rotatably mounted roll of sheet material having a width of at least about 5 inches, the system includes a dispenser housing including an interior which includes a first section for a stub roll of the sheet material and a second section for a reserve roll of the sheet material and an outlet through which the sheet material is dispensed; wherein the system is capable of dispensing a single segment of the sheet material by a user grasping only the sheet material of the system; wherein dispensing of a single segment of the sheet material produces a maximum sound level below about 81 decibels.

In another aspect of the invention, there is provided a system for dispensing sheet material product from at least one rotatably mounted roll of sheet material having a width of at least about 5 inches, the system includes a dispenser housing including an interior which includes a first section for a stub roll of the sheet material and a second section for a reserve roll of the sheet material and an outlet through which the sheet material is dispensed; wherein the system is capable of dispensing a single segment of the sheet material by a user grasping only the sheet material of the system; wherein the ratio of the maximum sheet material volume to the total enclosed volume of the dispenser is at least about 35%.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention. In the drawings,

Fig. 1 is a front perspective view of the sheet material dispensing apparatus with a front cover of the apparatus in a closed position;

Fig. 2 is a front perspective view of the apparatus illustrating sheet material being dispensed through a dispensing outlet in the front cover;

Fig. 3a is a front perspective view of the apparatus with the front cover opened to reveal the interior of a housing of the apparatus;

Fig. 3b is an exploded perspective view showing components mounted to the rear casing of the housing;

Fig. 4 is a front perspective view similar to Fig. 3a, showing a reserve roll of sheet material accommodated in a section of the housing;

Fig. 5 is a view similar to Fig. 4 with a sheet advancing lever of the apparatus pressed toward a rear of the housing to rotate rollers;

Fig. 6 is a view similar to Figs. 4 and 5 showing a camming element pressed toward a bottom of the housing and the sheet advancing lever pivoted away from the rear of the housing to allow a core of a stub roll to be removed from the housing interior while the reserve roll is in the housing;

Fig. 7 is a front perspective view of the apparatus with the front cover open and a stub roll sensor in a position allowing placement of the stub roll in a section of the housing interior;

Fig. 8 is an exploded perspective view of a mechanism for rotating the reserve roll in the housing;

Fig. 9 is a perspective view of the rotating mechanism of Fig. 8;

Fig. 10 is a perspective view of a one way clutch mechanism shown in Figs. 8 and 9;

Figs. 11 and 12 are exploded perspective views of the one way clutch mechanism shown in Figs. 8-10;

Fig. 13 is an exploded perspective view of a transfer mechanism and reserve roll sensor for the apparatus;

Fig. 14 is a partially exploded, perspective view of components of the front cover including the mechanism and sensor shown in Fig. 13;

Fig. 15 is a perspective view of the front cover shown in Fig 14;

Fig. 16 is a schematic side view of the interior of the housing during initial dispensing from the reserve roll of sheet material;

Fig. 17 is a view, similar to Fig. 16, showing dispensing from the reserve roll when the reserve roll reaches a diameter sufficient to place the reserve roll in a stub roll compartment of the housing interior;

Fig. 18 is a view, similar to Fig. 16, showing dispensing from a stub roll after the stub roll is placed in the stub roll compartment and a new reserve roll is loaded in the housing;

Fig. 19 is a view, similar to Fig. 16, showing dispensing from the stub roll just before transfer to the reserve roll;

Fig. 20 is a view, similar to Fig. 16, showing dispensing from both the stub roll and the reserve roll after transfer to the reserve roll;

Fig. 21 is a view, similar to Fig. 16, showing the reserve roll sensor and an indicator located in the housing during initial dispensing from the reserve roll;

Fig. 22 is a view, similar to Fig. 17, showing the indicator extending through an opening in the housing when the reserve roll is a predetermined size;

Fig. 23 is a partially schematic side view of the interior of the housing with the front cover opened to place the indicator in a nonindication position.

Fig. 24 is a schematic internal front view showing sheet material passing through a nip and the outlet of the apparatus;

Fig. 25 is a partially schematic side view showing testing conditions for measuring sound level during dispensing from the apparatus; and

Fig. 26 is a schematic side view of an alternate embodiment of the apparatus in which mating rollers form a nip for sheet material.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same parts.

In accordance with the invention, there is provided an apparatus for dispensing sheet material. As shown in Figs. 1, 2, and 3a, apparatus 10 includes a housing 12 having a first housing member 14, a second housing member 16, and a hinge member 18. Preferably, the first housing member 12 is a front cover having material dispensing outlet 38 in a lower portion of the

cover 12, the second housing member 16 is a rear casing, and the hinge 18 member is located at the lower portion of the front cover 12. Preferably, the rear casing 16 includes mounting holes 17, shown in Figs. 3a and 7, so that the housing 12 can be secured directly or indirectly to a mounting surface with fasteners and/or a releasable mounting bracket (not shown).

The hinge member 18 allows the front cover 14 to pivot with respect to

the rear casing 16 between an open position, shown in Figs. 3a, 4-7 and 23, allowing access to an interior of the housing 12, and a closed position, shown in Figs. 1, 2, and 16-22, limiting access to the interior of the housing 12. The hinge member 18 includes hinge pins 20a and 20b, shown in Figs. 3a, 14, and 15, extending respectively through first hinge brackets 22a and 22b on the front cover 14 and through second hinge brackets 24a and 24b, shown in Fig. 1, on the rear casing 16. The front cover 14 pivots about a common axis of the hinge pins 20a and 20b during movement between the open position and the closed position.

As shown in Figs. 14 and 15, biasing elements 26a and 26b are provided respectively about the hinge pins 20a and 20b. The biasing elements 26a and 26b are preferably torsion springs having ends contacting the rear casing 16 and the front cover 14 when the front cover 14 is connected to the rear casing 16. During movement of the front cover 14 to the open position, the biasing elements 26a and 26b rotationally bias the front cover 14 toward the closed position. This rotational biasing of the biasing elements 26a and 26b restricts free rotation of the front cover 14 toward the open position and thereby limits forcible impacting of the front cover 14 against a mounting surface when the front cover 14 is opened. In contrast to conventional dispensers, the biasing elements 26a and 26b minimize the risk of structural and/ or cosmetic damage to both the front cover 14 and a mounting surface during opening of the front cover 14.

A releasable latch mechanism 28, shown in Figs. 3a, 3b, 4-6, 14, and 15, is provided on the front cover 14 to retain the front cover 14 selectively in the closed position shown in Fig. 1. The releasable latch mechanism 28 engages a catch 30, shown in Figs. 3a and 3b, on the top of the rear casing 16 when the front cover 14 is closed. The latch mechanism 28 and catch 30 may be any type of conventional latching structure used for dispensers. For example, the latch mechanism 28 may be lock actuated by a corresponding key (not shown) to limit unauthorized access to the interior of the housing 12.

Preferably, the housing 12 defines an interior for accommodating one or more sources of sheet material. Each source preferably includes sheet

material wound in a cylindrical shaped roll either with or without a core. Alternatively, each source of sheet material is in an accordion folded stack or any other form allowing for uninterrupted, continuous feed.

As shown in Figs. 18 and 23, the housing 12 defines an interior having a section for accommodating a stub roll of sheet material S and section for accommodating a reserve roll of sheet material R. The stub roll of sheet material S rests on a lower surface of the rear casing 16. This lower surface of the rear casing 16 includes a plurality of ribs 32, shown in Fig. 7, to limit friction between the rear casing 16 and the stub roll S when the stub roll S rotates in the housing 12 during dispensing of sheet material from the stub roll. The ribs 32 also elevate the stub roll S from the bottom of the housing 12 to limit possible contact of the stub roll S with any moisture or dirt accumulated in the housing 12.

As shown in Figs. 3a, 3b, and 7, the interior of the housing 12 includes a pair of arms 34a and 34b having respective mounts 35a and 35b for mounting the reserve roll R in the interior of the housing 12 so that the reserve roll is placed on rollers 44a-44d, described below, during dispensing of sheet material from the reserve roll R as shown in Fig. 3b, the arms 34a and 34b are pivotally mounted to a rear wall of the rear casing 16, as shown in Figs. 16-22, to move the reserve roll R in an arc-shaped path during dispensing of sheet material from the reserve roll R, as shown in Figs. 16 and 17. For example, the pair of arms 34a and 34b are end portions of a U-shaped wire structure mounted to the back wall of the rear casing 16 so that the pair of arms 34a and 34b pivot in unison. The mounts 35a and 35b allow the reserve roll R to rotate about its axis of rotation during dispensing of sheet material therefrom. The mounts 35a and 35b are preferably connected to end portions of the arms 34a and 34b and are shaped to fit within a core of the reserve roll R.

Tensioning elements 36a and 36b, shown in Figs. 3a, 3b, and 7, are also connected to end portions of the arms 34a and 34b, respectively. The tensioning elements 36a and 36b each have a planar surface for contacting a respective end of the reserve roll R mounted in the mounts 35a and 35b. These surfaces of the tensioning elements 36a and 36b apply frictional thrust

forces to opposite ends of the reserve roll R to limit free rotation of the reserve roll R and thereby induce tension in sheet material pulled from the reserve roll R during dispensing. As shown in Figs. 3a, 3b and 7, the tensioning elements 36a and 36b have portions 37a and 37b for extending beyond the diameter of the reserve roll R in the vicinity of where the reserve roll R contacts the rollers 44a-44d to limit lateral travel of sheet material dispensed from the reserve roll R.

In a preferred practice of the invention, each of the stub roll S and the reserve roll R is a continuous web of sheet material wound into a roll either with or without a core. The sheet material has two side edges, a terminal end, and an initial end. The sheet material is preferably divided into a plurality of individual sheets by a plurality of perforation tear lines including frangible bonds and perforations spaced along each tear line and extending from one edge to the other. The spacing and size of the frangible bonds may be constant or variable across the width of the roll. The perforation tear lines are preferably aligned substantially parallel to each other and substantially perpendicular to the edges of the roll. For example, the sheet material may be constructed like the sheet material disclosed in above mentioned U.S. Patent No. 5,630,526, or like the sheet material disclosed in U. S. Patent No. 5,704,566 to Schutz et al.

Although rolls of sheet material having perforation tear lines are preferred, other types of sheet material may be used in the apparatus 10.

Preferably, the sheet material of the reserve roll R and stub roll S is absorbent paper toweling. However, many different types of sheet material are capable of being dispensed from the apparatus 10. The sheet material 10 may be formed in many different ways by many different processes. For example, the sheet material 10 could be a woven material or fabric, like most textiles, or a non-woven material. A non-woven is a fabric-like material composed of a conglomeration of fibrous materials and typically non-fibrous additives. Non-wovens may be classified further into wet-formed materials and dry-formed materials. As used herein, wet-formed materials are those

materials formed from an aqueous or predominantly aqueous suspension of natural fibers, such as vegetable, mineral or animal, or synthetic fibers, or combinations thereof by draining the suspension and drying the resulting mass of fibers; and dry-formed materials are those materials formed by other means such as air-laying, carding or spinbonding without first forming an aqueous suspension. Dry-formed non-wovens may further include composites of wet and dry formed materials where the composite is formed by means such as hydroentangling or laminating.

Preferably, the sheet material of the stub roll S and reserve roll R is constructed like the sheet material disclosed in U.S. Patent No. 6,228,454.

As shown in Fig. 2, the sheet material is dispensed from the interior of the housing 12 via the dispensing outlet 38 in the lower portion of the front cover 14. As shown in Figs. 2 and 4, the dispensing outlet 38 is defined at least partially by a lower edge of the front cover 14 including vertical curved walls 40a and 40b and horizontal planar walls 42a and 42b. The curved walls 40a and 40b provide ease of access to the dispensing outlet 38 and make it easier for a user to grasp an end portion of sheet material extending from the outlet 38 without touching the housing 12. End edges of the curved surfaces 40a and 40b are preferably located equidistant from the centerline of sheet material being dispensed from the outlet 38.

Preferably, the width of the dispensing outlet 38 is narrower than the width of sheet material being dispensed through the opening 38 so that the edges of the sheet material experience increased tensile forces induced by frictional forces as the sheet material passes through the outlet 38, as shown in Fig. 2. The distance A, shown in Fig. 4, between the edges of the walls 40a, 42a and the edges of walls 40b, 42b is preferably between about 20 and about 90 percent of the sheet material width B, more preferably between about 50 and about 80 percent of the sheet material width B, even more preferably between about 65 percent and about 75 percent of the sheet

material width B, and most preferably about 70 percent of the sheet material width B. Although dispensing outlet 38 having a width narrower than the width of the sheet material is preferred, other configurations are possible.

As described below, the apparatus 10 reliably dispenses individual sheets from a wound roll of perforated sheet material without normally requiring a user to contact a portion of the apparatus 10 other than the sheet material itself. After a sheet is dispensed, a sufficient length of sheet material or tail remains exposed from the dispensing outlet 38 so the next user can easily grasp and dispense the next sheet without contacting the apparatus 10. In the event that the tail of sheet material extending from the outlet 38 is not long enough for a user to easily grasp it, a lever 66, shown in Fig. 1 and described below, can be depressed, as shown in Fig. 5, to expose additional sheet material.

Fig. 2 illustrates a sheet of the perforated sheet material being dispensed from the dispensing apparatus 10. As a user pulls the terminal end T1 of the sheet material from the dispensing outlet 38, tensile stresses are induced in the sheet material as a result of the opposed pulling force and frictional forces generated within the apparatus 10. When a perforation tear line L passes through and contacts the edges of the dispensing outlet 38, the tensile stresses are concentrated at the edges of the sheet material. Separation at the perforation tear line L typically initiates from one or both of the edges of the sheet material because this is where concentrated tensile stresses exceed the maximum tensile stress of the frangible perforation bonds along the perforation tear line L. As the user continues to pull the sheet material from the dispensing apparatus 10, separation of the perforation tear line L propagates across the sheet material from the edges of the sheet material toward the center of the sheet material. Eventually, a single sheet is separated from the remainder of the sheet material, and a sufficient length of a tail of sheet material T2 remains for a subsequent user to easily grasp and dispense the next sheet.

As shown in Figs. 3a, 4, and 7, the dispensing rollers 44a, 44b, 44c, and 44d are mounted for rotation in the housing 12 between the dispensing outlet

38 and the section of the housing 12 for accommodating the reserve roll of material R. Preferably, the dispensing rollers 44a-44d are the only rollers provided in the apparatus 10, and each of these rollers 44a-44d rotates about the same rotational axis. As shown in Fig. 8, the dispensing rollers 44a and 44b are formed by joining two half sections 46a and 46b together around a shaft 48, and the dispensing rollers 44c and 44d are formed by joining two half sections 46c and 46d together around the shaft 48. L-shaped bearing clips 63a and 63b, shown in Figs. 8 and 9, are provided at opposite ends of the shaft 48 to mount the shaft 48 for rotation in the rear casing 16.

The circumferential surfaces of the rollers 44a, 44b, 44c, and 44d include respective friction bands 50a, 50b, 50c, and 50d made of a relatively high friction material, such as an elastomeric rubber material. The friction bands 50a, 50b, 50c, and 50d reduce slippage between the rollers 44a, 44b, 44c, and 44d and sheet material contacting the rollers 44a, 44b, 44c, and 44d during dispensing, as described below. Guides 64a and 64b located on a front portion of the L-shaped bearing clips 63a and 63b are spaced respectively from the outer circumferential surfaces of the rollers 44a and 44d to guide an end portion of sheet material from the reserve roll R prior to dispensing of the reserve sheet material, as described below.

A one-way clutch assembly 52 is located on the shaft 48 between the middle dispensing rollers 44b and 44c to allow for rotation of the shaft 48 and rollers 44a-44d in a single rotational direction by actuating the lever 66 shown in Figs. 1, 3a, 3b, and 4-7. The clutch assembly 52 also allows the rollers 44a-44d and shaft 48 to rotate independent of the movement of the lever 66. Locating the clutch assembly 52 between rollers 44b and 44c minimizes torsion and bending deflection of the shaft 48. As shown in Figs. 11 and 12, the clutch assembly 52 preferably includes a drive gear 54, pawl 56, sprocket 58, driver 60, spring housing 62, and return spring 64. However, other clutch configurations are possible.

The lever 66, shown in Figs. 1, 3a, 3b and 4-7 is pivotally coupled to the lower portion of the rear casing 16 so that the lever 66 may be pressed inward toward the rear casing 16, as shown in Fig. 5, to cause the clutch assembly

52 to rotate the dispensing rollers 44a-44d and thereby dispense sheet material from the dispensing outlet 38. Pressing the lever 66 inwardly urges the lever 66 against the driver 60, shown in Figs. 11 and 12, to pivot the driver 60. When the driver 60 pivots, the driver 60 engages and rotates the sprocket 58. Rotation of the sprocket 58 pivots the pawl 56 in the sprocket 58 to thereby place the pawl 56 in engagement with the drive gear 54, which is coupled to slots in the half sections 46a and 46b shown in Fig. 8. The sprocket 58 is coupled to the spring housing 62 so that the rotation of the sprocket 58 winds the return spring 64, and the return spring 64 biases and returns the lever 66 to its original position shown in Figs. 1, 3a, 4, and 7.

Because the dispensing apparatus 10 normally allows for dispensing of sheet material by pulling an end portion of the sheet material, the lever 66 is preferably used as a secondary feeding mechanism only. In other words, the lever 66 is preferably used to dispense sheet material only when the sheet material does not extend from the dispensing outlet 38 or when the end portion of sheet material extending from the outlet 38 is too short to be grasped by a user. For example, each depression of the lever 66 rotates the rollers 44a-44d to advance the sheet material about one inch.

The lever 66 is pivotally coupled to the housing 12 below the rollers 44a-44d and extends behind the dispensing outlet 38 to define a rear edge of the dispensing outlet 38. As sheet material is dispensed from the outlet 38, the sheet material passes substantially over the lever 66 and covers the lever 66. This location of the lever 66 helps to limit user contact with the lever 66 when the sheet material is pulled from the opening 38. Because the lever 66 is normally hidden by the tail of sheet material, a user will normally remove sheet material from the apparatus 10 by pulling the end portion of the sheet material rather than actuating the lever 66.

As shown in Fig. 1, the front surface of the lever 66 includes a pair of protuberances 68a and 68b tapered from opposite side edges of the lever 66 toward a middle portion of the lever 66. The protuberances 68a and 68b guide the sheet material outwardly away from the lever 66 as the sheet material passes through the outlet 38 to make the end portion of sheet

material easier to grasp. In addition, the protuberances 68a and 68b limit pinching of the sheet material between the lever 66 and the front cover 14 when the lever 66 is depressed.

As shown in Figs. 3a and 6, the lever 66 extends in front of the portion of rear casing 16 for accommodating the stub roll S. Preferably, the pivotal coupling of the lever 66 allows the lever 66 to be pivoted upwards away from the rear casing 16, as shown in Fig. 6. This movement of the lever 66 allows access to the stub roll in the rear casing 16 to remove a stub roll core from the rear casing by moving the core between ribs 32, shown in Fig. 6, in the stub roll compartment.

The outer circumferential surfaces of the dispensing rollers 44a-44d shown in Figs. 3a, 4, and 7 provide a nipping surface. As shown in Figs. 16-20, a nipping element 70 cooperates with this outer surface of the dispensing rollers 44a-44d to form a nip (i.e., restricted pathway) therebetween for passage of the sheet material before the sheet material passes through the outlet 38.

As described below and shown in Figs. 3a, 4-7 and 13-15, the nipping element 70 is a curved nipping plate pivotally coupled to the front cover 14 of the housing 12 so that the nipping element 70 pivots between different positions depending upon whether sheet material is being dispensed primarily from the stub roll S or the reserve roll R. In particular, the nipping element 70 pivots between a first position, shown in Figs. 18 and 19, and a second position, shown in Figs. 16, 17, and 20. In the first position, shown in Figs. 18 and 19, an upper portion of the nipping element 70 is spaced from the rollers 44a-44d, and a lower portion of the nipping element 70 and the outer nipping surface of the rollers 44a-44d form a nip for an end portion of sheet material from the stub roll S. In the second position, shown in Figs. 16, 17, and 20, the upper and lower portions of the nipping element 70 and the outer nipping surface of the rollers 44a-44d form a nip for an end portion of sheet material from the reserve roll R. When sheet material is initially dispensed from the reserve roll R, as shown in Fig. 20, the nipping element 70 is in the second position, and the upper and lower portions of the nipping element 70 and the

rollers 44a-44d form a nip for both an end portion of sheet material from the reserve roll R and an end portion of sheet material of the stub roll S.

Although the nip is preferably formed between the nipping element 70 and each of the outer surfaces of the rollers 44a-44d, the nip could be formed between many different structural elements. For example, the nip could be formed between the rollers 44a-44d and one or more additional rollers 45 (see Fig. 26) mating with the rollers 44a-44d, or the nip could be formed between a surface of the housing 12 and the rollers 44a-44d. Alternatively, the nip could be formed between the nipping element 70 and a single roller (not shown) or any other number of rollers.

As shown in Figs. 3a, 4, 14, and 15, a mounting plate 72 is attached to the inside of the front cover 14. As shown in Fig. 13, the mounting plate 72 includes opposite side portions 74a and 74b having respective elongated slots 76a and 76b. As is also shown in Fig. 13, the nipping element 70 includes projection pins 78a and 78b extending in opposite directions from a lower portion of the nipping element 70. The nipping element 70 is coupled to the mounting plate 72, as shown in Figs. 14 and 15, so that the projection pins 78a and 78b are rotationally and axially movable in the slots 76a and 76b, respectively, to allow for both pivotal movement of the nipping element 70 and axial movement of the nipping element 70 toward and away from the dispensing rollers 44a-44d shown in Figs. 3a, 4 and 7.

The pivotal movement of the nipping element 70 allows the nipping element 70 to be moved between the first and second pivot positions shown in Figs. 18 and 19 and Figs. 16, 17, and 20, respectively. The axial and rotational movement of the nipping element 70 allows axial and rotational biasing (described below) of the nipping element 70 against the dispensing rollers 44a-44d to form the nip.

As shown in Figs. 13 and 14, a first pair of biasing elements 80a and 80b are connected between a top portion of the nipping element 70 and a portion of the mounting plate 72 to bias the nipping element 70 rotationally toward the dispensing rollers 44a-44d shown in Figs. 3a, 4 and 7. In addition, a second pair of biasing elements 82a and 82b shown in Fig. 13 are provided

about the projection pins 78a and 78b to bias the nipping element 70 axially toward the dispensing rollers 44a-44d. Preferably, the first pair of biasing elements 80a and 80b are axial coil springs and the second pair of biasing elements 82a and 82b are torsion springs.

As shown in Figs. 16-20, the biasing elements 80a, 80b and 82a, 82b maintain at least a portion of the nipping element 70 biased toward the dispensing rollers 44a-44d to form a nip between the nipping element 70 and the dispensing rollers 44a- 44d when the front cover 14 is closed. Because the rollers 44a-44d are mounted in the rear casing 16 and the nipping element 70 is mounted in the front cover 14, the nipping element 70 moves away from the rollers 44a-44d during opening of the front cover 14. In other words, the opening of the front cover 14 "opens" (eliminates) the nip formed between the nipping element 70 and rollers 44a-44d. This opening of the nip permits sheet material to be positioned on an outer surface of the rollers 44a-44d, and this sheet material is eventually placed in the nip automatically after the front cover 14 is closed, as explained below. Although the preferred embodiment shown in the drawings includes the nipping element 70 mounted in the front cover 14 and the rollers 44a-44d mounted in the rear casing 16, other mounting configurations are possible.

The inventors have discovered that certain characteristics of the sheet material 10 and the dispenser 32 are related to effecting improved reliability of dispensing and/ or separation of individual material sheets. These characteristics include the relationship between the width S (see Fig. 7) of the outlet 34, the overall sheet material 10 width W, the distance D, and the angle X. When the front cover 14 is closed, at least an inner surface of a lower edge 84, shown in Fig. 4, of the nipping element 70 and an outer surface of the rollers 44a-44d form the nip. The exit end of the nip (the downstream portion of the nip in the direction of travel of the sheet material) is preferably spaced the same distance away from the edge 43a of the horizontal planar wall 42a and the edge 43a of the horizontal planar wall 42b partially defining the dispensing outlet 38. As shown schematically in Figure 7, a nipping plate is biased against the rollers 40 and thereby forms a nip

(restricted passageway) for the sheet material. The dispenser further includes at least one surface having an edge defining at least a portion of the outlet of the dispenser. Point A is defined by the outermost lateral end of the nip containing the sheet material. The surface is preferably spaced a minimum distance D of from about 0.1 inch to about 3 inches from Point A, most preferably spaced a minimum distance D of from about 0.9 inch to about 1.0 inch from Point A. In other words, the exit end of the nip is preferably spaced by the distance D from edges of the wall surfaces 36 and 38 defining the outlet 34.

Spacing the exit end of the nip from the opening 34 causes each of the edges 12 and 14 of the sheet of material 10 and an edge of the outlet 34 (an imaginary surface containing the opening 34) to define an angle X, shown in Fig. 7. In accordance with the invention, the angle X is preferably from about 26 ° to about 39 °, more preferably from about 29 ° to about 36 ° , and most preferably from about 32 ° to about 33 °. In addition, the width S of the outlet 34 is preferably from about 60% to about 80% of the sheet material width W, and more preferably from about 70% of the sheet material width W.

A sensor is provided in the dispensing apparatus 10 for sensing the diameter of the stub roll S and for controlling the pivoting of the nipping element 70 in response to sensing a predetermined diameter for the stub roll S. The sensor preferably includes a contact element 86 and camming element 88 pivotally mounted in the rear casing 16, as shown in Figs. 16-20. The contact element 86 is pivotally connected to the bottom rear interior surface of the rear casing 16. As sheet material is dispensed from a stub roll S in the rear casing 16, the contact element 86 pivots counterclockwise, as shown in the views of Figs. 16-20, from a first position shown in Fig. 18 to a second position shown in Figs. 16, 17, and 20. During this pivoting, a lower contacting surface of the contact element 86 contacts the outer circumferential surface of the stub roll S.

The camming element 88 is pivotally connected to a rear wall of the rear casing 14. As shown in Figs. 16-20, a projection pin 92 extends from the camming element 88 into an elongated slot 90 in the contact element 86 to

couple pivotal movement of the contact element 86 and the camming element 88. As the sheet material is dispensed from the stub roll S, the camming element 88 pivots clockwise, as shown in the views of Figs. 16-20, from a first position shown in Fig. 18 to a second position shown in Figs. 16, 17, and 20. During this pivoting, the projection pin 92 moves along the length of the slot 90.

Preferably, one or more biasing elements 116, such as torsion springs, are provided at the pivot point of the camming element 88 to bias the camming element 88 rotationally in the clockwise direction as shown in Figs. 16-20. Because the movement of the camming element 88 and contact element 86 are linked to one another, the biasing elements 116 also bias the contact element 86 toward the stub roll S in the rear housing 16. This ensures that the lower contacting surface of the contact element 86 remains in contact with the stub roll S to track the diameter of the stub roll S as sheet material is dispensed therefrom. The biasing of the contact element 86 against the stub roll S also provides a force that maintains the stub roll S between the contact element 86 and ribs 32, shown in Figs. 6 and 7, in the rear casing 16 without allowing the stub roll S to translate upwards toward the dispensing rollers 44a-44d throughout the dispensing of sheet material from the stub roll S. In addition, the biasing of the contact element 86 against the stub roll S limits free rotation of the stub roll S throughout the dispensing from the stub roll S. To limit free rotation of the stub roll S even more, the contact element 86 also may include ribs (not shown) to increase friction between the stub roll S and the contact element 86.

As shown in Figs. 3a, 3b and 7, the camming element 88 includes a pair of arms 94a and 94b spaced apart so that the tensioning elements 36a and 36b are positioned therebetween. The arms 94a and 94b include tabs 96a and 96b, respectively. When the front cover 14 is open, the tabs 96a and 96b may be pressed by a user to pivot the camming element 88 and contact element 86 away from the stub roll compartment of the rear housing 16, as shown in Figs. 6 and 7. This allows for insertion of a stub roll into the stub roll compartment of the rear casing 16. In addition, the movement of the

camming element 88 and contact element 86 allows for removal of a core D of a stub roll (see Figs. 16 and 17) after pivoting the lever 66 away from the rear casing 16, as shown in Fig. 6.

As shown in Figs. 3a, 3b and 7, cam surfaces 98a and 98b are provided on the front of the arms 94a and 94b to control pivoting of the nipping element 70. Cam followers 100a and 100b, shown in Figs. 4 and 13-15, extend from opposite ends of the nipping element 70 and contact the cam surfaces 98a and 98b during dispensing of sheet material from the stub roll S. To maintain the contact between the cam followers 100a and 100b and the cam surfaces 98a and 98b, the biasing elements 80a and 80b and 82a and 82b, shown in Fig. 13, bias the cam followers 100a and 100b toward the cam surfaces 98a and 98b.

As shown in Figs. 18 and 19, when the sheet material is dispensed from the stub roll S, the cam surfaces 98a and 98b slide with respect to the cam followers 100a and 100b away from the rollers 44a-44d while the arms 94a and 94b pivot in the clockwise direction. When almost all of the sheet material is removed from the stub roll S, as shown in Fig. 20, the cam surfaces 98a and 98b slide past the cam followers 100a and 100b. This places the cam followers 100a and 100b out of engagement with the cam surfaces 98a and 98b and thereby allows the biasing elements 80a and 80b, shown in Fig. 13, to bias the nipping element 70 pivotally toward the dispensing rollers 44a-44d, as shown in Figs. 16 and 17.

Prior to pivoting of the nipping element 70, the guides 64a and 64b extending from the L-shaped bearing clips 63a and 63b, shown in Figs. 3b, 8, and 9, align an end portion of sheet material from the reserve roll between the nipping element 70 and stub roll sheet material contacting the dispensing rollers 44a-44d. Preferably, the cam surfaces 98a and 98b, shown in Figs. 3a, 3b, and 7, are shaped so that the pivoting of the nipping element 70 toward the rollers 44a-44d occurs just prior to when all of the sheet material is removed from the stub roll S. When the nipping element 70 pivots toward the rollers 44a-44d into the position shown in Fig. 20, the upper portion of the nipping element 70 places the end portion of sheet material from the reserve roll R in

a nip formed between the nipping element and rollers 44a-44d. Continued dispensing of material from the stub roll S causes rotation of the rollers 44a-44d to also dispense the sheet material of the reserve roll R from the outlet 38, as shown in Fig. 20.

The dispensing apparatus 10 also preferably includes structure for limiting contact of the reserve roll R with the outer surface of the rollers 44a-44d and stub roll sheet material on the rollers 44a-44d during dispensing of sheet material from the stub roll S, as shown in Figs. 18-20. As shown in Figs. 3a and 13-15, isolating elements 102a and 102b are pivotally coupled to the mounting plate 72 attached to the inside of the front cover 14. The isolating elements 102a and 102b include respective side slots 104a and 104b, shown in Fig. 13, for controlling pivoting of the isolating elements 102a and 102b.

Projection pins 106a and 106b extending from a top portion of nipping element 70 move in the slots 104a and 104b, respectively, during pivoting of the nipping element 70 to control movement of the isolating elements 102a and 102b. The slots 104a and 104b are shaped so that the top end portions of the isolating elements 102a and 102b move upwards in the housing 12 above a top surface of the nipping element 70 when the nipping element 70 pivots away from the rollers 44a-44d, as shown in Figs. 18 and 19. In this position, the isolating elements 102a and 102b lift the reserve roll R above the outer surface of the dispensing rollers 44a-44d so that the reserve roll R does not rotate along with dispensing rollers 44a-44d during dispensing of the stub roll sheet material.

When the nipping element 70 pivots toward the dispensing rollers 44a-44d, as shown in Fig. 20, the projection pins 106a and 106b, shown in Fig. 13, slide in the slots 104a and 104b, and the top end portions of the isolating elements 102a and 102b move downwards in the housing 12 approximately level with a top surface of the nipping element 70. In this position, shown in Figs. 16, 17, and 20, the reserve roll R is placed on stub roll sheet material covering the dispensing rollers 44a-44d so that the reserve roll R and rollers 44a-44d rotate together. Because the isolating elements 102a and 102b

extend and retract in response to pivoting of the nipping element 70, the pivotal movement of the contact element 86 and camming element 88 and movement of the camming surfaces 98a and 98b control the movement of the isolating elements 102a and 102b.

During placement of the reserve II R on the rollers 44a-44d, the guides 37a and 37b, shown in Figs. 3a, 3b and 7, guide the sheet material of the reserve roll R to limit lateral sheet material tracking in the dispenser 10. In addition, the friction bands 50a, 50b, 50c, and 50d, shown in Figs. 8 and 9, on respective rollers 44a, 44b, 44c, and 44d increase friction between the reserve roll R and the rollers 44a-44d.

As shown in Figs. 21-23, a movable reserve roll diameter sensor 108 and indicator 110 are provided for respectively monitoring the diameter of the reserve roll R and providing an indication when the reserve roll R is a predetermined diameter. The indicator 110 extends from the roll diameter sensor 108 and includes a projection 118 placed in a slot 112 (see Figs. 13 and 21-23) formed in the mounting plate 72 for controlling movement of the indicator 110. As shown in Figs. 21-23, the roll diameter sensor 108 has a surface for contacting the reserve roll R during dispensing of sheet material from the reserve roll R. When sheet material is removed from the reserve roll R, the roll diameter sensor 108 pivots due to gravity toward the reserve roll R and thereby pivots the projection 118 in the slot 112.

As shown in Figs. 3a and 4, a bottom portion of the front cover 14 includes an indicator opening 114. When the reserve roll R is a predetermined diameter, the indicator 110 and projection 118 pivot so that the slot 112 allows a portion of the indicator 110 to drop through the indicator opening 114, as shown in Fig. 22.

As shown in Figs. 16-23, the interior section of the housing 12 for accommodating the stub roll S is smaller than the interior section of the housing 12 for accommodating the reserve roll R. Preferably, the slot 112, shown in Figs. 13 and 21-23, is shaped so that the portion of the indicator 110 drops through the indicator opening 114 when the diameter of the reserve roll R is small enough to place the reserve roll R in the stub roll

compartment of the housing 12. In other words, the indicator 110 provides a discrete, visual indication of when the reserve roll R will fit and can be placed in the stub roll compartment and a new reserve roll can be loaded in the housing 12. The indicator 110 differs from conventional sheet material dispensers including a display proportional to the diminishing diameter of a product roll, because these conventional displays do not indicate a definitive time when the reserve roll will fit in the stub roll compartment, but rather leave the decision about whether a new roll of material can be loaded up to the subjective discretion of an operator person. Thus, the present invention reduces problems associated with premature opening of the cabinet by inexperienced operators.

The indicator 110 extends from the indicator opening 114 until the front cover 14 is opened and a new reserve roll R is loaded in the housing 12. Opening the front cover 14 moves the indicator 110 in the housing 12 via the opening 114, as shown in Fig. 22, and resets the indicator 110 for sensing the diameter of the new reserve roll R.

Methods of dispensing sheet material from at least one roll of sheet material are discussed below with reference to Figs. 1, 2, 3a, 3b and 4 to 23. The roll of sheet material includes a plurality of individual sheets separated by perforation tear lines including frangible perforation bonds and perforations. Although the invention is described in connection with the structure shown in Figs. 1, 2, 3a, 3b, and 4 to 23, and in connection with the dispensing of sheet material having perforation tear lines including uniform frangible perforation bonds and perforations, it should be understood that the invention in its broadest sense is not so limited.

To load the dispensing apparatus 10 initially with sheet material, an operator moves the front cover 14 to the open position, as shown in Fig. 3a, so that the nipping element 70 moves away from the rollers 44a-44d to open the nip. The operator then mounts a roll of sheet material R in the mounts 35a and 35b on the arms 34a and 34b, as shown in Fig. 4, and allows the roll of sheet material R to rest on the surface of the rollers 44a-44d. While the cover 14 is still in the open position, the operator extends a tail end portion of sheet material from the reserve roll R and passes this tail end portion along the

surface of the rollers 44a-44d, between the rollers 44a and 44d and the guides 64a and 64b, and through the dispensing outlet 38.

Then, the operator pivots the front cover 14 to the closed position shown in Figs. 1 and 2. When the front cover 14 is closed, upper and lower portions of the nipping element 70 form a nip for passage of the sheet material between the nipping element 70 and the outer nipping surface of the rollers 44a-44d, as shown in Fig. 16, and the biasing elements 80a, 80b, 82a, and 82b, shown in Fig. 13, bias the nipping element 70 toward the rollers 44a-44d. The nip, friction bands 50a, 50b, 50c, and 50d shown in Figs. 8 and 9, and tensioning elements 36a and 36b shown in Figs. 3a, 3b and 7, apply frictional braking forces on the sheet material to limit free rotation of the sheet material roll R and to restrain lateral translation of the sheet material relative to the rollers 44a-44d during dispensing of the sheet material through the dispensing outlet 38.

When a user pulls the end portion of sheet material extending from the dispensing outlet 38, the roll of sheet material rotates and tension induced in the sheet material is concentrated at the edges of the sheet material by the narrowed dispensing outlet 38 initiating separation at the perforation tear line from one or both edges. Continued pulling of the end portion of sheet material propagates the perforation separation across the sheet from the edges toward the center to dispense a single sheet, as shown in Fig. 2. During pulling of the sheet material the rollers 44a-44d, shown in Figs. 3a, 4, and 7-9, and the sheet material roll R rotate in the housing 12.

If the end portion of sheet material does not extend a sufficient distance out from the dispensing outlet 38, a user may depress the lever 66, as shown in Fig. 5, while the front cover 14 is maintained in the closed position. Actuating the lever 66 rotates the rollers 44a-44d and thereby passes sheet material in the nip out from the dispensing outlet 38.

As the diameter of the roll R of sheet material is reduced, the roll diameter sensor 108 monitors the diameter of the roll R and, when the diameter of the roll R is small enough to place the roll R in the stub roll compartment of the rear casing 16, a portion of the indicator 110 extends

from the housing 12, as shown in Fig. 22. This provides a visual indication of the need to place a new reserve roll in the housing 12.

To load a new reserve roll of sheet material in the apparatus 10, the operator pivots the front cover 14 to the open position shown in Figs. 3a and 23. When the front cover 14 is opened, the indicator 110 moves in the housing 12 via the opening 114, as shown in Fig. 23, so that the indicator 110 and roll diameter sensor 108 are reset to the position shown in Fig. 21 upon loading of the new reserve roll and closing of the front cover 12.

Opening the front cover 12 also moves the nipping element 70 away from the rollers 44a-44d to remove the sheet material nip. If a core D, shown in Figs. 16 and 17, of a previously expired stub roll is present in the stub roll compartment of the rear casing 16, one or both of the tabs 96a and 96b, shown in Figs. 3a, 3b and 7, are pressed to pivot the contact element 86 away from the core D, and the lever 66 is pivoted up and away from the rear casing 16, as shown in Fig. 6. The core D is then passed under the rollers 44a-44d and between ribs 32, to remove it from the rear casing 16.

To move the partially consumed reserve roll R to the stub roll compartment of the rear casing 16, the operator presses one or both of the tabs 96a and 96b shown in Figs. 3a, 3b and 7 to pivot the camming element 88 and contact element 86 away from the stub roll compartment, as shown in Figs. 6 and 7. The operator then removes the partially consumed reserve roll R shown in Fig. 17 from the mounts 35a and 35b and moves this roll into the stub roll compartment of the rear casing 16 to act as a stub roll S, as shown in Fig. 18. When the stub roll S is moved into the stub roll compartment, the end portion of sheet material extending from the stub roll S remains on the exterior surface of the rollers 44a-44d and continues to extend from the dispensing outlet 38. Releasing the pressure applied to the tabs 96a and 96b allows the biasing elements 116 to bias the contact element to 86 against the outer surface of the stub roll S, as shown in Fig. 18.

The operator then places a new reserve roll R in the mounts 35a and 35b and passes a relatively short end portion of sheet material from the reserve roll R between the guides 64a and 64b shown in Figs. 3a and 4 and

the end portion of stub roll sheet material passing on the outer surface of the rollers 44a-44d. When the front cover 14 is pivoted to the closed position, as shown in Fig. 18, the cam followers 100a and 100b contact the respective cam surfaces 98a and 98b on the arms 94a and 94b. This pivots the upper portion of the nipping element 70 away from the rollers 44a-44b to prevent nipping of the end portion of sheet material extending from the reserve roll R. The pivoted position of the nipping element 70, shown in Fig. 18, also extends the isolating elements 102a and 102b above a top surface of the nipping element 70. This causes the isolating elements 102a and 102b to lift the reserve roll R away from the outer surface of the rollers 44a-44d and thereby limits contact between the reserve roll R and the rollers 44a-44d and between the reserve roll R and stub roll sheet material on the rollers 44a-44d.

As shown in Fig. 18, a lower portion of the nipping element 70 and the outer nipping surface of the rollers 44a-44d form a nip for the end portion of sheet material from the stub roll S only. The sheet material is dispensed from the stub roll S in the same way in which sheet material was dispensed from the reserve roll R - by pulling the end portion of sheet material extending from the dispensing outlet 38, or by pressing the lever 66 to rotate the rollers 44a-44d. As the diameter of the stub roll S is reduced, the contact element 86 is biased against the outer surface of the stub roll S and pivots toward the stub roll S, as shown in Figs. 19 and 20. The biasing of the contact element restricts free rotation of the sub roll S and prevents upward movement of the stub roll S in the casing 16 throughout dispensing from the sub roll S. The pivoting of the contact element 86 causes the camming element 88 to pivot in a counter clockwise direction, as shown in the views of Figs. 19 and 20, thereby moving the cam surfaces 98a and 98b with respect to the cam followers 100a and 100b.

When almost all of the sheet material is dispensed from the stub roll S, the cam surfaces 98a and 98b move past the cam followers 100a and 100b and place the cam followers 100a and 100b out of contact with the cam surfaces 98a and 98b, as shown in Fig. 20. The biasing of the biasing elements 80a and 80b shown in Fig. 13 pivots the upper portion of the

nipping element 70 toward the rollers 44a-44d, as shown in Fig. 20, to place the end portion of sheet material from the reserve roll R in the nip between the nipping element 70 and the outer nipping surface of the rollers 44a-44d. The pivoting of the nipping element 70 also causes the isolating elements 102a and 102b to retract and lower the reserve roll R into contact with the end portion of stub roll sheet material passing on the outer circumferential surface of the rollers 44a-44d.

When the nipping element 70 initially pivots toward the rollers 44a-44d, end portions of sheet material from both the reserve roll R and the stub roll S are placed in the nip, as shown in Fig. 20. When a user pulls the remaining sheets from the stub roll or actuates the lever 66 to dispense sheet material of the stub roll, the rollers 44a-44d rotate and feed the sheet material of the reserve roll R through the nip and out from the dispensing aperture 38 along with the last few sheets from the stub roll. Sheet material is then dispensed from the reserve roll R in the same manner as described above in connection with the initial roll R.

The dispenser of the present invention holds a high capacity of sheet material in a compact space. The capacity of a dispenser is important to the purchasers of such systems since the capacity is directly related to costs associated with refilling the dispenser with sheet material. Purchasers of sheet material dispensing systems are also concerned with the space that the sheet material dispenser occupies when in use, i.e., the wall space. The space that a dispenser occupies can be expressed in a variety of ways. One way is by the total volume that the dispenser occupies. Another way is by the projected area of the sheet material dispenser against the mounting surface 9, i.e., the wall area. Yet another way is by the area of the profile of the side of the dispenser, i.e., the profile area. A “capacity efficient” sheet material dispenser is one which maximizes the ratio of the sheet material volume (capacity) to the total enclosed dispenser volume. One way of evaluating the “capacity efficiency” is by calculating the ratio of the sheet material volume (capacity) to the projected area of the dispenser on the mounting surface. Another way of evaluating the “capacity efficiency” is by calculating the ratio

of the sheet material volume (capacity) to the profile area of the side of the dispenser. In effect the maximum amount of sheet material in the smallest amount of space is the ideal.

For a touchless sheet material dispenser wherein a roll of sheet material having a width of at least about 5 inches is rotatably mounted in the interior and whose interior further includes at least a first portion for a stub roll of sheet material and at least a second portion for a reserve roll of sheet material, the value for the ratio of the maximum sheet material volume (in roll form) to the total enclosed volume of the dispenser is preferably at least about 35%, more preferably at least about 40%, and most preferably at least about 45%.

For a touchless sheet material dispenser wherein a roll of sheet material having a width of at least about 5 inches is rotatably mounted in the interior and whose interior further includes at least a first portion for a stub roll of sheet material and at least a second portion for a reserve roll of sheet material, the value for the ratio of the maximum sheet material volume (in roll form) expressed in cubic inches to the projected area of the dispenser on the mounting surface expressed in square inches is preferably at least about 3.0 cubic inches/square inch, more preferably at least about 3.1 cubic inches/square inch, and most preferably at least about 3.2 cubic inches/square inch.

For a touchless sheet material dispenser wherein a roll of sheet material having a width of at least about 5 inches is rotatably mounted in the interior and whose interior further includes at least a first portion for a stub roll of sheet material and at least a second portion for a reserve roll of sheet material, the value for the ratio of the maximum sheet material volume (in roll form) expressed in cubic inches to the side profile area of the dispenser expressed in square inches is preferably at least about 4.5 cubic inches/square inch, more preferably at least about 5.0 cubic inches/square inch, and most preferably at least about 5.5 cubic inches/square inch.

In a majority of the areas where sheet material dispensers are typically used, dispensers that produce a low sound level are preferable, particularly in

health care facilities and office buildings. The sound level produced by the sheet material dispenser can be magnified depending on the mounting surface material and construction and dispensing environment. Therefore, it is desirable to have a sheet material dispenser that minimizes the sound produced when it is used to dispense sheet material. Known sheet material dispensers were compared to the sheet material dispenser of the present invention to determine the level of sound generated when a segment of sheet material was dispensed from the dispensers. The sound was measured in decibels (dBA).

The apparatus as shown in Fig. 25 illustrates the testing conditions used to measure the sound level in Examples 1 and 2. Each sheet material dispenser was securely mounted to a portable stand 200 constructed of 3/4" thick plywood. The test was performed in a soundproof enclosure manufactured by: Industrial Acoustics Co., Bronx, NY, Model IC 250 Mini Booth. A Permissible Noise Dosimeter manufactured by Quest Electronics, Model Micro-14 was used to record the maximum sound level detected during each dispense. The dosimeter 210 was placed five inches from the center of the dispenser outlet. Ten readings were taken and averaged for each dispenser. A similar type of sheet material was dispensed from each dispenser within a given example.

The sheet material dispenser of the present invention produces a maximum sound level preferably less than about 81 dBA, more preferably less than about 79 dBA, and most preferably less than about 76 dBA, when dispensing sheet material therefrom.

EXAMPLE 1

Dispense	Roll Towel Dispenser, Readings in dBA		
Number	A	B	1
1	84.7	84.3	72.7
2	88.5	84.3	77.6
3	85.5	86.2	75.3
4	82.5	85.5	75.3
5	87.7	84.3	75.7
6	85.1	87.3	78.3
7	87.0	85.5	76.5
8	87.0	82.8	77.6
9	88.5	82.1	75.3
10	87.0	85.5	76.5
Ave.	86.4	84.8	76.1
Std. Dev.	1.89	1.55	1.60

Example 1 illustrates a comparison of the compilation of test results of the recorded maximum sound level of individual towel dispenses from different dispensers in a controlled acoustical environment. Comparative Dispensers A and B are counter rotating cut off roll type dispensers. Non-perforated white paper roll toweling was dispensed from Dispensers A and B. Dispenser 1 is a dispenser according to the present invention. Perforated white paper roll toweling was dispensed from Dispenser 1.

EXAMPLES 2 and 3

Dispense	Readings in dBA	
Number	2	3
1	81.3	79.1
2	80.6	71.6
3	82.5	78.7
4	81.7	74.6
5	81.7	71.6
6	78.7	77.6
7	80.6	75.7
8	81.3	79.1
9	83.2	75.7
10	81.3	75.7
Ave.	81.3	75.9
Std. Dev.	1.20	2.78

Examples 2 and 3 illustrate a compilation of test results of the recorded maximum sound level of individual towel dispenses in a controlled acoustical environment. Examples 2 and 3 were performed with Dispenser 1 of Example 1. The same perforated white paper roll toweling used in Dispenser 1 of Example 1 was dispensed from Dispenser 1 in Example 3. Brown perforated paper roll toweling having a higher tensile modulus than the white paper toweling used in Dispenser 1 was dispensed from Dispenser 1 in Example 2.

EXAMPLE 4

	Dispenser 1	Dispenser C	Dispenser D	Dispenser E
msmv/tev	42.8%	32.1%	27.8%	27.1%
v/pa	3.2	2.9	2.2	2.1
v/spa	5.7	4.1	3.4	3.3

The capacity efficiency of Dispenser 1 according to the present invention and Comparative Dispensers C, D and E was calculated. Comparative Dispenser C is a counter rotating cut off roll type dispenser with calculations approximating the addition of a stub roll. Comparative Dispensers D and E are counter rotating cut off roll type dispensers. The msmv/tev is the maximum sheet material volume per total enclosed volume expressed as a percentage. The v/pa is the ratio of maximum sheet material volume to projected area expressed as cubic inches/square inches. The v/spa is the ratio of maximum sheet material volume to side profile area expressed as cubic inches/square inches.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure and methodology of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An apparatus for dispensing sheet material from at least one source of sheet material, the apparatus comprising:

a housing defining

an interior including a first section for a first source of sheet material and a second section for a second source of sheet material, and

an outlet though which an end portion of sheet material is dispensed from at least one of the sources;

at least one nipping surface disposed in the housing; and

a nipping element pivotally mounted in the housing so that the nipping element pivots between a first position in which a first portion of the nipping element and the nipping surface form a nip for the end portion of sheet material, and a second position in which at least a second portion of the nipping element and the nipping surface form a nip for the end portion of sheet material.

2. The apparatus of claim 1, further comprising at least one roller disposed in the housing, wherein the nipping surface is on the roller.

3. The apparatus of claim 1, further comprising a plurality of rollers in the housing, wherein the nipping surface is on at least one of the rollers and each of the rollers is mounted in the housing so that the rollers rotate about the same rotational axis.

4. The apparatus of claim 1, wherein the nipping element is a plate pivotally mounted in the housing so that the plate pivots between a first position in which an upper portion of the plate is spaced from the nipping surface and a lower portion of the plate and the nipping surface form a nip for an end portion of the sheet material of the first source, and a second position in which the upper and lower portions of the plate and the nipping surface form a nip for at least an end portion of the sheet material of the second source.

5. The apparatus of claim 1, further comprising at least one biasing element rotationally biasing the nipping element toward the nipping surface.

6. The apparatus of claim 1, wherein the first source of sheet material is a roll of sheet material, and wherein the apparatus further comprises a sensor for sensing the diameter of the roll of sheet material, the sensor comprising at least one surface moving in response to a change in diameter of the roll of sheet material.

7. The apparatus of claim 6, further comprising at least one cam follower cooperating with the nipping element, the cam follower contacting a cam surface on the sensor to control pivoting of the nipping element between the first and second positions.

8. The apparatus of claim 7, wherein the cam surface is shaped so that the nipping element pivots from the first position to the second position before all of the sheet material is dispensed from the roll, the second portion of the nipping element and the nipping surface forming a nip for

at least the sheet material from the second source when the nipping element is in the second position.

9. The apparatus of claim 6, wherein the sensor further comprises a contacting element pivotally mounted in the housing, the contacting element including a contacting surface for contacting the roll when the roll is in the first section of the housing, the cam surface cooperating with the contacting element to move in response to pivoting of the contacting element.

10. The apparatus of claim 9, wherein the sensor further comprises a cam element having the cam surface thereon, the cam element being pivotally mounted in the housing and being coupled to the contacting element so that pivotal movement of the contacting element moves the cam element.

11. The apparatus of claim 10, wherein the contacting element includes at least one slot and wherein the cam element includes at least one projection extending in the slot to guide movement of the cam element.

12. The apparatus of claim 9, further comprising at least one biasing element for biasing the contacting element against the roll when the roll is in the first section of the housing.

13. The apparatus of claim 1, further comprising at least one isolating element movably coupled to the housing, the isolating element preventing dispensing of sheet material from the second source until a predetermined amount of sheet material from the first source remains.

14. The apparatus of claim 13, wherein the apparatus further comprises at least one roller disposed in the housing, the nipping surface being on the roller, the second source being a roll of sheet material, and the isolating element being coupled to the nipping element so that the isolating element moves between a first position placing the roll out of contact with the nipping surface of the roller and a second position placing the roll on the nipping surface of the roller.

15. The apparatus of claim 13, wherein the isolating element includes at least one slot and wherein the nipping element further comprises at least one projection extending in the slot to control movement of the isolating element.

16. The apparatus of claim 1, further comprising at least one guide in proximity to the nipping surface, the guide positioning an end portion of sheet material from the second source such that the end portion of sheet material from the second source is positioned in the nip formed between the nipping surface and the second portion of the nipping element when the nipping element pivots to the second position and outside the nip formed between the nipping surface and the first portion of the nipping element when the nipping element is in the first position.

17. The apparatus of claim 1, wherein the housing further comprises a first housing member, a second housing member, and at least one hinge allowing the first housing member to pivot with respect to the second housing member between a closed position and an open position, one of the nipping element and the nipping surface being located in the first housing member and the other of the nipping element and the nipping surface being located in the second housing member such

that the nipping element and the nipping surface form a nip for the end portion of the sheet material when the first housing member is in the closed position and such that the nip opens when the first housing member is in the open position.

18. The apparatus of claim 17, wherein the apparatus further comprises at least one roller having the nipping surface thereon, and wherein the first housing member is a front cover and wherein the second housing member is a casing, the nipping element being located in the front cover and the roller being located in the casing.

19. The apparatus of claim 1, wherein the housing includes a first elongated slot and a second elongated slot and wherein the nipping element includes a first projection movable in the first slot and a second projection movable in the second slot such that the nipping element is capable of moving axially toward and away from the nipping surface.

20. The apparatus of claim 19, further comprising at least one biasing element axially biasing the nipping element toward the nipping surface.

21. The apparatus of claim 20, further comprising at least one additional biasing element rotationally biasing the nipping element toward the nipping surface.

22. The apparatus of claim 1, further comprising at least one roll of sheet material for being placed in one of the first section and the second section, the sheet material including perforations.

23. The apparatus of claim 1, further comprising at least one roll of wound sheet material for being placed in one of the first section and the second section, the sheet material comprising a web of sheet material having two side edges, a terminal end, and an initial end, the sheet material being divided into a plurality of individual sheets by a plurality of perforation tear lines including frangible bonds spaced along the tear line and extending from one edge to the other.

24. The apparatus of claim 1, wherein the outlet has a width narrower than a width of the sheet material of both the first and second sources.

25. The apparatus of claim 24, wherein the outlet has a width of from about 20% to about 90% of the width of the sheet material.

26. The apparatus of claim 24, wherein the outlet has a width of from about 55% to about 85% of the width of the sheet material.

27. The apparatus of claim 24, wherein the outlet has a width of from about 65% to about 75% of the width of the sheet material.

28. The apparatus of claim 24, wherein the outlet has a width of about 70% of the width of the sheet material.

29. The apparatus of claim 1, wherein the closest point on a line extending along an exit end of the nip formed between the first portion of the nipping element and the nipping surface is spaced a distance of from about 0.1 inch to about 3 inches to a point of contact between the sheet material and the edge of the outlet.

30. The apparatus of claim 29, wherein said distance is from about 0.8 inch to about 1.1 inches.

31. The apparatus of claim 29, wherein said distance is from about 0.9 inch to about 1 inch.

32. The apparatus of claim 1, wherein the second source is a roll of sheet material, and wherein the apparatus further comprises at least one tensioning element for contacting an end of the roll of sheet material, the tensioning element limiting free rotation of the reserve roll of sheet material in the second section to induce tension in sheet material being dispensed from the roll.

33. The apparatus of claim 1, wherein the second source is a roll of sheet material, and wherein the apparatus further comprises at least one roller having the nipping surface thereon and at least one arm for mounting the roll of sheet material in the second section, the arm allowing the roll of sheet material to contact the roller during dispensing of sheet material from the roll.

34. The apparatus of claim 33, further comprising a tensioning element on the arm, the tensioning element contacting an end of the roll of sheet material to limit free rotation of the roll

of sheet material, a portion of the tensioning element extending beyond the diameter of the roll of sheet material in the vicinity of a point of contact between the roll of sheet material and the roller to limit lateral travel of sheet material dispensed from the roll.

35. The apparatus of claim 1, further comprising at least one roller disposed in the housing and a lever pivotally coupled to the housing, the lever cooperating with the roller so that movement of the lever rotates the roller to feed the end portion of sheet material through the outlet.

36. An apparatus for dispensing sheet material from at least one source of sheet material, the apparatus comprising:

a housing defining

an interior including a first section for a first source of sheet material and a second section for a second source of sheet material, and

an outlet though which an end portion of sheet material is dispensed from at least one of the sources;

at least one nipping surface disposed in the housing;

a sensor for sensing the amount of sheet material of the first source of sheet material, the sensor comprising at least one cam surface moving in response to a change in size of the first source of sheet material;

a nipping element cooperating with the nipping surface to form a nip between the nipping element and the nipping surface, the nipping element being movably mounted in the housing to move toward and away from the nipping surface; and

at least one cam follower cooperating with the nipping element, the cam follower contacting the cam surface and the cam surface moving with respect to the cam follower to control movement of the nipping element.

37. The apparatus of claim 36, further comprising at least one roller disposed in the housing, the nipping surface being on the roller.

38. The apparatus of claim 36, further comprising a plurality of rollers in the housing, the nipping surface being on at least one of the rollers and each of the rollers being mounted in the housing so that the rollers rotate about the same rotational axis.

39. The apparatus of claim 36, further comprising at least one biasing element for biasing the cam follower toward the cam surface.

40. The apparatus of claim 36, wherein the nipping element is movable between a first position and a second position, the nipping element and the nipping surface forming a nip for at least the sheet material of the second source when the nipping element is in the second position, the nip for the sheet material of the second source being opened when the nipping element is in the first position.

41. The apparatus of claim 40, wherein the cam surface is shaped so that the nipping element moves from the first position to the second position before all of the sheet material is dispensed from the first source.

42. The apparatus of claim 36, wherein the sensor further comprises a contacting element pivotally mounted in the housing, the contacting element including a contacting surface for contacting the first source when the first source is in the first section of the housing, the cam surface cooperating with the contacting element to move in response to pivoting of the contacting element.

43. The apparatus of claim 42, wherein the sensor further comprises a cam having the cam surface thereon, the cam being movably mounted in the housing and being coupled to the contacting element so that pivotal movement of the contacting element moves the cam.

44. The apparatus of claim 43, wherein the contacting element includes at least one slot and wherein the cam includes at least one projection extending in the slot to guide movement of the cam.

45. The apparatus of claim 42, further comprising at least one biasing element for biasing the contacting element against the first source when the first source is in the first section of the housing.

46. The apparatus of claim 36, further comprising at least one isolating element pivotally coupled to the housing, the isolating element preventing dispensing of sheet material from the second source until a predetermined amount of sheet material from the first source remains.

47. The apparatus of claim 46, wherein the apparatus further comprises at least one roller having the nipping surface thereon, and wherein the isolating element is coupled to the nipping element so that the isolating element moves between a first position placing the second source out of contact with the nipping surface of the roller and a second position placing the second source on the nipping surface of the roller.

48. The apparatus of claim 46, wherein the isolating element includes at least one slot and wherein the nipping element further comprises at least one projection extending in the slot to control movement of the isolating element.

49. The apparatus of claim 36, further comprising at least one roll of sheet material for being placed in one of the first section and the second section, the sheet material including perforations.

50. The apparatus of claim 36, further comprising at least one roll of wound sheet material for being placed in one of the first section and the second section, the sheet material comprising a web of sheet material having two side edges, a terminal end, and an initial end, the sheet material being divided into a plurality of individual sheets by a plurality of perforation tear lines including frangible bonds spaced along the tear line and extending from one edge to the other.

51. The apparatus of claim 36, wherein the outlet has a width narrower than a width of the sheet material of both the first and second sources.

52. The apparatus of claim 36, wherein the nipping element is a plate pivotally mounted in the housing.

53. An apparatus for dispensing sheet material from at least one source of sheet material, the apparatus comprising:

a housing defining

an interior including a first section for a first source of sheet material and a second section for a second source of sheet material, and

an outlet though which an end portion of sheet material is dispensed from at least one of the sources;

at least one nipping surface disposed in the housing;

a nipping element disposed in the housing, the nipping element cooperating with the nipping surface to form a nip for passage of the sheet material; and

at least one isolating element movably mounted in the housing, the isolating element moving between a second source isolating position in which the isolating element positions the second source out of contact with the nipping surface and a second source dispensing position placing the second source on the nipping surface.

54. The apparatus of claim 53, further comprising at least one roller disposed in the housing, the nipping surface being on the roller.

55. The apparatus of claim 53, further comprising a plurality of rollers in the housing, the nipping surface being on at least one of the rollers and each of the rollers being mounted in the housing so that the rollers rotate about the same rotational axis.

56. The apparatus of claim 53, wherein the nipping element is movably mounted in the housing so that the nipping element moves between a first position and a second position, the nipping element and the nipping surface forming a nip for at least the sheet material of the second source when the nipping element is in the second position, the nip for the sheet material of the second source being opened when the nipping element is in the first position.

57. The apparatus of claim 56, wherein the isolating element is coupled to the nipping element so that the isolating element pivots from the second source isolating position to the second source dispensing position when the nipping element moves from the first position to the second position.

58. The apparatus of claim 57, wherein the isolating element includes at least one slot and wherein the nipping element further comprises at least one projection extending in the slot to control movement of the isolating element.

59. The apparatus of claim 53, further comprising a sensor for sensing the amount of sheet material of the first source of sheet material, the isolating element being coupled to the sensor so that the isolating element pivots from the second source isolating position to the second source dispensing position before all of the sheet material has been dispensed from the first source.

60. The apparatus of claim 59, wherein the sensor comprises a contacting element pivotally mounted in the housing, the contacting element including a contacting surface for contacting the first source when the first source is in the first section of the housing.

61. The apparatus of claim 59, wherein the sensor comprises a movable cam having at least one cam surface thereon, and wherein the apparatus further comprises at least one cam follower cooperating with the isolating element, the cam follower contacting the cam surface to control movement of the isolating element.

62. The apparatus of claim 59, wherein the second source is a roll of sheet material, and wherein apparatus further comprises a roller having the nipping surface thereon, the isolating element being positioned under the roll when the roll is in the second section of the housing, the isolating element lifting the roll from the nipping surface of the roller when the isolating element is in the second source isolating position.

63. The apparatus of claim 53, further comprising at least one roll of sheet material for being placed in one of the first section and the second section, the sheet material including perforations.

64. The apparatus of claim 53, further comprising at least one roll of wound sheet material for being placed in one of the first section and the second section, the sheet material comprising a web of sheet material having two side edges, a terminal end, and an initial end, the sheet material

being divided into a plurality of individual sheets by of perforation tear lines including frangible bonds spaced along the tear line and extending from one edge to the other.

65. The apparatus of claim 53, wherein the outlet has a width narrower than a width of the sheet material of both the first and second sources.

66. A method of dispensing sheet material from a dispenser comprising a housing, at least one nipping surface, and a movable nipping element, the housing defining an interior including a first section accommodating a first source of sheet material and a second section accommodating a second source of sheet material, and an outlet, the method comprising the steps of:

dispensing sheet material from the first source, the dispensing comprising passing an end portion of sheet material from the first source through a nip formed between the nipping element and the nipping surface and through the outlet;

moving the nipping element with respect to the nipping surface to place an end portion of sheet material from the second source in the nip formed between the nipping element and the nipping surface; and

dispensing sheet material from the second source, the dispensing of sheet material from the second source including passing the end portion of the sheet material from the second source through the nip and through the outlet.

67. The method of claim 66, wherein the dispensing of sheet material from the first source comprises dispensing sheet material from a stub roll of sheet material and wherein the dispensing

of sheet material from the second source comprises dispensing sheet material from a reserve roll of sheet material.

68. The method of claim 66, wherein the dispensing of sheet material from the second source occurs before all of the sheet material is dispensed from the first source.

69. The method of claim 66, wherein the moving of the nipping element further comprises pivoting the nipping element between a first position in which a first portion of the nipping element and the nipping surface form a nip for the end portion of sheet material from the first source and a second position in which at least a second portion of the nipping element and the nipping surface form a nip for at least the end portion of sheet material from the second source.

70. The method of claim 66, wherein the nipping element is a plate, and wherein the moving of the nipping element further comprises pivoting the plate from a first position, in which a first portion of the plate is spaced from the nipping surface and a second portion of the plate and the nipping surface form a nip, and a second position, in which the first and second portions of the plate and the nipping surface form a nip.

71. The method of claim 66, further comprising rotationally biasing the nipping element toward the nipping surface.

72. The method of claim 66, further comprising axially biasing the nipping element toward the nipping surface.

73. The method of claim 66, further comprising sensing the size of the first source of sheet material, and wherein the moving step further comprises moving the nipping element when a predetermined size of the first source is sensed.

74. The method of claim 73, wherein the dispenser further comprises a cam surface and a cam follower, and wherein the method further comprises moving the cam surface with respect to the cam follower to control movement of the nipping element.

75. The method of claim 74, further comprising the step of biasing the cam follower toward the cam surface.

76. The method of claim 74, wherein the dispenser further comprises a contacting element contacting the first source, and wherein the method further comprises moving the contacting element when sheet material is dispensed from the first source and moving the cam surface in response to movement of the contacting element.

77. The method of claim 76, further comprising biasing the contacting element against the first source.

78. The method of claim 66, wherein the method further comprises the step of placing the second source out of contact with the nipping surface during at least a portion of the dispensing

of sheet material from the second source and placing the second source on the nipping surface during the dispensing of sheet material from the second source.

79. The method of claim 78, wherein the second source is a roll of sheet material and wherein the dispenser further comprises a roll isolating element and at least one roller having the nipping surface thereon, the method further comprises moving the isolating element between a first position in which the isolating element moves the roll out of contact with the roller and a second position in which the roll is on the roller.

80. The method of claim 66, further comprising the step of positioning the end portion of sheet material from the second source so that the end portion of sheet material from the second source is placed in the nip formed between the nipping element and the nipping surface when the nipping element moves to the second position.

81. The method of claim 66, wherein the housing comprises a first housing member, a second housing member, and at least one hinge allowing the first housing member to pivot with respect to the second housing member, and wherein the method further comprises the steps of pivoting the first housing member with respect to the second housing member to place the first housing member in an open position allowing access to the interior of the housing and pivoting the first housing member with respect to the second housing member to place the first housing member in a closed position limiting access to the interior of the housing, the nip formed between the nipping element and the nipping surface being open when the first housing member is in the open position.

82. The method of claim 66, wherein the dispenser further comprises at least one roller having the nipping surface thereon, and wherein the method further comprises rotating the roller during the dispensing of sheet material from the first source and during the dispensing of sheet material from the second source.

83. The method of claim 82, wherein the dispenser further comprises a lever cooperating with the roller and wherein the step of rotating the roller further comprises moving the lever.

84. The method of claim 83, wherein the first source is a stub roll of sheet material and wherein the method further comprises the steps of pivoting the lever to allow access to the first portion of the housing and removing an unused portion of the stub roll from the first portion of the housing.

85. The method of claim 66, wherein the dispensing of sheet material from the first source further comprises pulling the end portion of sheet material from the first source, and wherein the dispensing of sheet material from the second source further comprises pulling the end portion of sheet material from the second source.

86. The method of claim 85, wherein the outlet has a width less than a width of sheet material of the first and second sources, and wherein the method further comprises inducing tension forces in the sheet material at the outlet when the sheet material is pulled.

87. The method of claim 85, wherein the sheet material of both the first and second sources includes perforation tear lines, and wherein the method further comprises separating a sheet of material from the sheet material by tearing the sheet material along one of the perforation tear lines.

88. The method of claim 66, wherein the second source is a roll of sheet material and wherein the method further comprises the step of limiting free rotation of the roll during the dispensing of sheet material from the roll.

89. A method of dispensing sheet material from a dispenser comprising a housing, at least one nipping surface, and a nipping element, the housing defining an interior including a first section accommodating a first source of sheet material and a second section accommodating a second source of sheet material, and an outlet, the method comprising the steps of:

positioning the second source out of contact with the nipping surface;

dispensing sheet material from the first source, the dispensing comprising passing an end portion of sheet material from the first source through a nip formed between the nipping element and the nipping surface and through the outlet;

sensing the quantity of the first source;

placing the second source on the nipping surface when a predetermined quantity of the first source is sensed; and

dispensing sheet material from the second source, the dispensing of sheet material from the second source comprising passing an end portion of sheet material from the second source through the nip and through the outlet.

90. The method of claim 89, wherein the first source is a stub roll of sheet material and the second source is a reserve roll of sheet material, and wherein the step of sensing the quantity of the first source comprises sensing the diameter of the stub roll of sheet material.

91. The method of claim 89, further comprising the step of moving the nipping element, when the predetermined quantity of the first source is sensed, from a first position, in which a first portion of the nipping element cooperates with the nipping surface to form the nip, to a second position, in which at least a second portion of the nipping element cooperates with the nipping surface to form the nip.

92. The method of claim 89, wherein the dispenser further comprises at least one roller having the nipping surface thereon, and wherein the method further comprises rotating the roller during the dispensing of sheet material from the first source and during the dispensing of sheet material from the second source.

93. The method of claim 92, wherein the dispensing of sheet material from the first source further comprises pulling the end portion of sheet material from the first source to rotate the roller, and wherein the dispensing of sheet material from the second source further comprises pulling the end portion of sheet material from the reserve roll to rotate the roller.

94. The method of claim 92, wherein the dispenser further comprises a lever cooperating with the roller, wherein the step of dispensing the sheet material from the first source and the

step of dispensing sheet material from the second source comprise moving the lever to rotate the roller.

95. The method of claim 94, wherein the first source is a stub roll of sheet material and wherein the method further comprises the steps of pivoting the lever to allow access to the first portion of the housing and removing an unused portion of the stub roll from the first portion of the housing.

96. The method of claim 89, wherein the dispenser further comprises a cam surface and a cam follower, and wherein the method further comprises moving the cam surface with respect to the cam follower to control placement of the second source on the nipping surface.

97. The method of claim 96, further comprising biasing the cam follower toward the cam surface.

98. The method of claim 96, wherein the dispenser further comprises a contacting element contacting the first source, and wherein the method further comprises moving the contacting element when sheet material is dispensed from the first source and moving the cam surface in response to movement of the contacting element.

99. The method of claim 98, further comprising the step of biasing the contacting element against the outer portion of the first source.

100. The method of claim 89, wherein the second source is placed on the nipping surface before all of the sheet material is dispensed from the first source.

101. The method of claim 91, further comprising the step of positioning a terminal end of sheet material from the second source so that the end portion of sheet material from the second source is placed in the nip formed between the nipping surface and the nipping element when the nipping element moves to the second position.

102. The method of claim 89, wherein the dispensing of sheet material from the first source further comprises pulling the end portion of sheet material from the first source, and wherein the dispensing of sheet material from the second source further comprises pulling the end portion of sheet material from the second source.

103. The method of claim 102, wherein the outlet has a width less than a width of sheet material of the first and second sources, and wherein the method further comprises inducing tension forces in the sheet material at the outlet when the sheet material is pulled.

104. The method of claim 102, wherein the sheet material of both the first and second sources includes perforation tear lines, and wherein the method further comprises separating a sheet of material from the sheet material by tearing the sheet material along one of the perforation tear lines.

105. The method of claim 89, wherein the second source is a roll of sheet material and wherein the method further comprises the step of limiting free rotation of the roll during the dispensing of sheet material from the second source.

106. The method of claim 89, wherein the housing comprises a first housing member and a second housing member movable with respect to the first housing member between a closed position limiting access to the interior of the housing and an open position allowing access to the interior of the housing, and wherein the step of positioning the second source out of contact with the nipping surface further comprises placing the second housing member in the open position to open the nip and placing the second housing member in the closed position to place sheet material from the first source in the nip.

107. The method of claim 89, wherein the housing comprises a first housing member and a second housing member movable with respect to the first housing member between a closed position limiting access to the interior of the housing and an open position allowing access to the interior of the housing, and wherein the step of positioning the second source out of contact with the nipping surface further comprises placing the second housing member in the closed position and isolating the second source out of contact with the nipping surface when the second housing member is placed in the closed position.

108. An apparatus for dispensing perforated sheet material, the apparatus comprising:

a housing defining an interior for accommodating at least one source of sheet material therein and an outlet through which an end of the sheet material is dispensed from the

at least one source, the outlet having a width less than the overall width of the sheet material; and

a first surface and a second surface forming a nip through which the sheet material passes,

wherein the nip and the outlet are configured such that a least one angle defined by a first line extending along an exit of the nip and a second line formed between the outermost lateral exit end of the nip along the first line that contains the sheet material and the point of contact between the sheet material and the edge of the outlet is from about 26° to about 36°, and

wherein the closest point on a line extending along an exit of the nip is spaced a distance of from about 0.1 inch to about 3 inches to the point of contact between the sheet material and the edge of the outlet.

109. The apparatus of claim 108, further comprising a nipping element and at least one roller, said first surface being on the nipping element and said second surface being on the roller.

110. The apparatus of claim 108, wherein the distance is from about 0.9 inch to about 1 inch.

111. The apparatus of claim 108, wherein the at least one angle is from about 29° to about 36°.

112. The apparatus of claim 108, wherein the at least one angle is from about 32° to about 33°.

113. The apparatus of claim 108, wherein the outlet has a width of from about 20% to about 90% of the width of the sheet material.

114. The apparatus of claim 108, wherein the outlet has a width of from about 55% to about 85% of the width of the sheet material.

115. The apparatus of claim 108, wherein the outlet has a width of from about 65% to about 75% of the width of the sheet material.

116. The apparatus of claim 108, wherein the outlet has a width of about 70% of the width of the sheet material.

117. The apparatus of claim 108, wherein said source of sheet material is a roll of sheet material.

118. The apparatus of claim 117 wherein said roll of sheet material includes a web of sheet material comprising two side edges, a terminal end and an initial end, wound into a roll and divided into a plurality of individual sheets by a plurality of perforation tear lines including frangible bonds spaced along the tear line and extending from one edge of the roll to the other.

119 The apparatus of claim 117, wherein the roll of sheet material is rotatably mounted in said housing.

120. The apparatus of claim 108, wherein the overall width of the sheet material is from about 4 inches to about 14 inches.

121. The apparatus of claim 108, wherein the sheet material comprises paper toweling.

122. The apparatus of claim 108, wherein the sheet material comprises nonwoven material.

123. The apparatus of claim 108, wherein the sheet material comprises airlaid material.

124. The apparatus of claim 1 further comprising:

a sensor for sensing the amount of sheet material of the first source of sheet material, the sensor comprising at least one cam surface moving in response to a change in size of the first source of sheet material; and

at least one cam follower cooperating with the nipping element, the cam follower contacting the cam surface and the cam surface moving with respect to the cam follower to control movement of the nipping element.

125. The apparatus of claim 1 further comprising at least one isolating element movably mounted in the housing, the isolating element moving between a second source isolating position in which the isolating element positions the second source out of contact with the nipping surface and a second source dispensing position placing the second source on the nipping surface.

126. The apparatus of claim 1, wherein the second section is larger than the first section, and wherein the apparatus further comprises:

a sensor disposed in the housing for sensing the size of the second source while the second source is in the second section; and

an indicator cooperating with the sensor to provide an indication when the size of the second source is small enough to place the second source of sheet material in the first section of the housing interior.

127. An apparatus for dispensing sheet material from at least one source of sheet material, the apparatus comprising:

a housing defining

an interior including a first section for a first source of sheet material and a second section for a second source of sheet material, the second section being larger than the first section, and

an outlet though which an end portion of sheet material is dispensed from at least one of the sources;

at least one nipping surface disposed in the housing;

a nipping element pivotally mounted in the housing so that the nipping element pivots between a first position in which a first portion of the nipping element and the nipping surface form a nip for the end portion of sheet material, and a second position in which at least a second portion of the nipping element and the nipping surface form a nip for the end portion of sheet material;

at least one isolating element movably mounted in the housing, the isolating element moving between a second source isolating position in which the isolating element positions the second source out of contact with the nipping surface and a second source dispensing position placing the second source on the nipping surface

a first sensor for sensing the amount of sheet material of the first source of sheet material, the first sensor comprising at least one cam surface moving in response to a change in size of the first source of sheet material;

at least one cam follower cooperating with the nipping element, the cam follower contacting the cam surface and the cam surface moving with respect to the cam follower to control movement of the nipping element;

a second sensor disposed in the housing for sensing the size of the second source while the second source is in the second section; and

an indicator cooperating with the second sensor to provide an indication when the size of the second source is small enough to place the second source of sheet material in the first section of the housing interior.

128. An apparatus for dispensing sheet material from at least one source of sheet material, the apparatus comprising:

a housing defining an interior for accommodating at least one source of sheet material herein and an outlet through which the sheet material is dispensed;

at least one roller in the housing;

a nipping element cooperating with the roller to form a nip between the nipping element and the roller for passage of the sheet material; and

a lever coupled to the housing and cooperating with the roller so that moving the lever rotates the roller, the lever being located with respect to the outlet so that sheet material dispensed through the outlet passes substantially over the lever.

129. The apparatus of claim 128, wherein the lever includes a surface having at least one protuberance, the protuberance guiding the sheet material when the sheet material is dispensed through the outlet.

130. The apparatus of claim 128, wherein the housing includes a first section for accommodating a stub roll of sheet material and a second section for accommodating a reserve roll of sheet material, the lever being pivotally movable with respect to the housing to allow an unused portion of the stub roll to be removed from the first section of the housing without removing the reserve roll from the second section.

131. The apparatus of claim 128, further comprising a clutch mechanism coupled to the roller and cooperating with the lever, the clutch mechanism allowing rotation of the roller independent of the moving of the lever so that the sheet material may be manually dispensed through the outlet.

132. The apparatus of claim 128, further comprising a roll of sheet material for being placed in the interior of the housing.

133. The apparatus of claim 132, wherein the sheet material is perforated.

134. The apparatus of claim 132, wherein the sheet material comprises a web of wound sheet material having two side edges, a terminal end, and an initial end, the sheet material being divided into a plurality of individual sheets by a plurality of perforation tear lines including frangible bonds spaced along the tear line and extending from one edge to the other.

135. The apparatus of claim 128, wherein the outlet has a width narrower than a width of the sheet material.

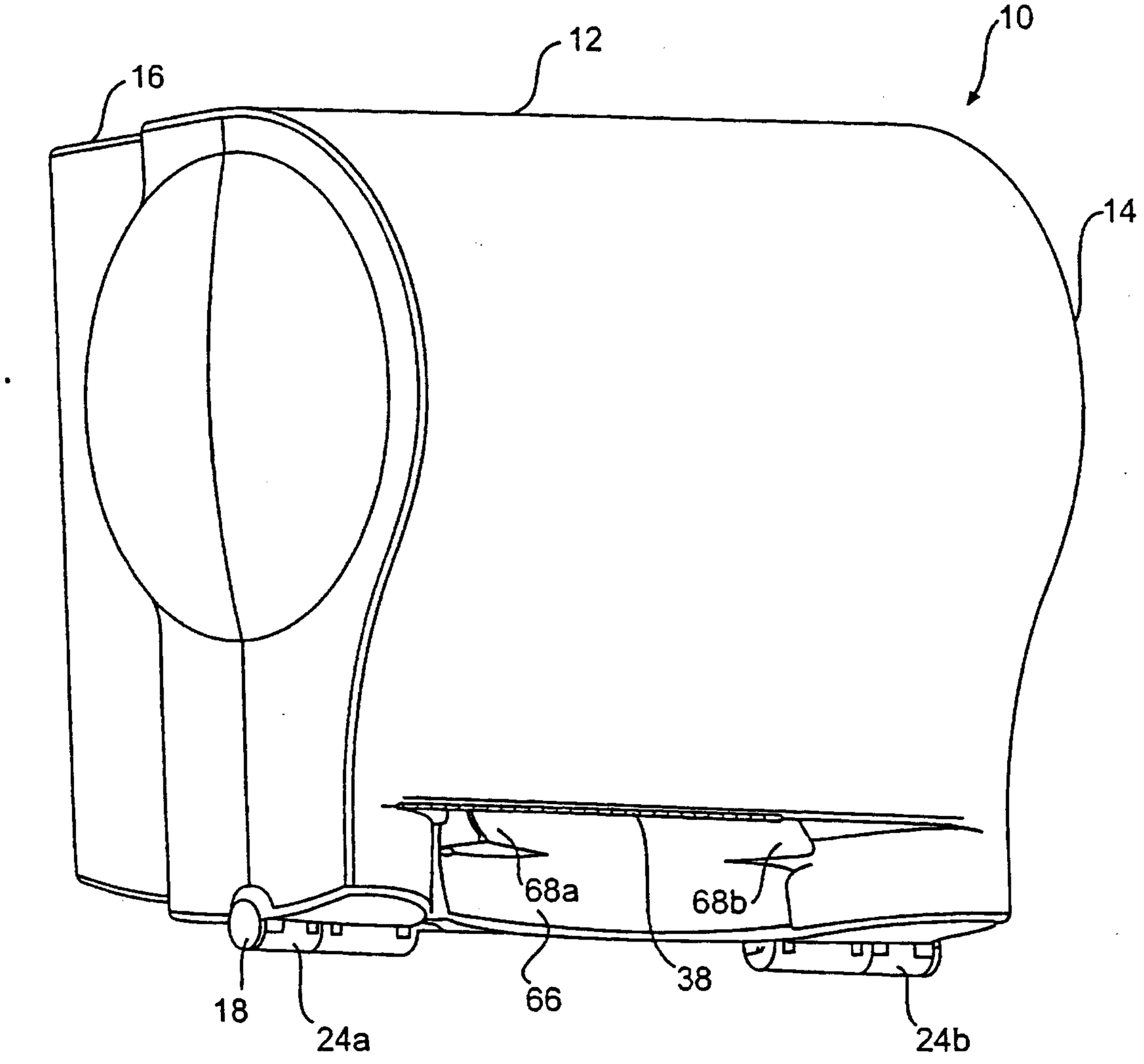


FIG. 1

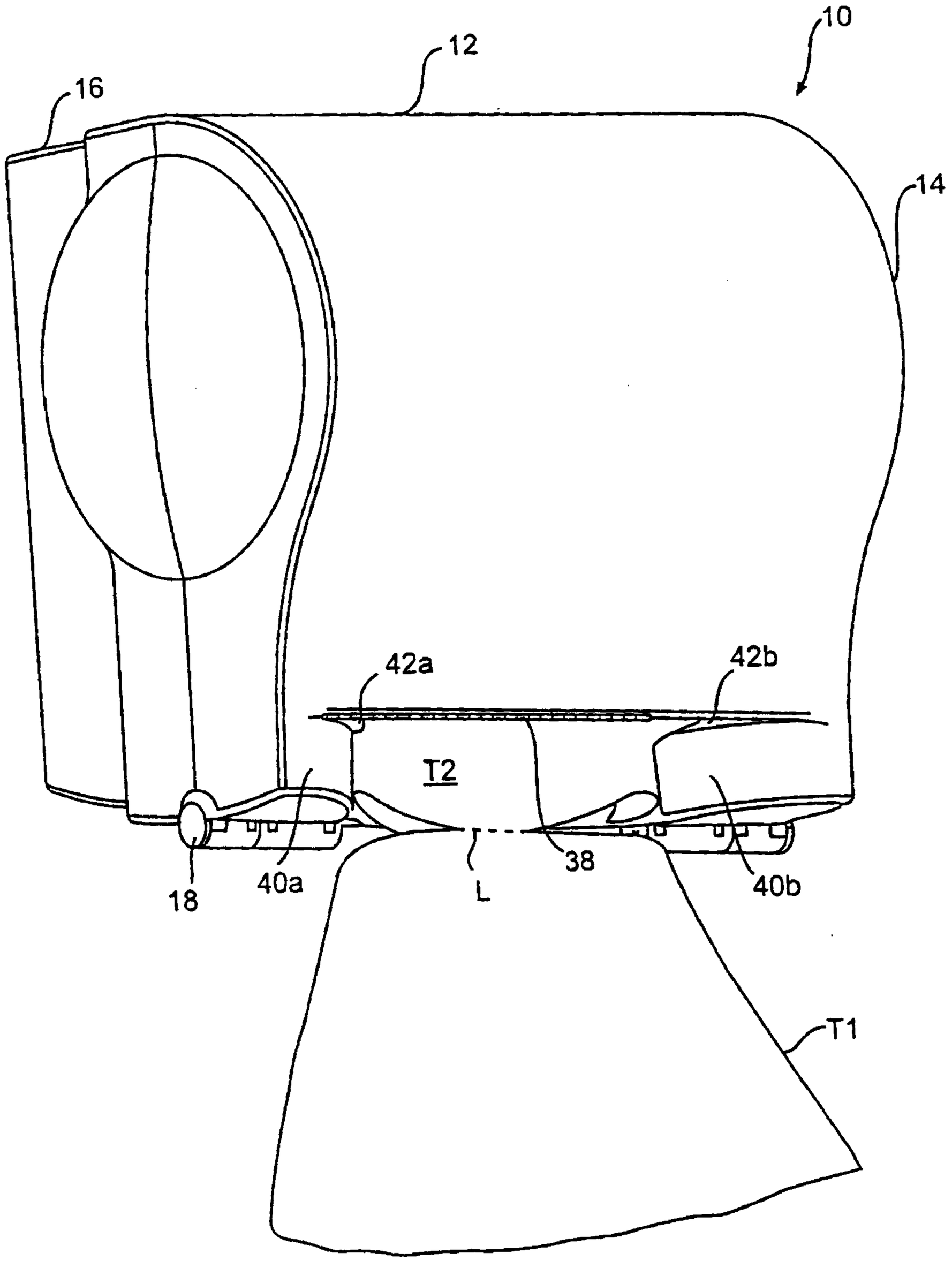
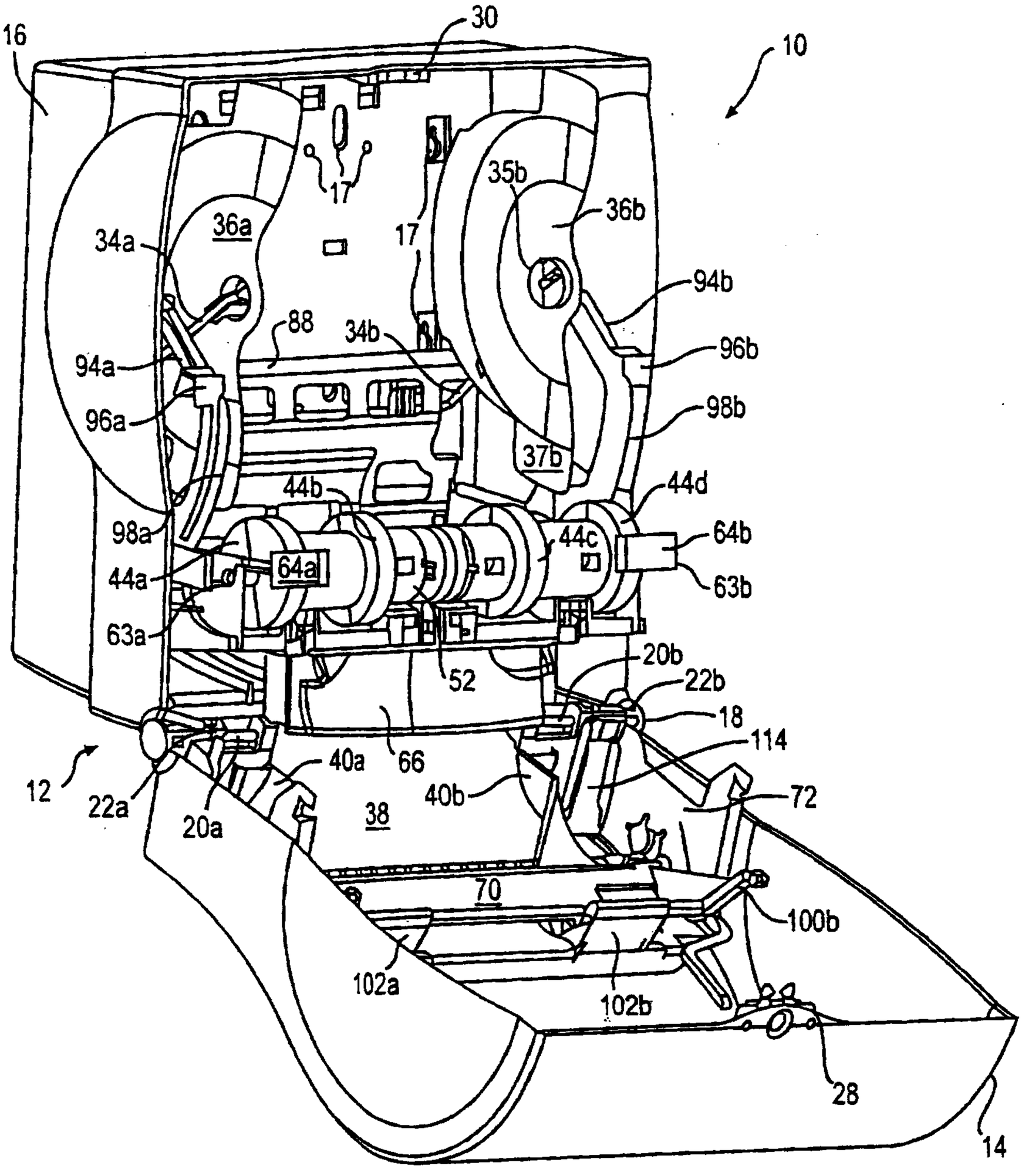


FIG. 2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44b
64b
98a
44c
44a
64a
63b
63a
20b
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22b
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100b
102a
102b
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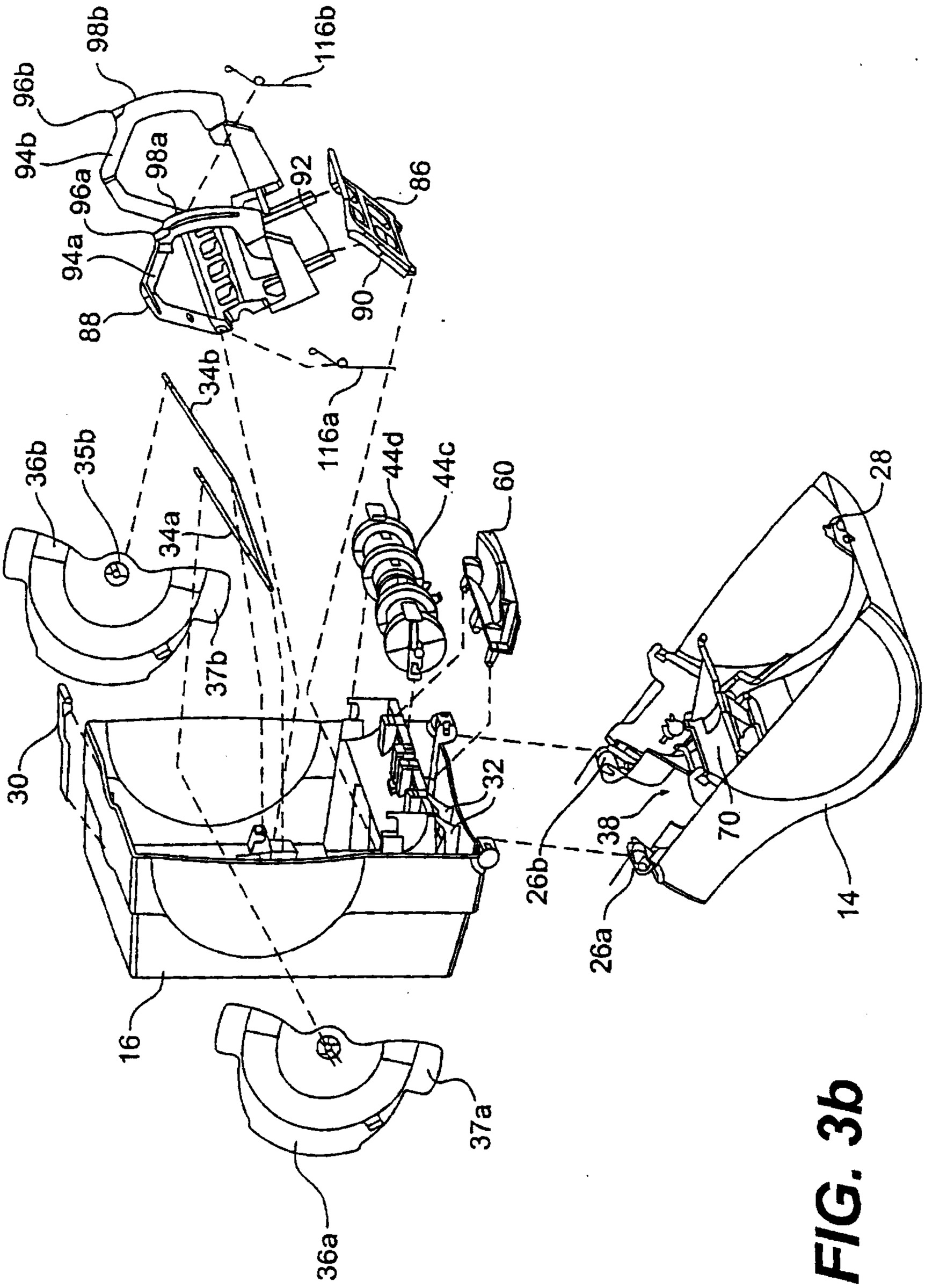
14

FIG. 3a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116a
36b
35b
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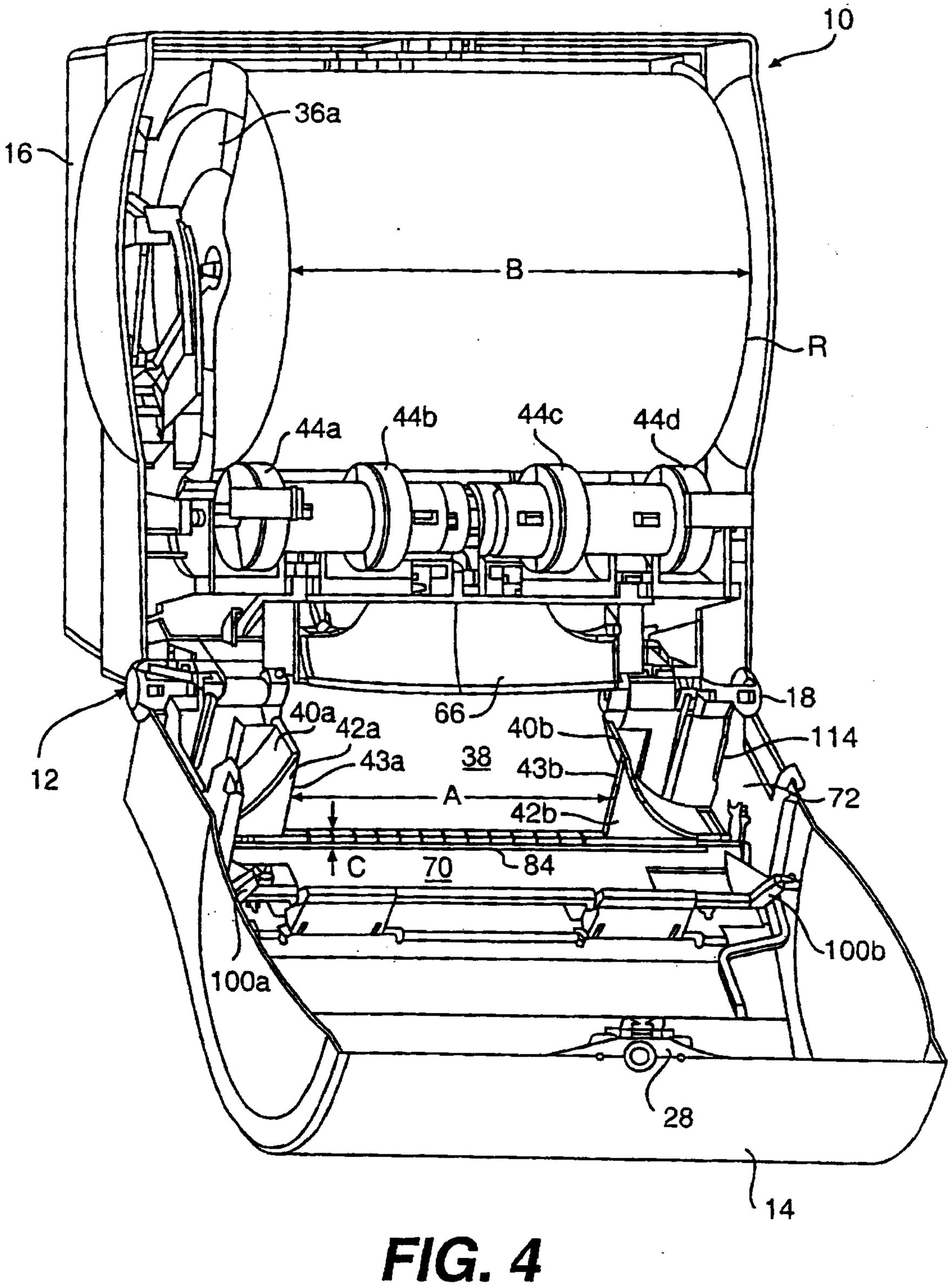
37a
36a
28
38
70
26b
26a
14

FIG. 3b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A
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100a
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14

FIG. 4

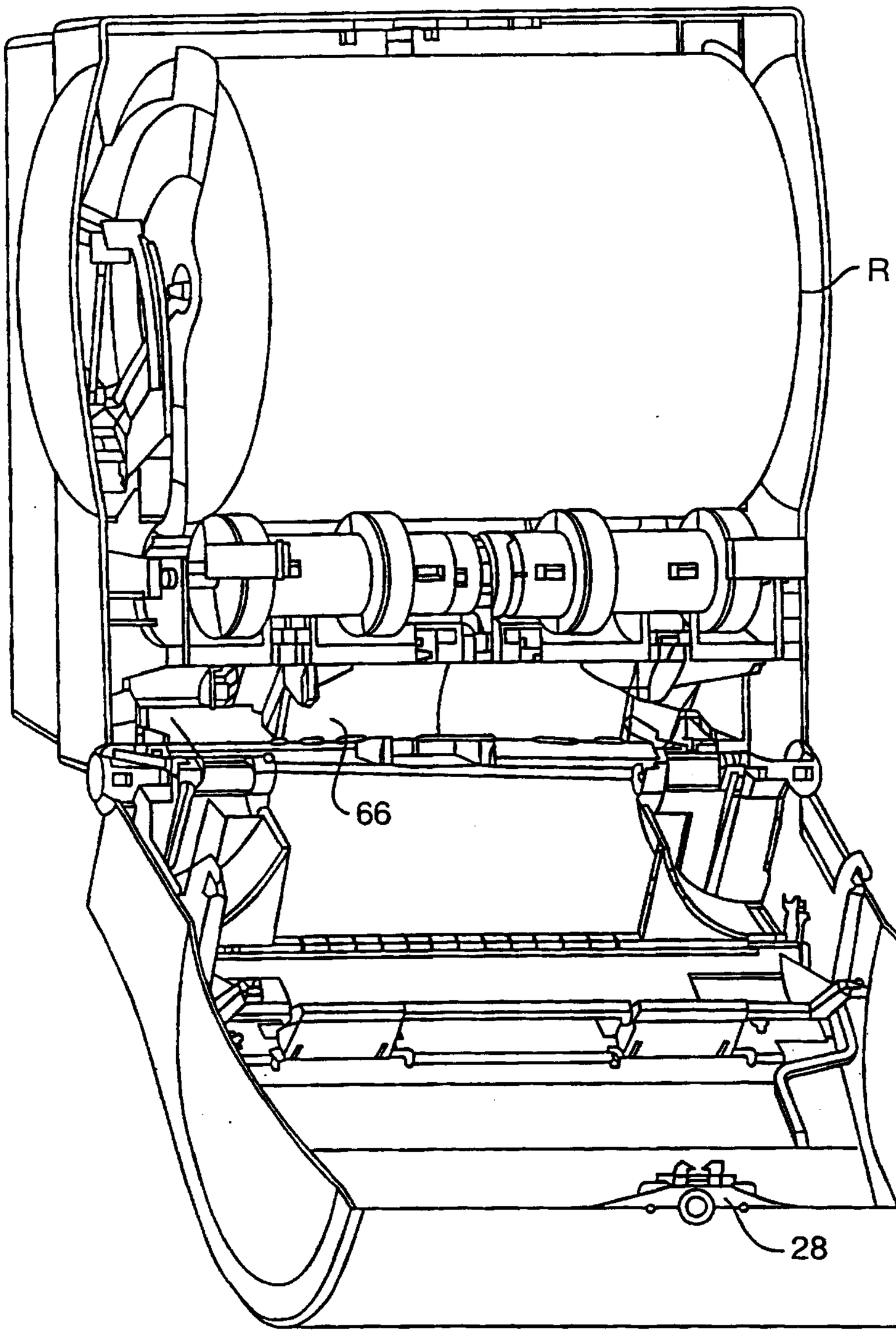


FIG. 5

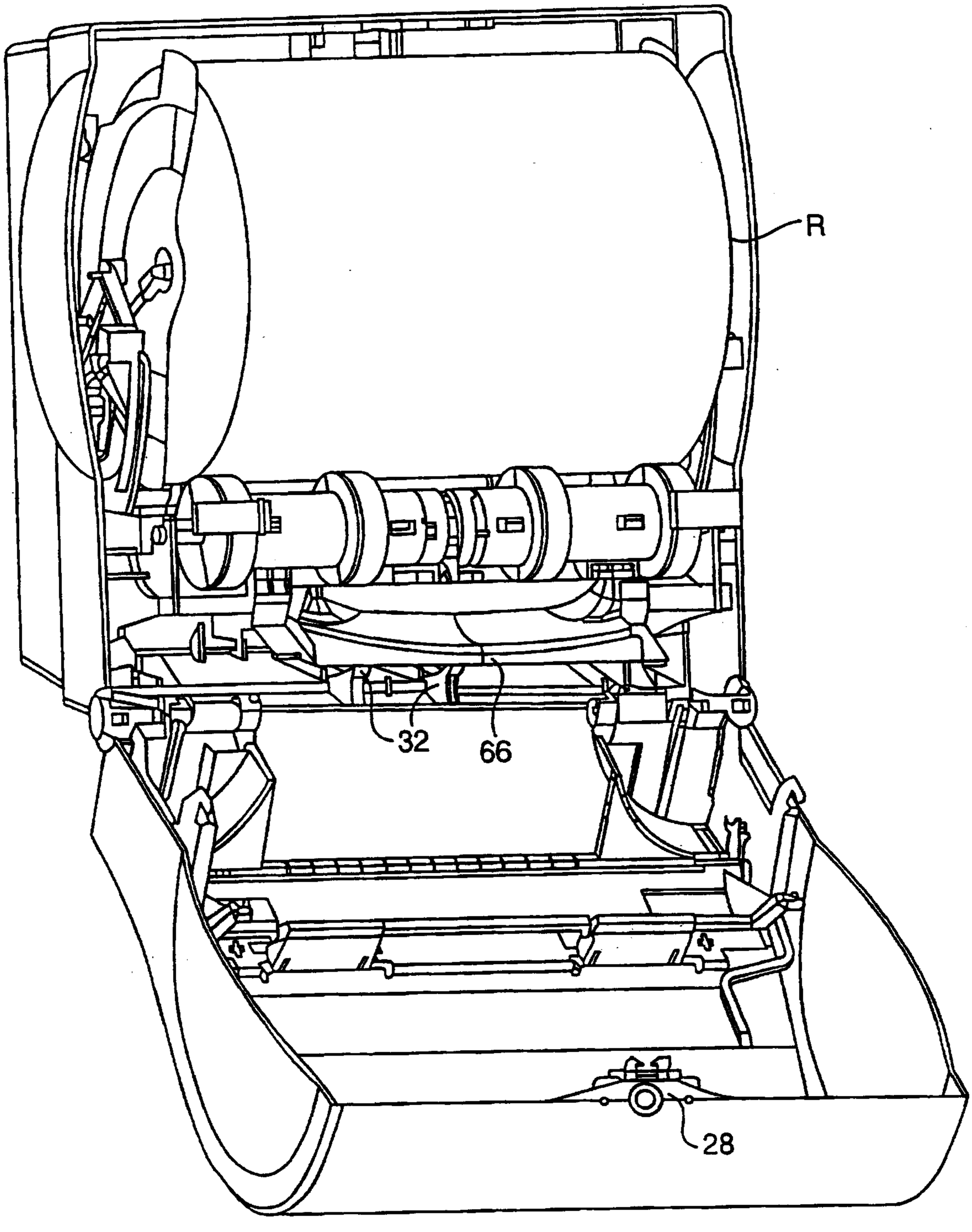
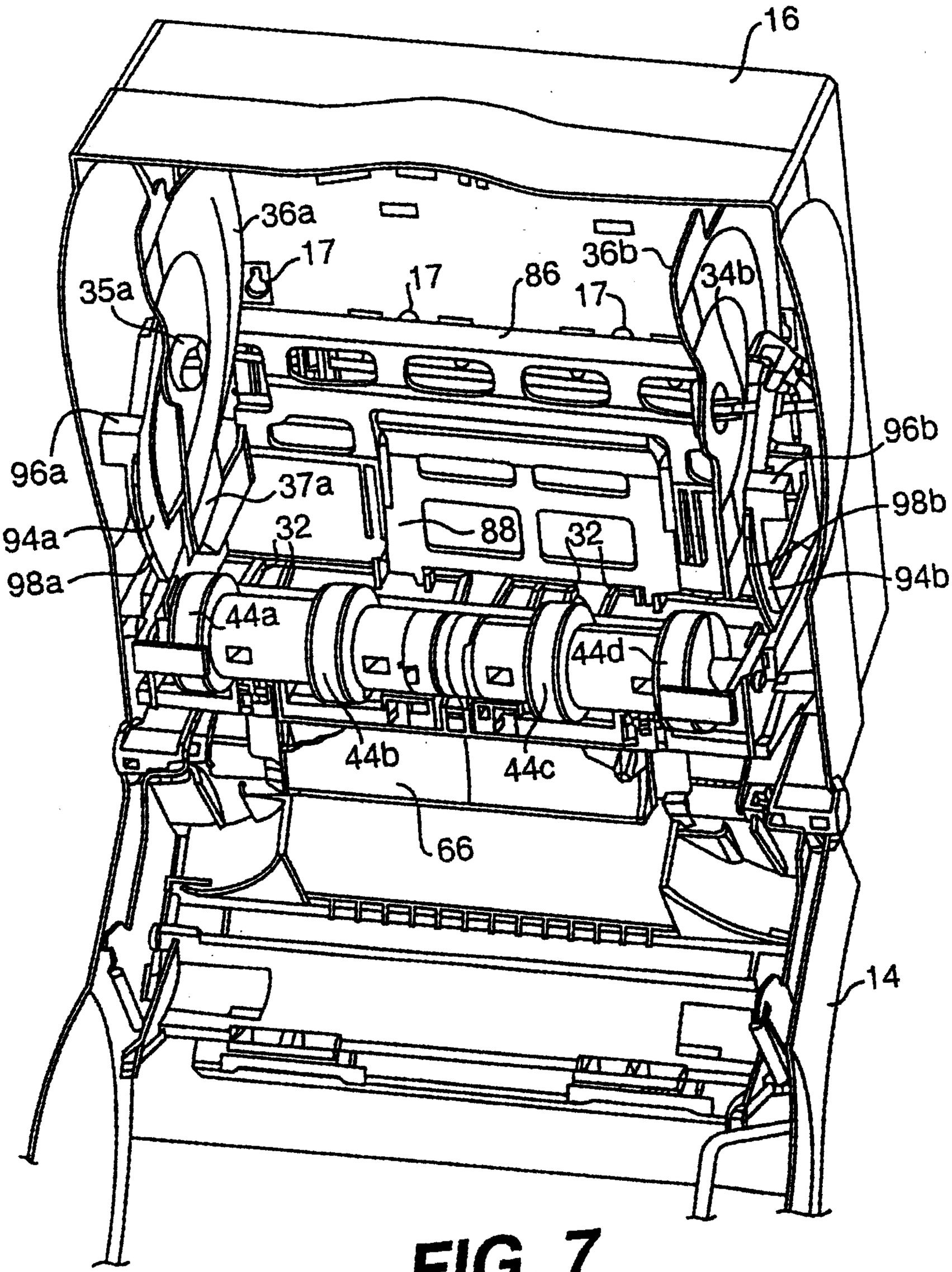


FIG. 6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44c
66
14

FIG. 7

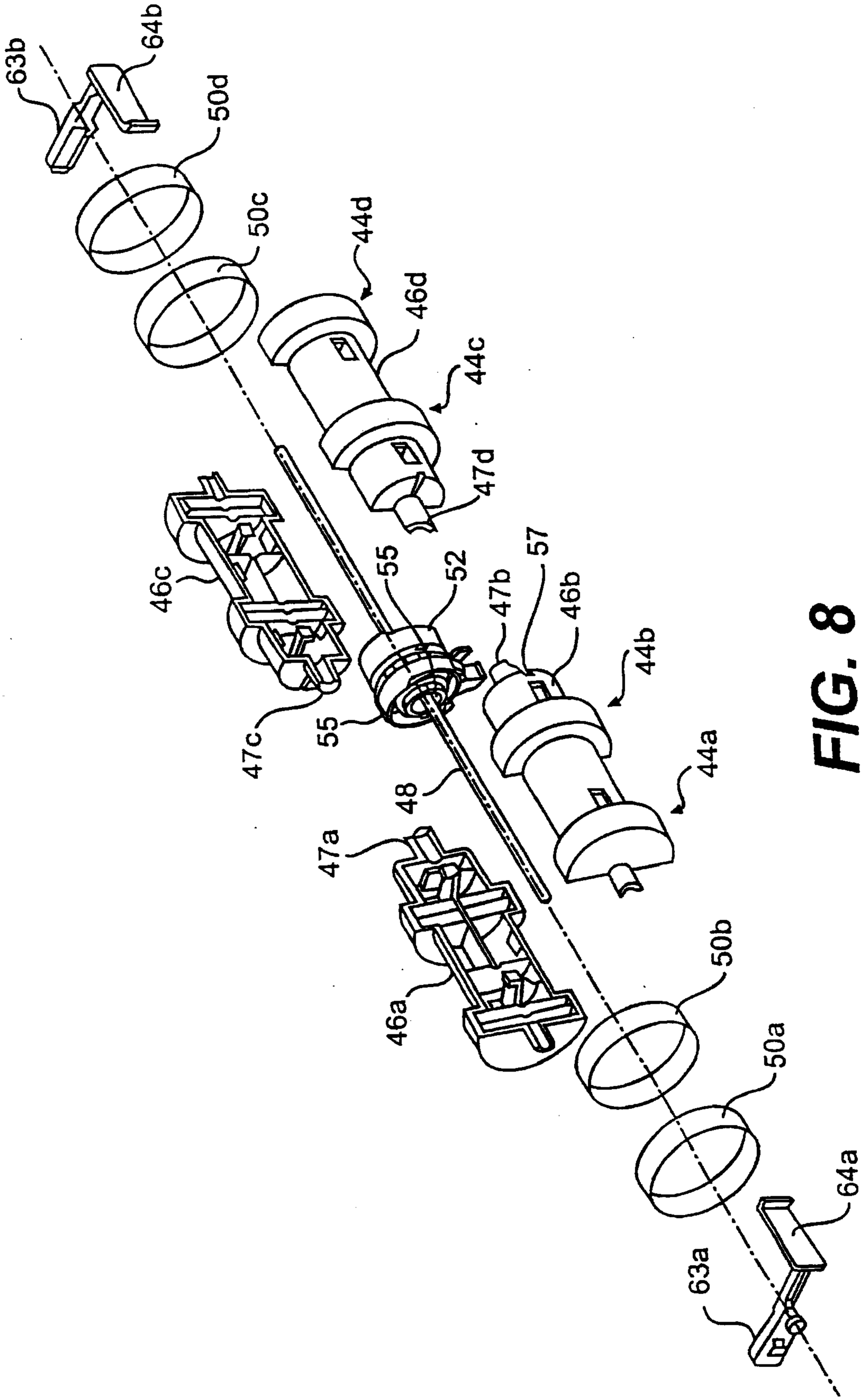
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FIG. 8

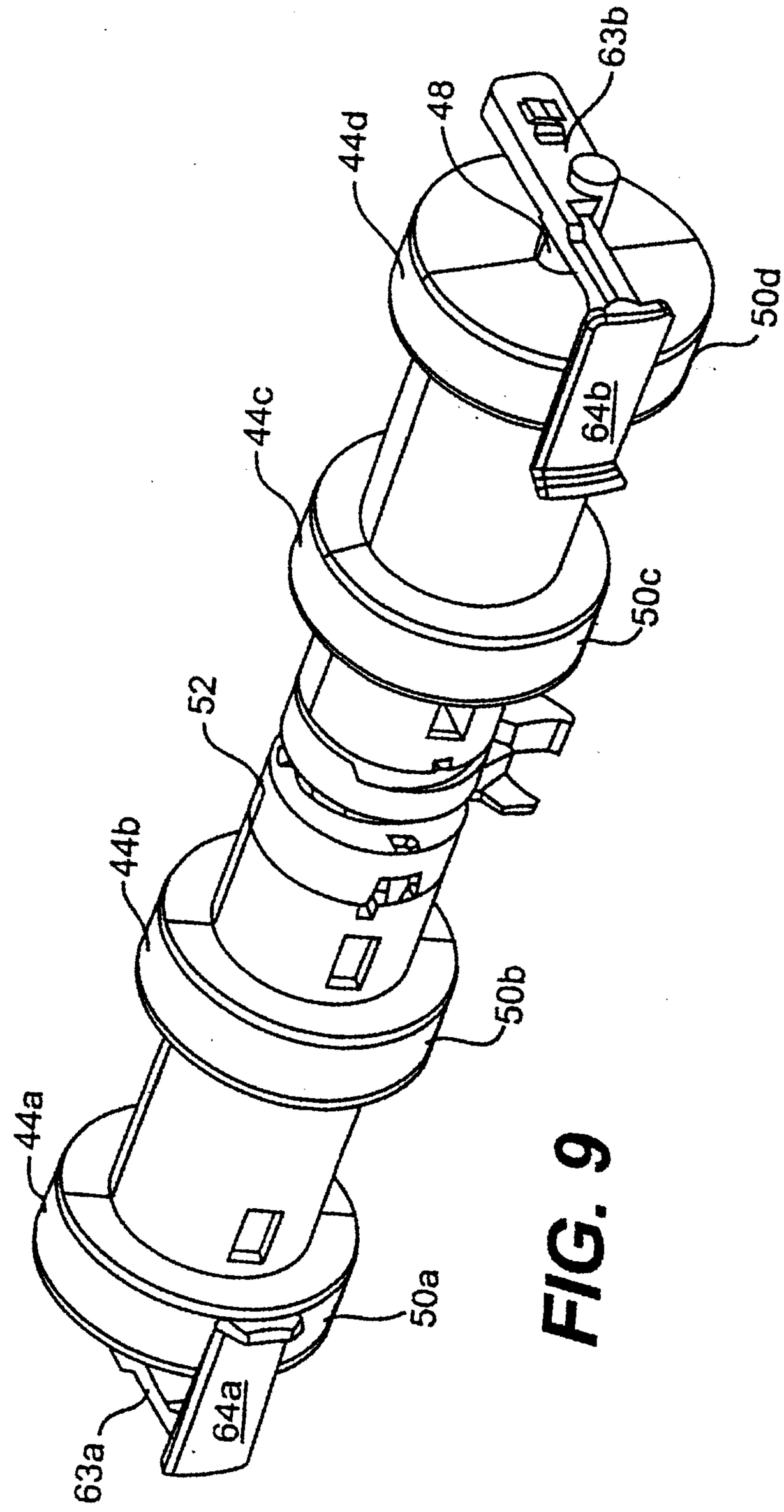

FIG. 9

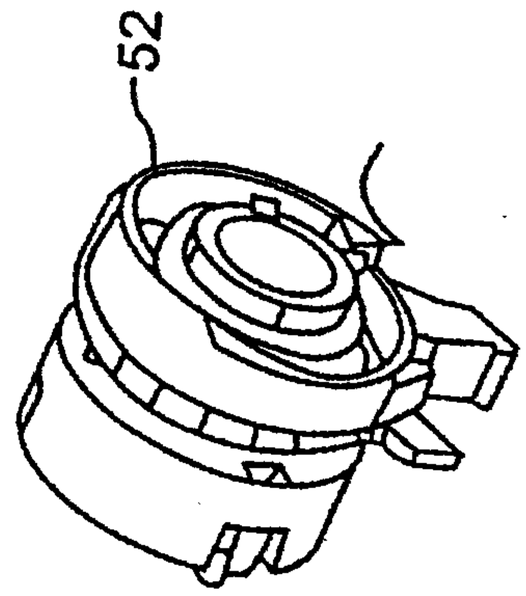

FIG. 10

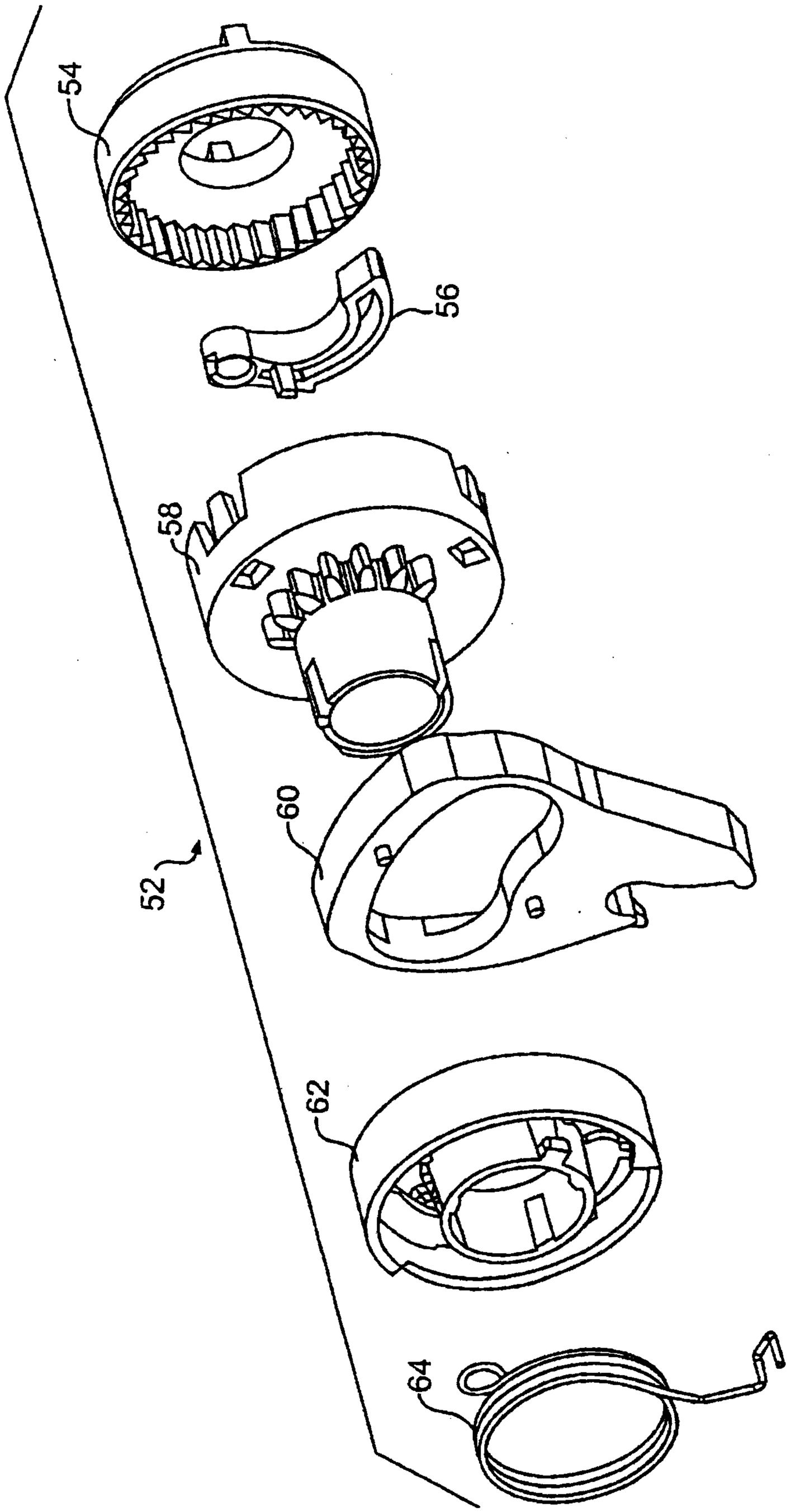

FIG. 11

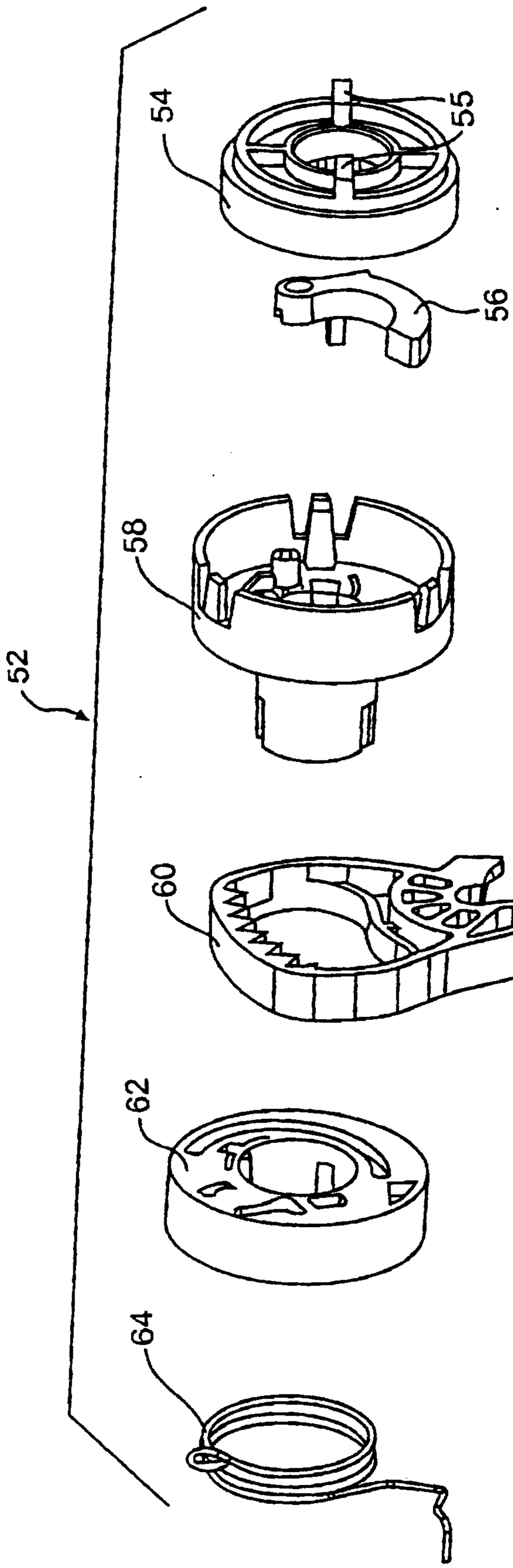

FIG. 12

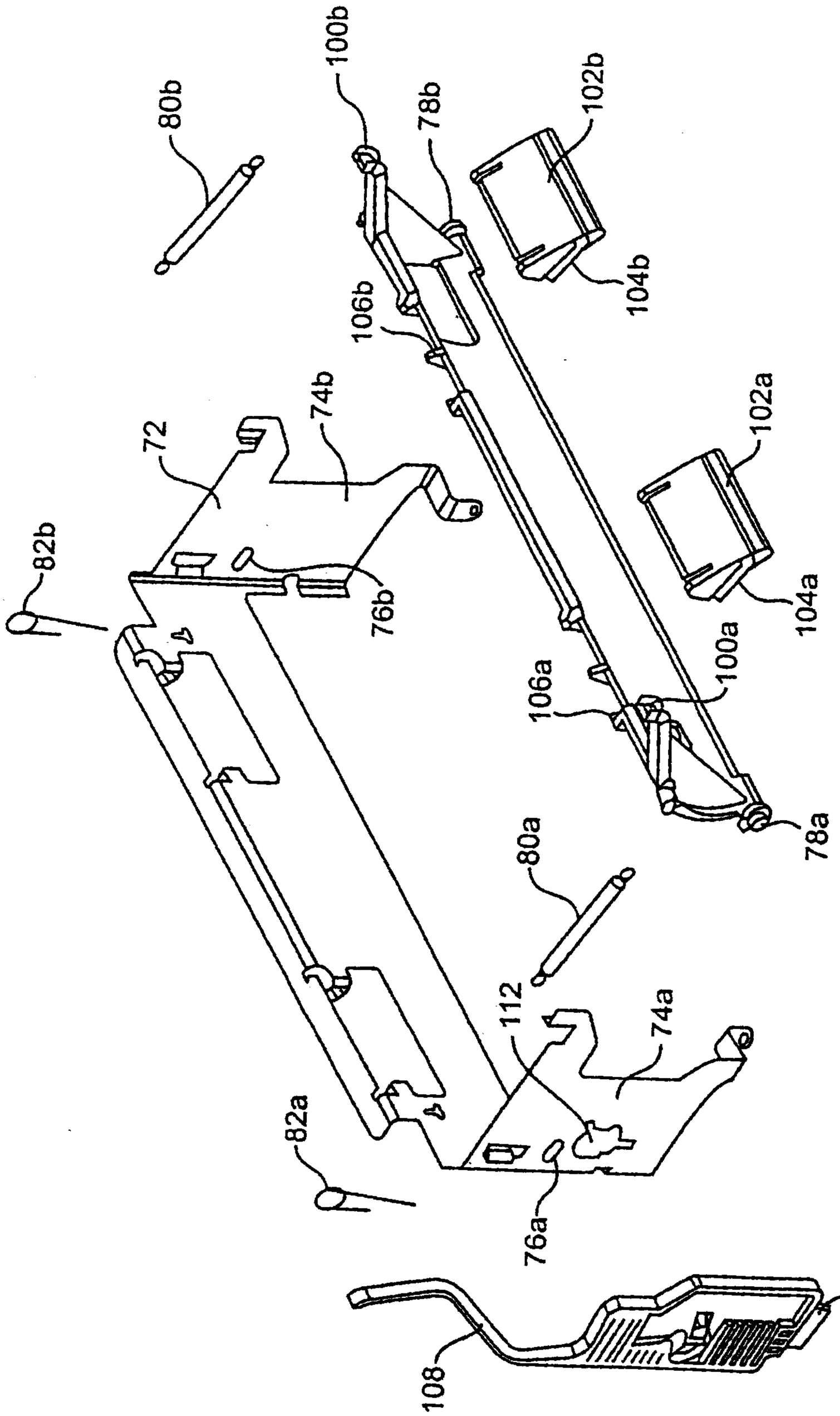
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FIG. 13

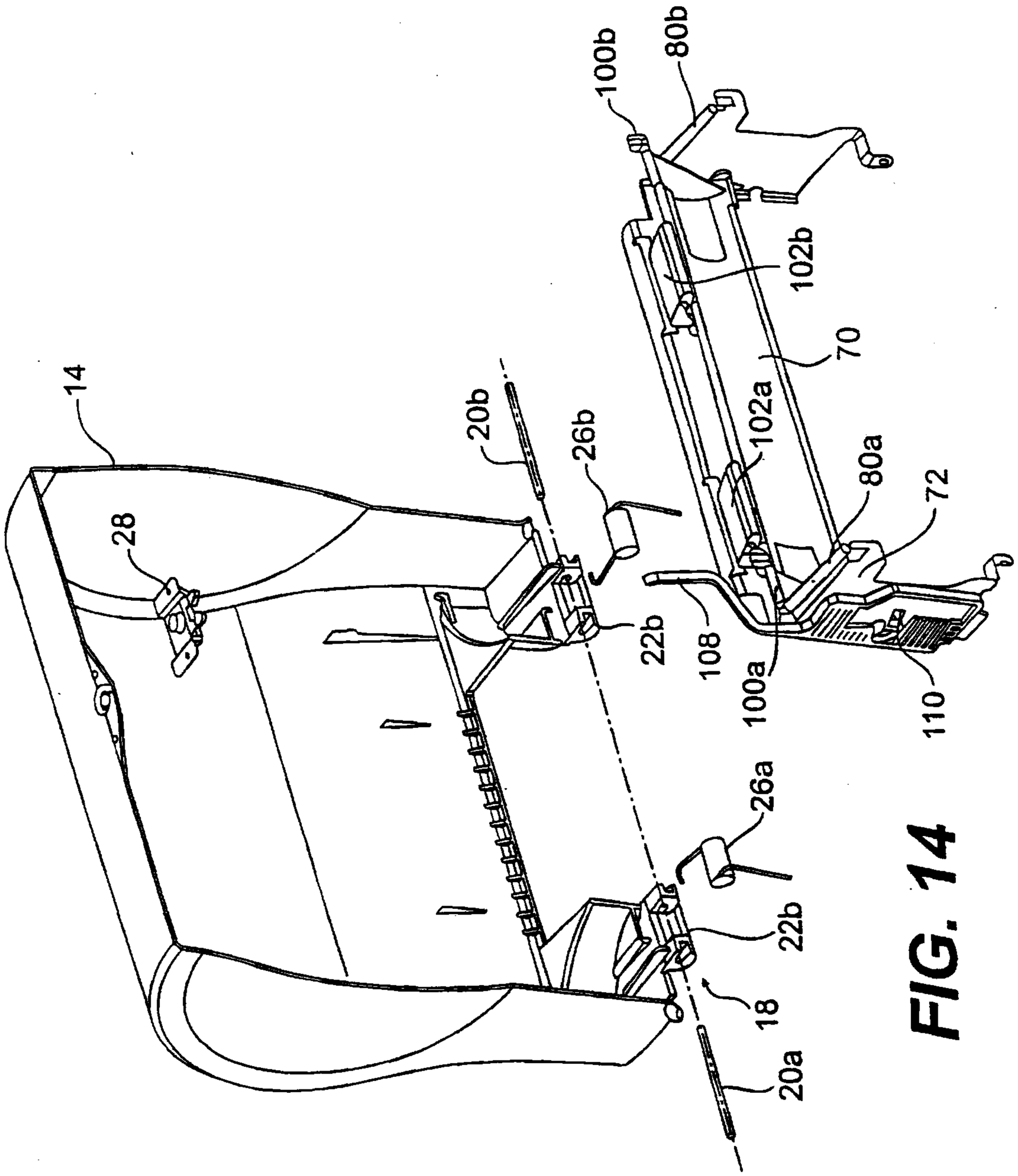
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FIG. 14

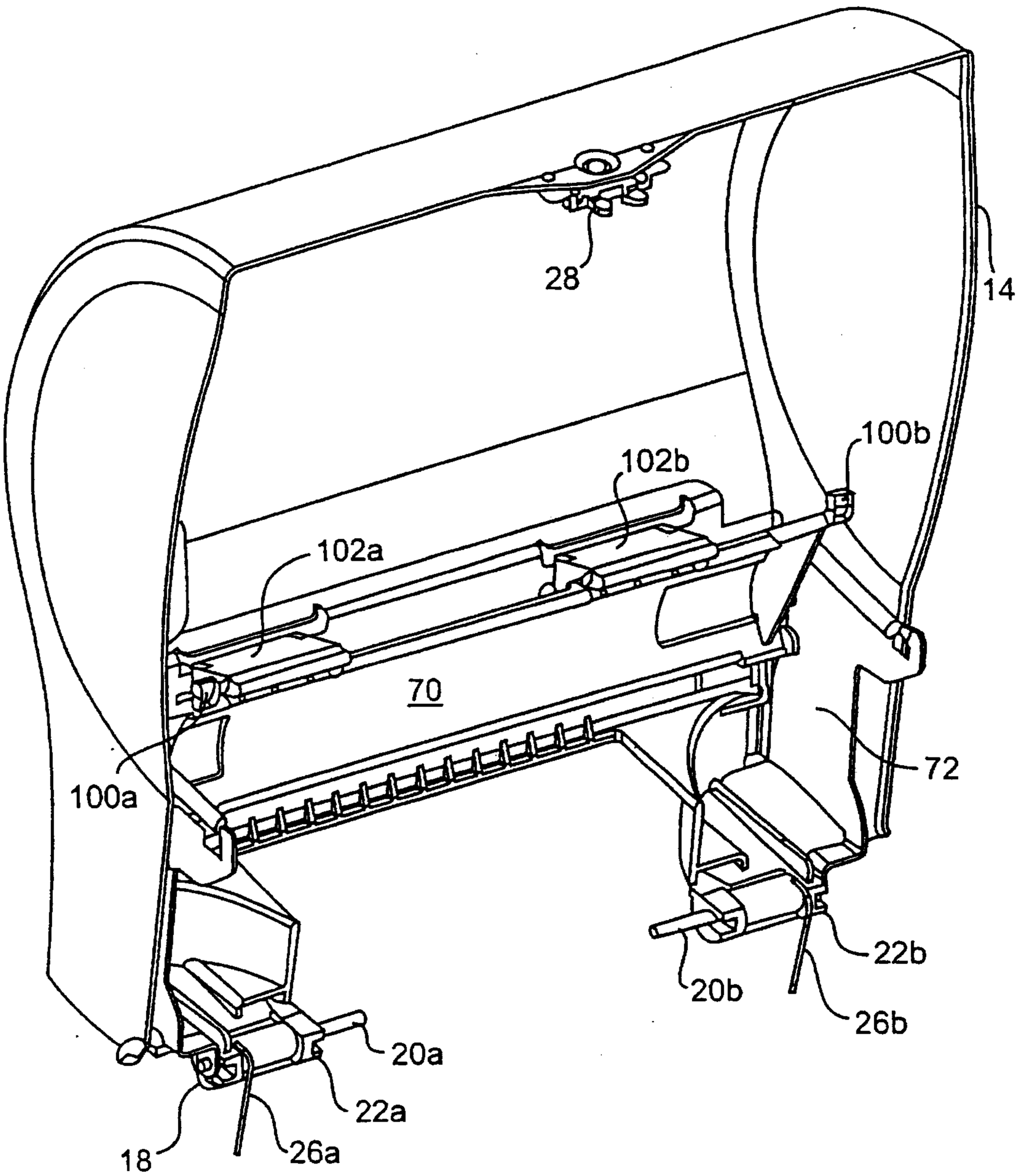

FIG. 15

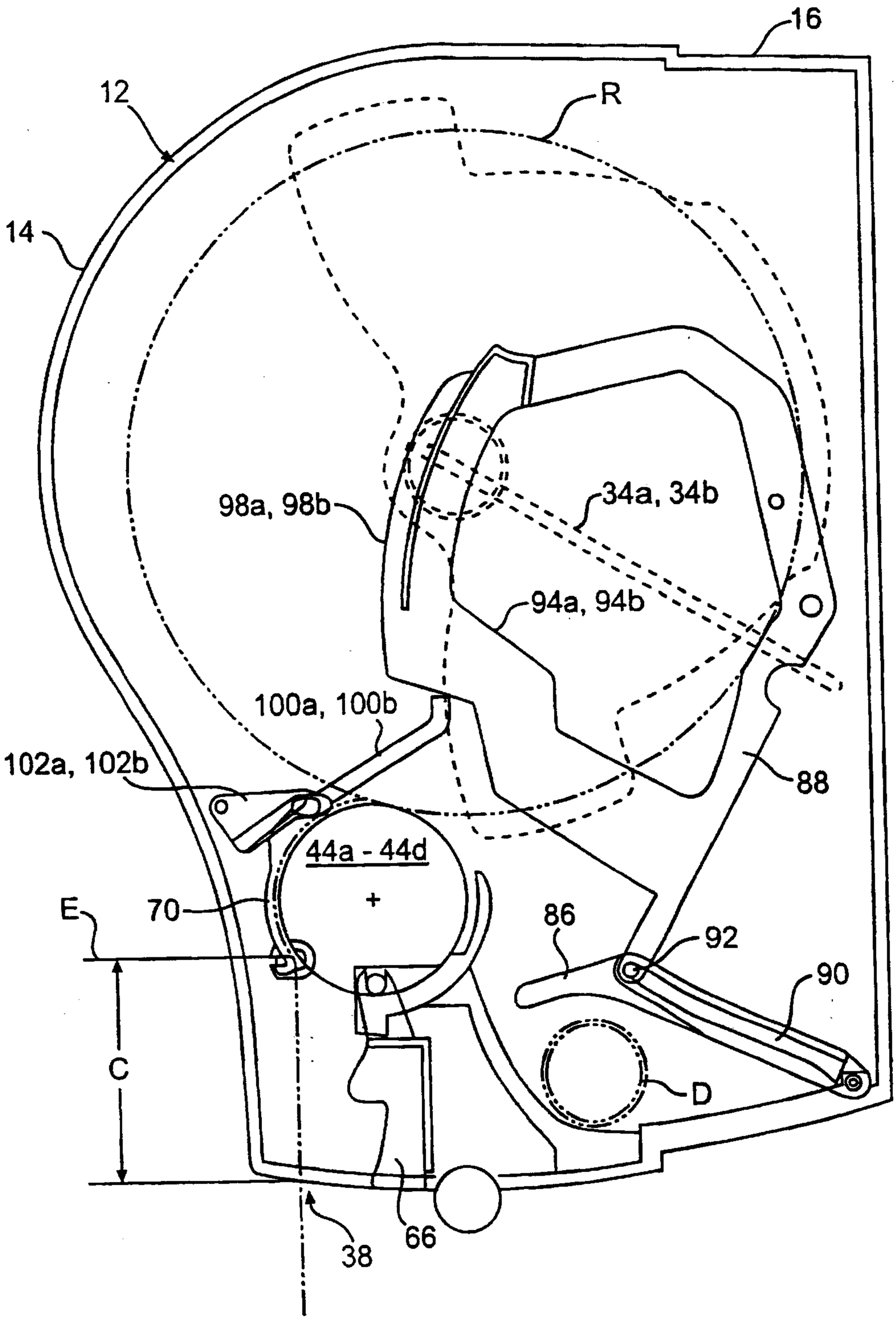
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FIG. 16

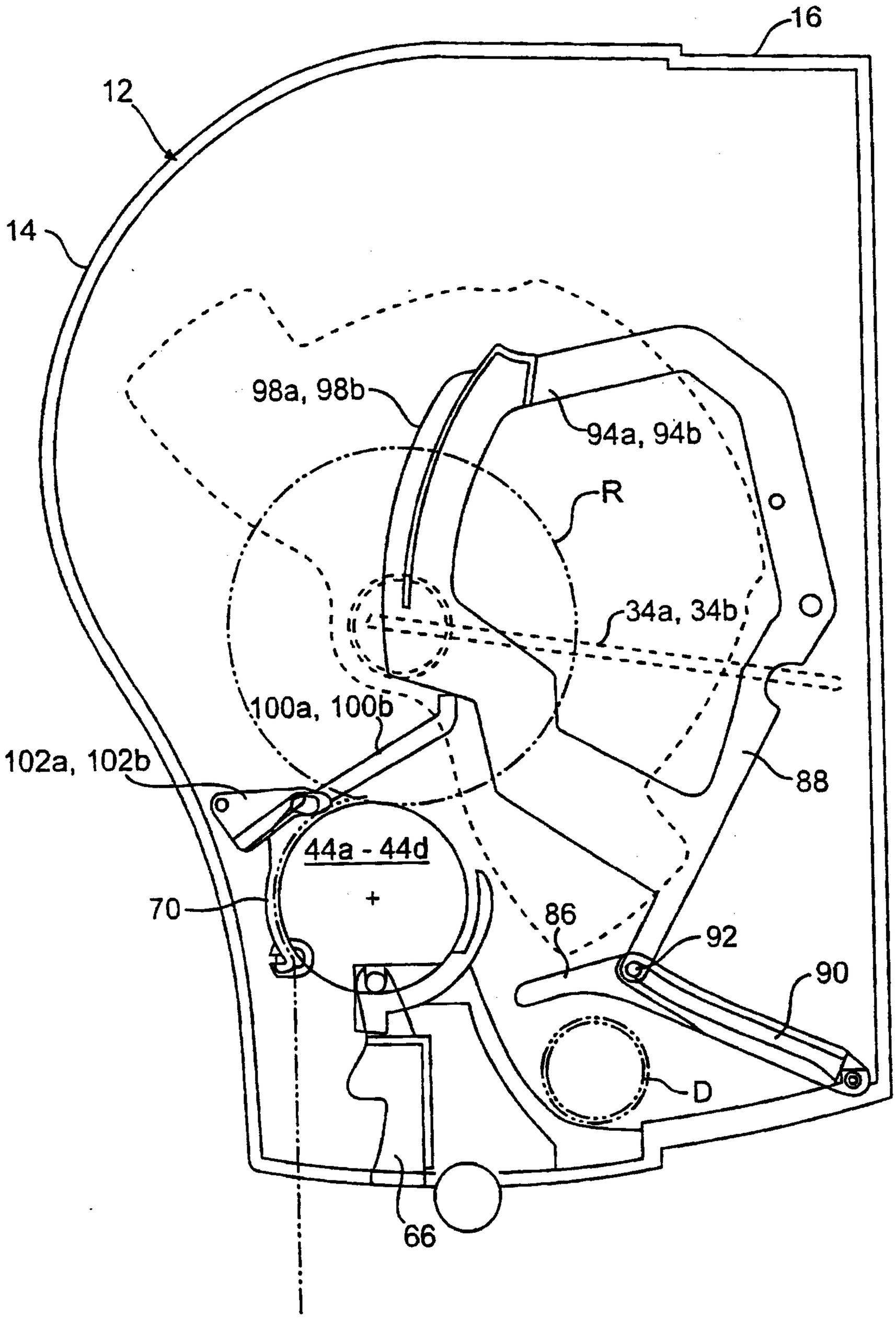
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FIG. 17

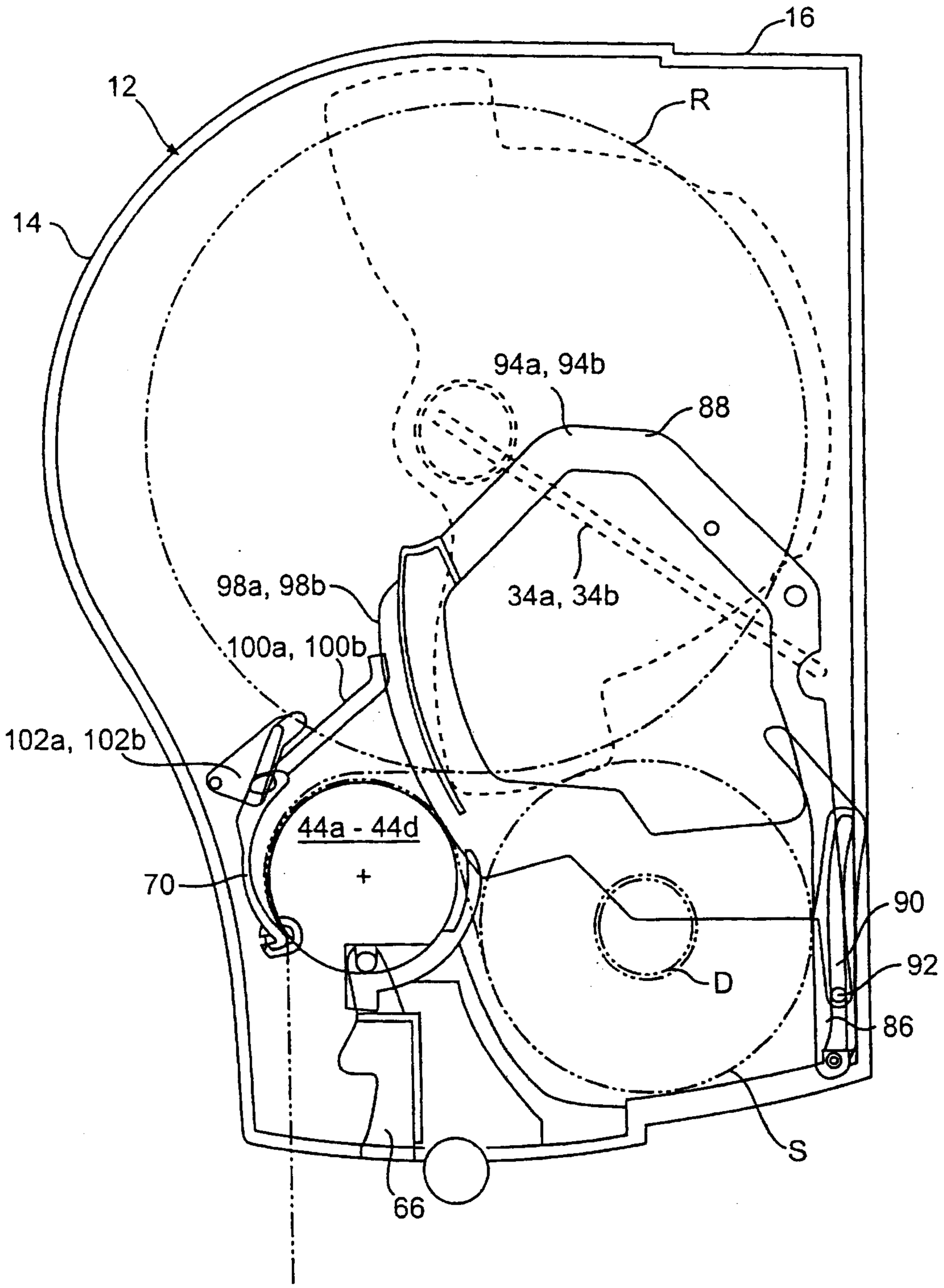
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FIG. 18

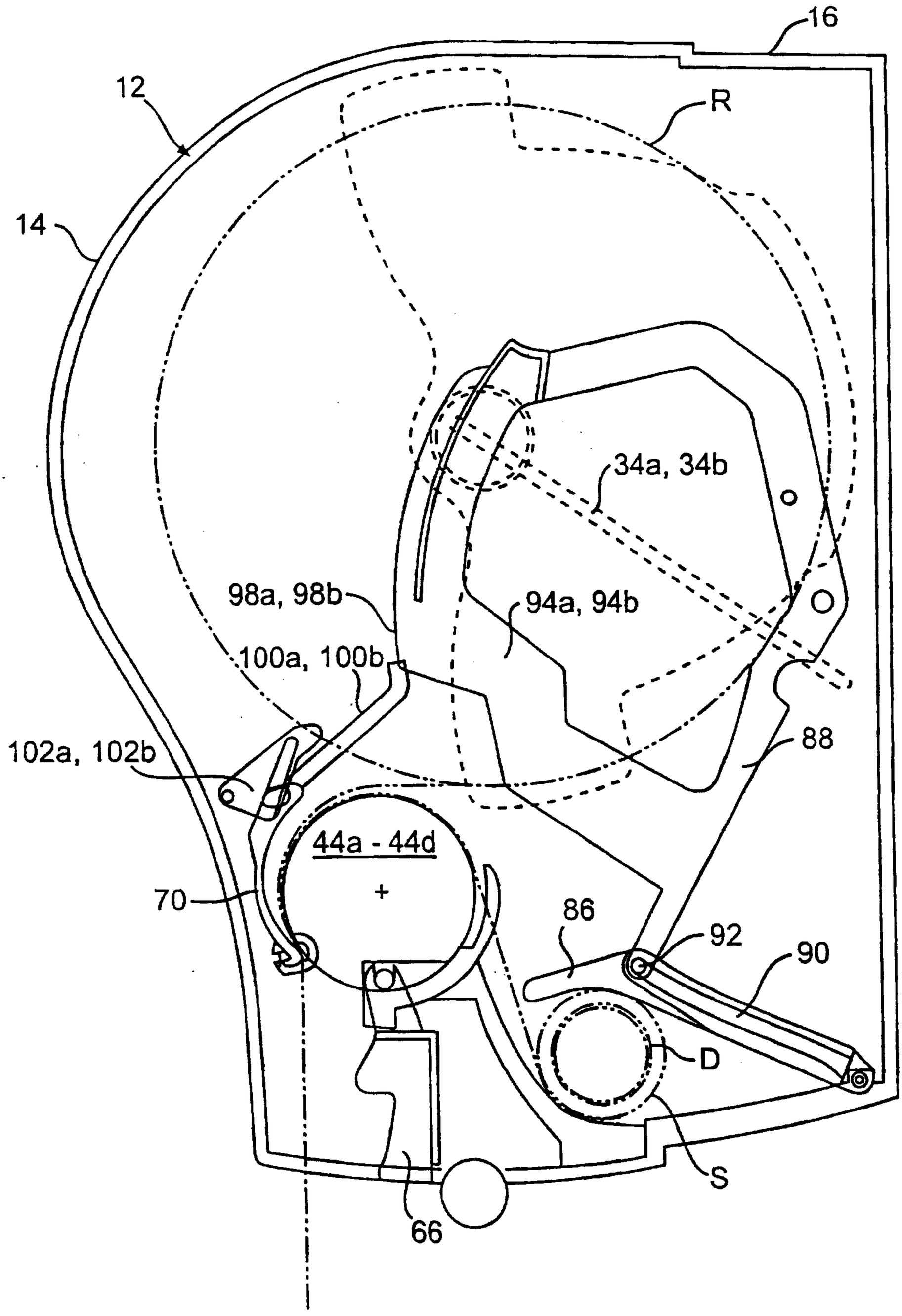
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FIG. 19

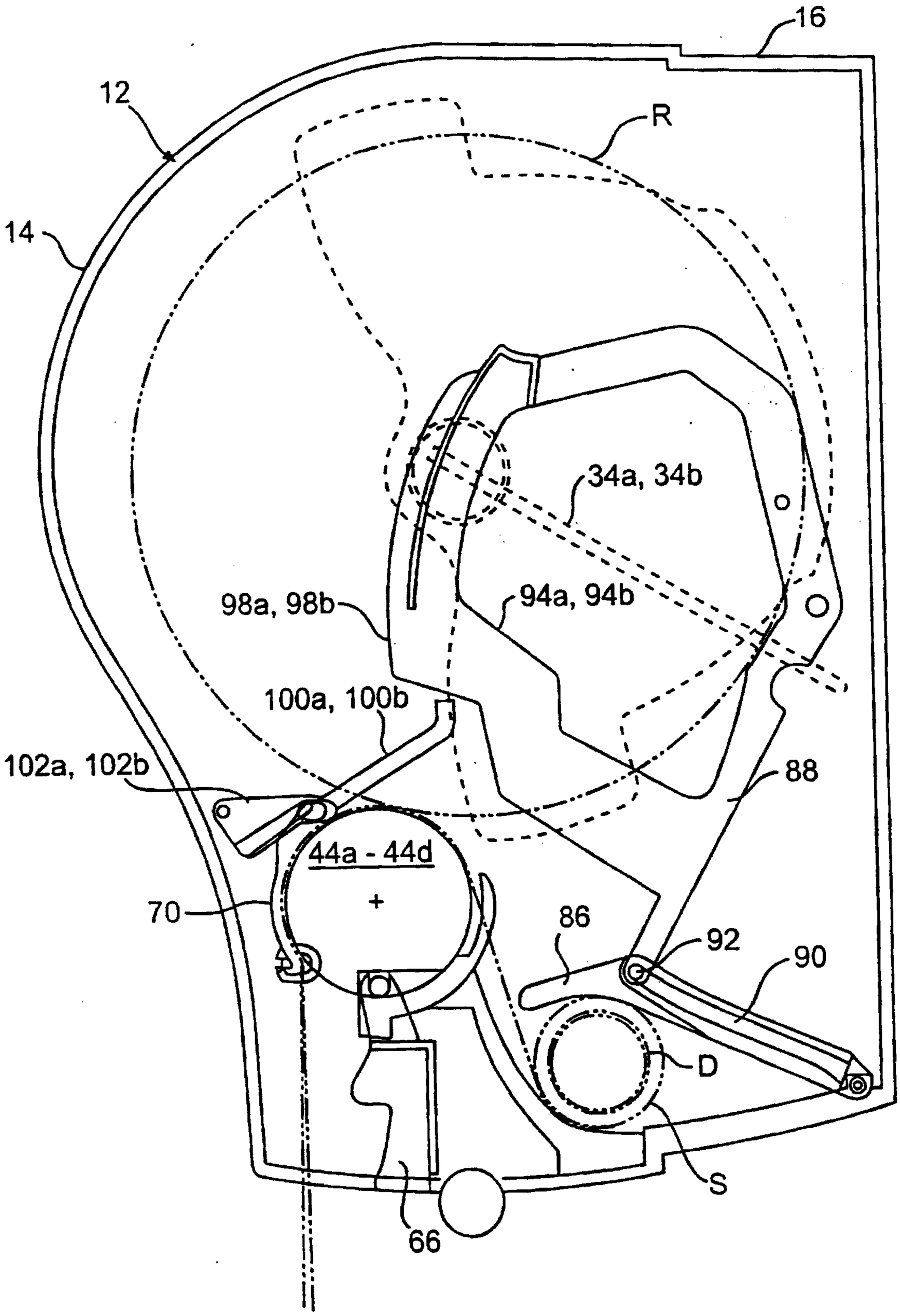
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FIG. 20

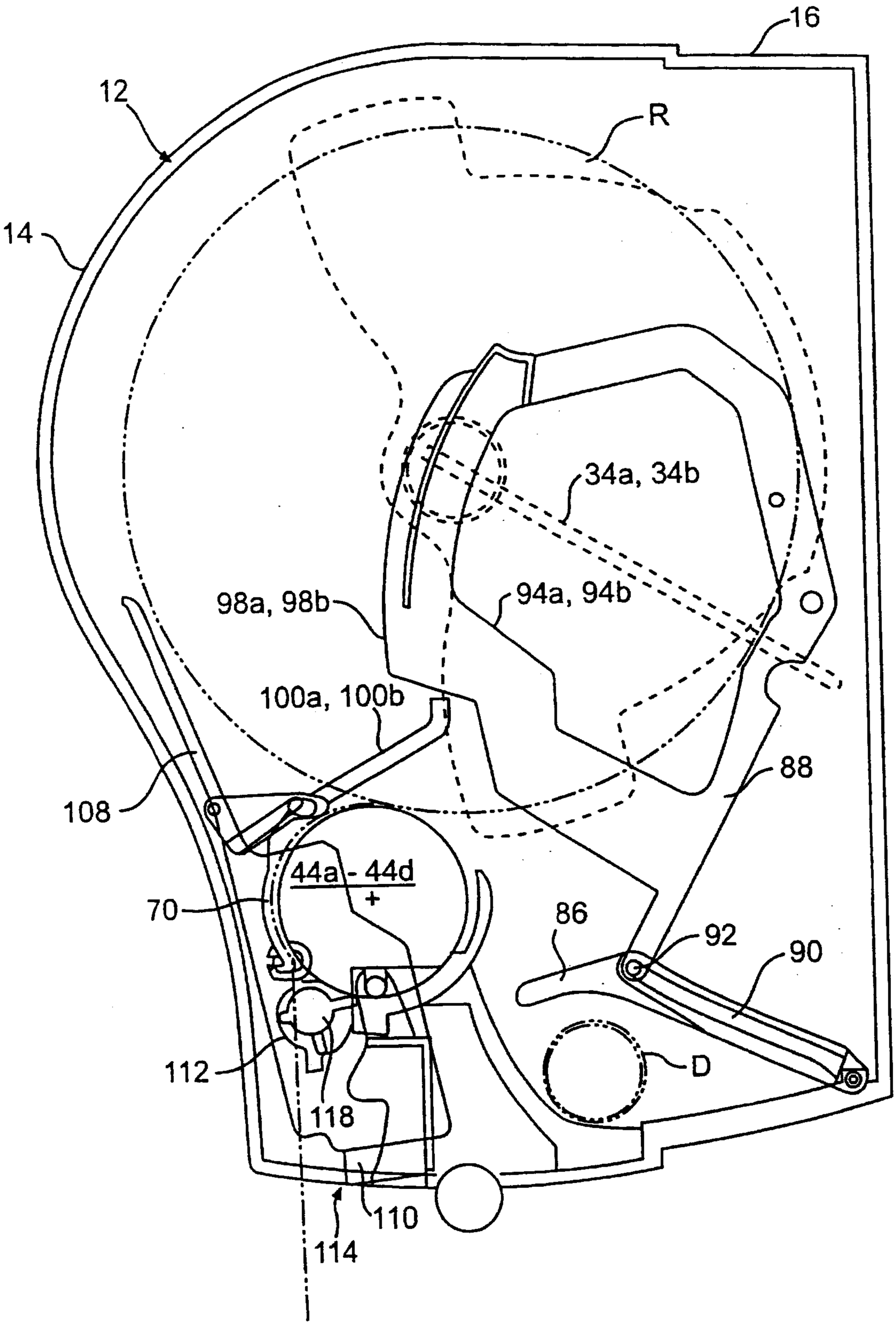
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FIG. 21

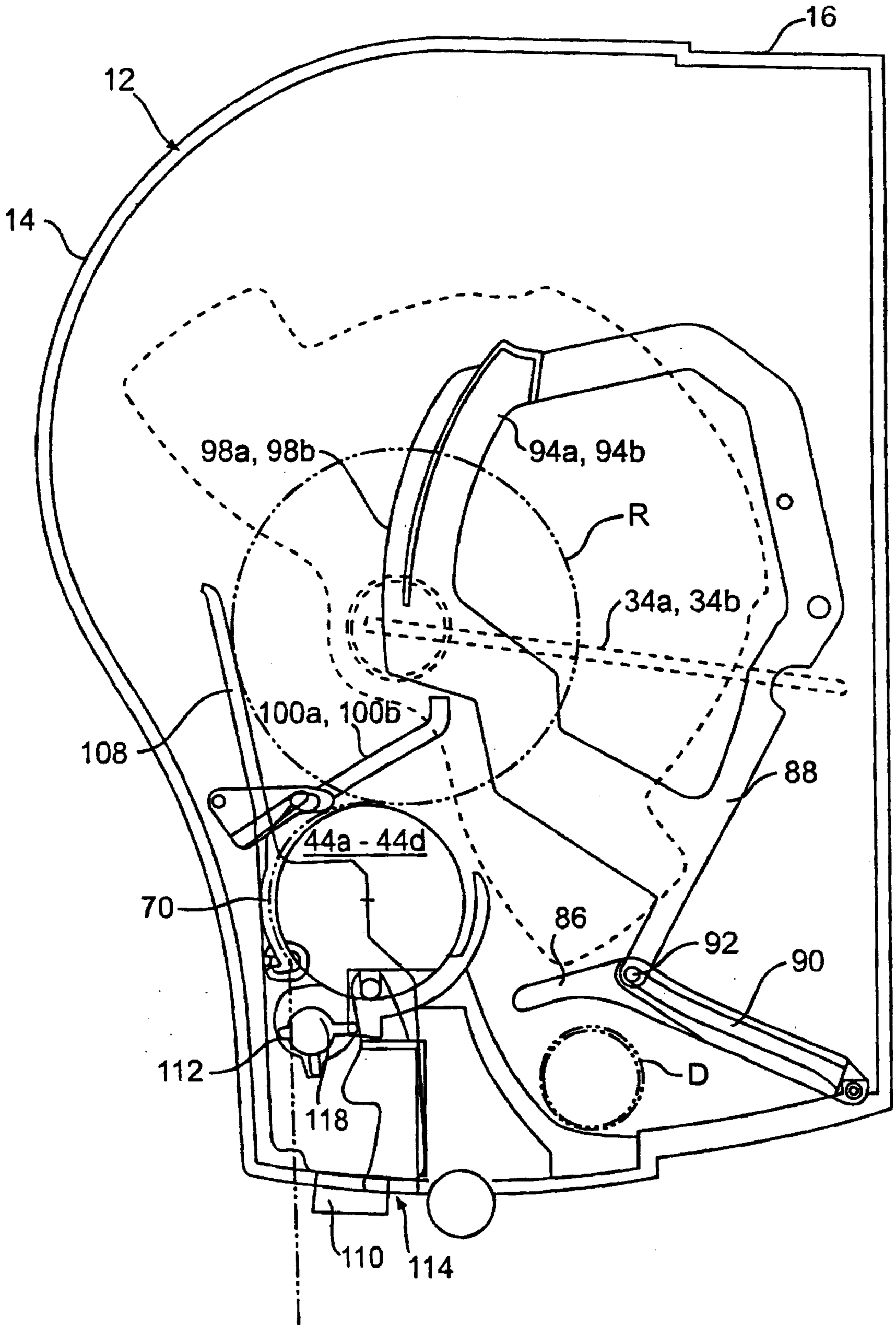
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FIG. 22

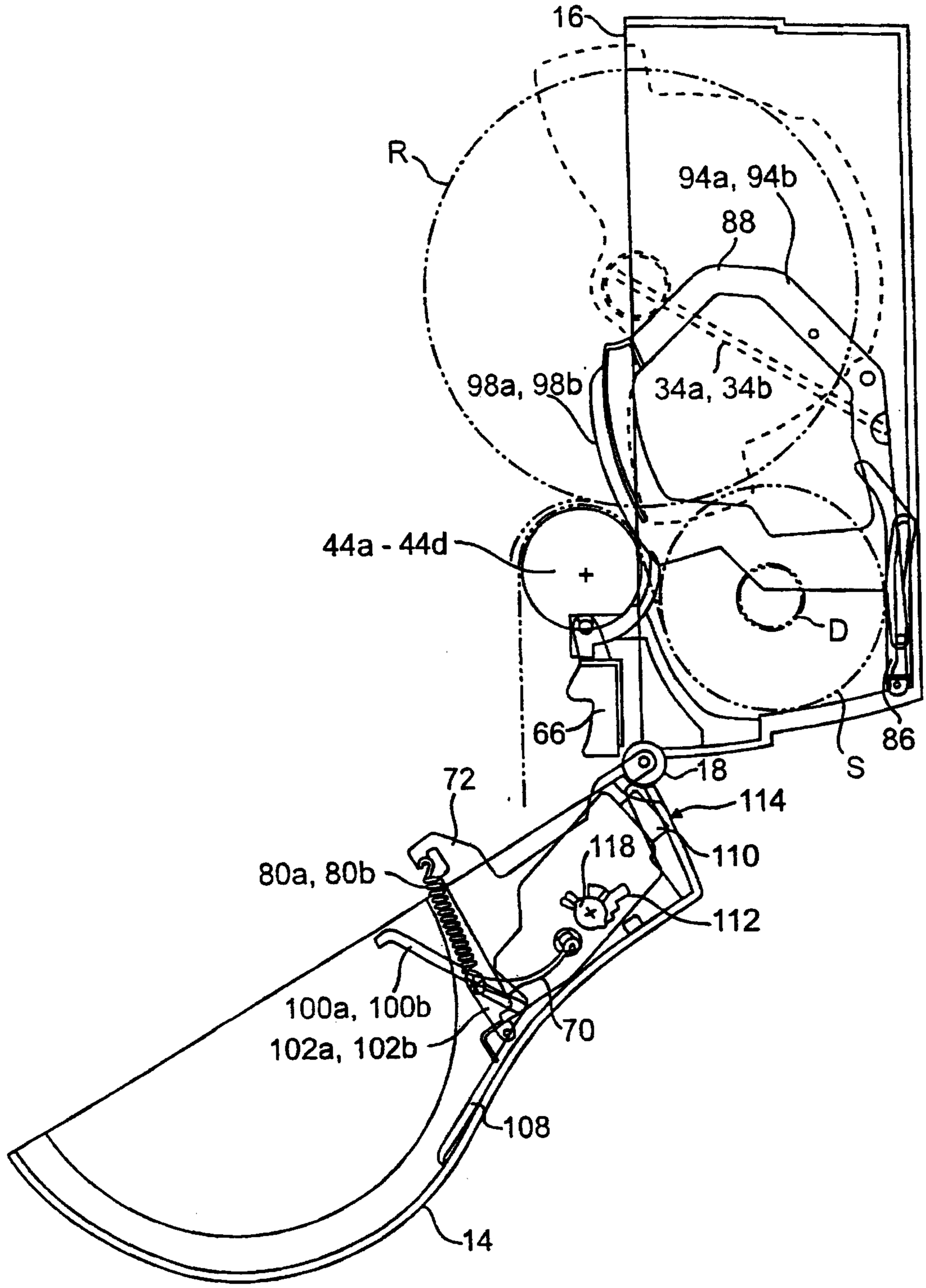
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FIG. 23

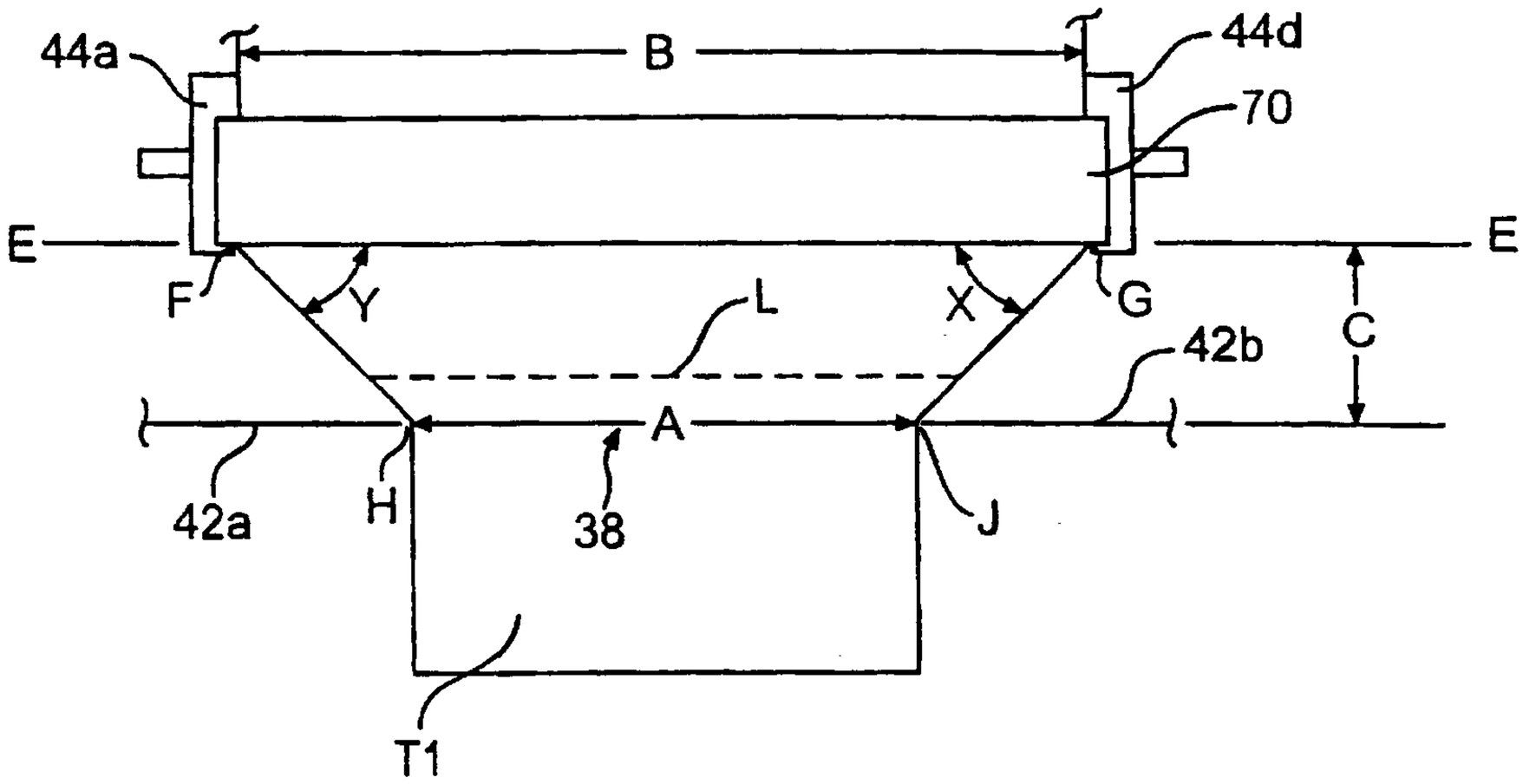


FIG. 24

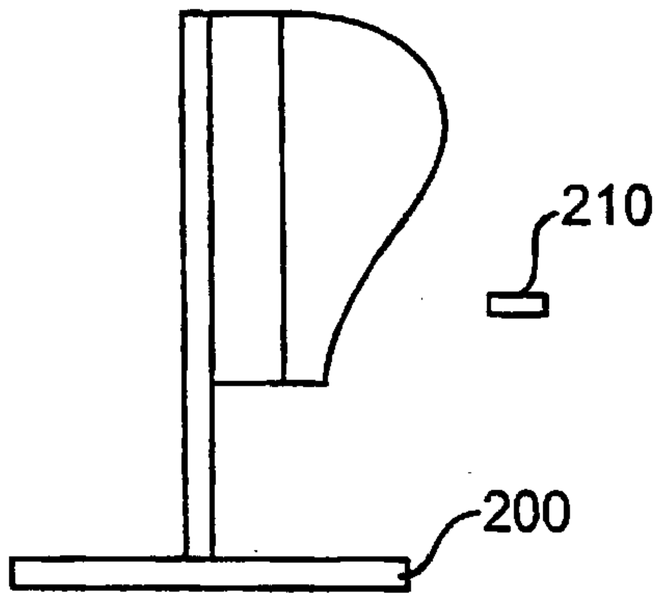


FIG. 25

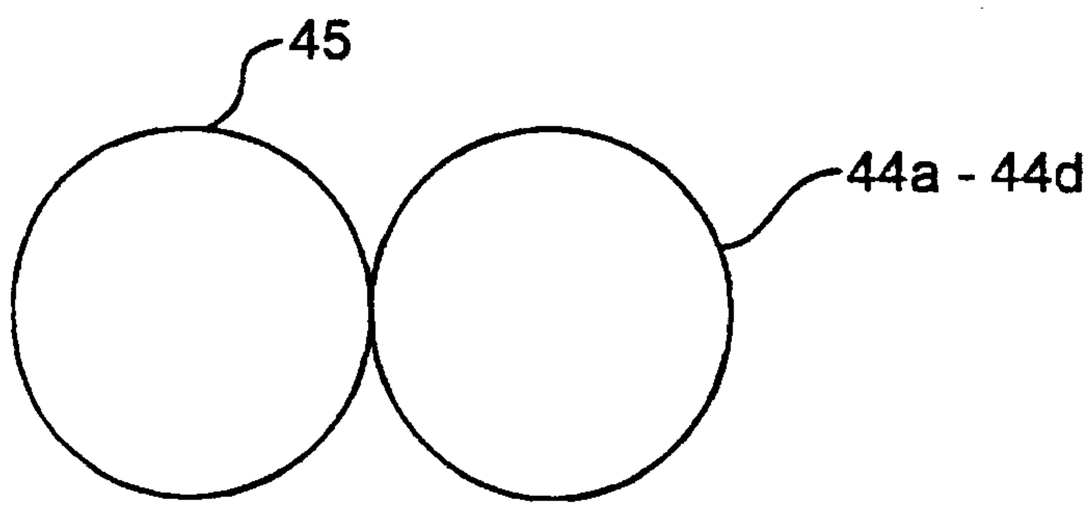
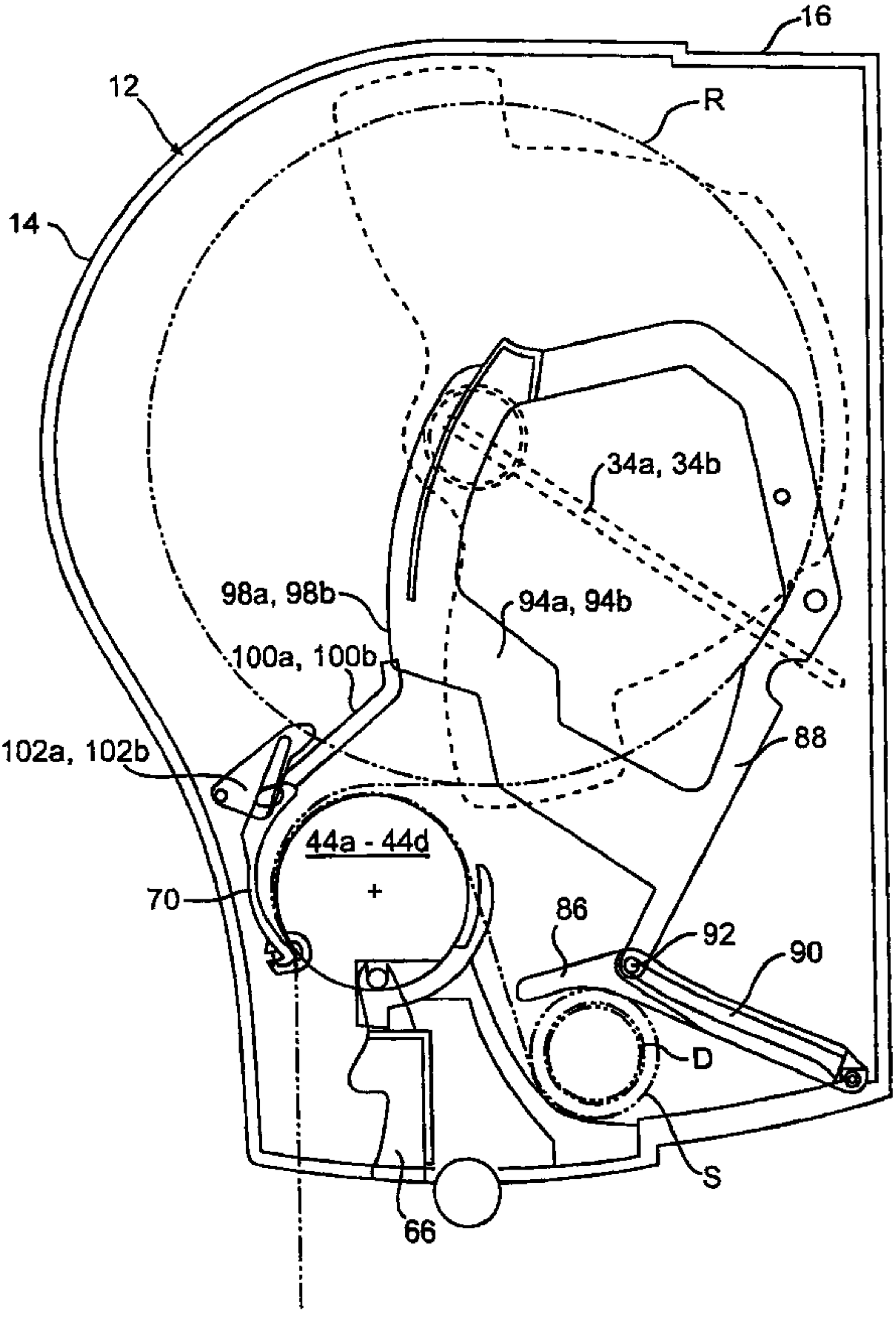


FIG. 26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