Nov. 12, 1968 J. McCARTHY 3,410,427

REFUSE PACKING SYSTEM

Filed Dec. 27, 1965 2 Sheets-Sheet 1

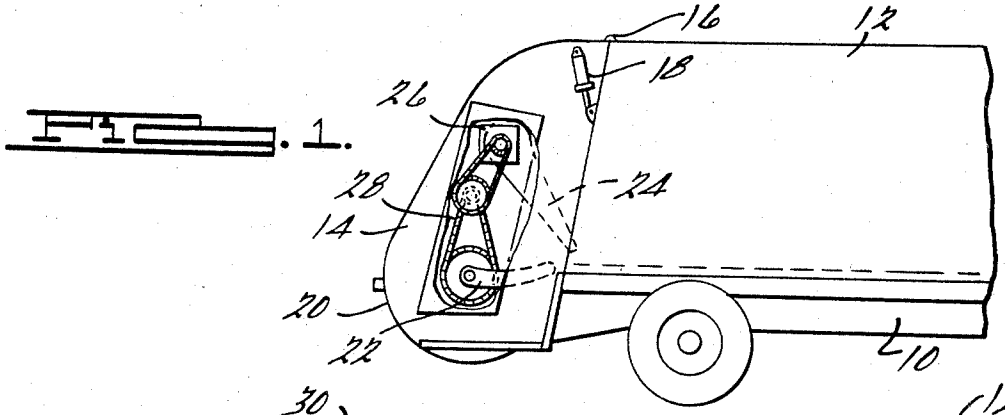


FIG. 1.

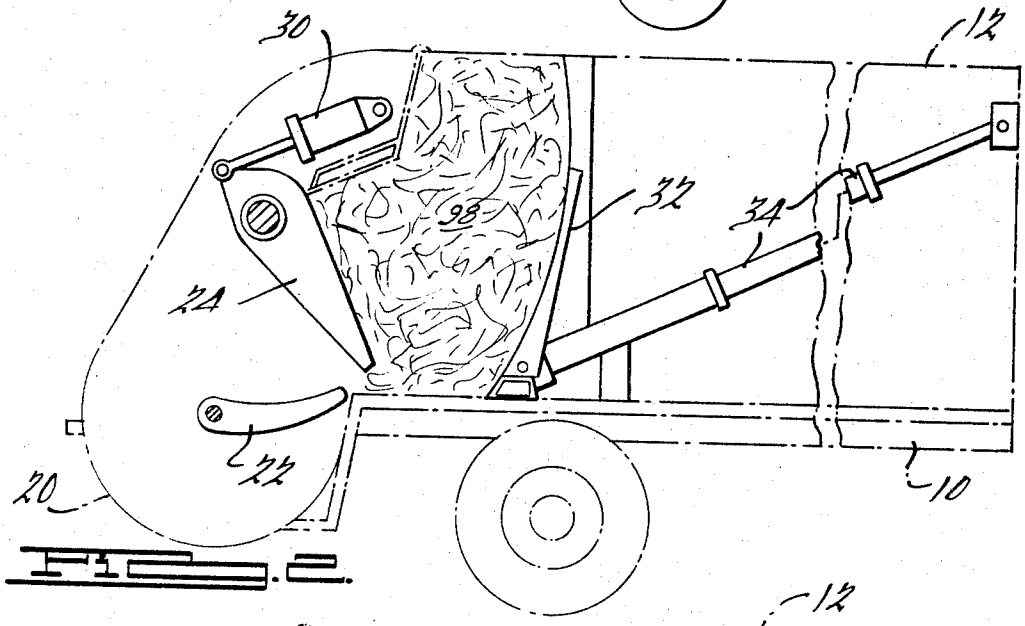


FIG. 2.

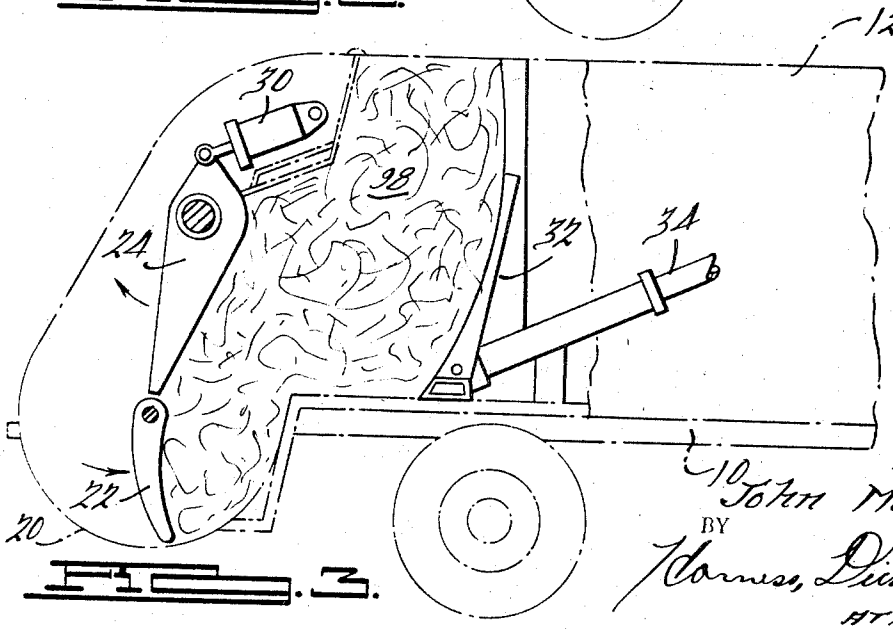


FIG. 3.

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REFUSE PACKING SYSTEM

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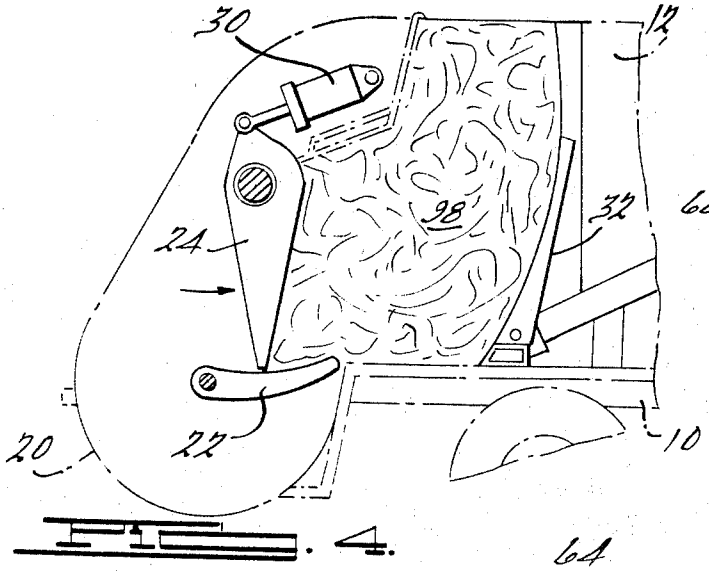


FIG. 4.

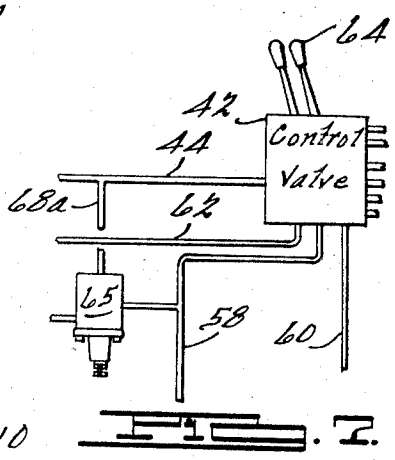


FIG. 7.

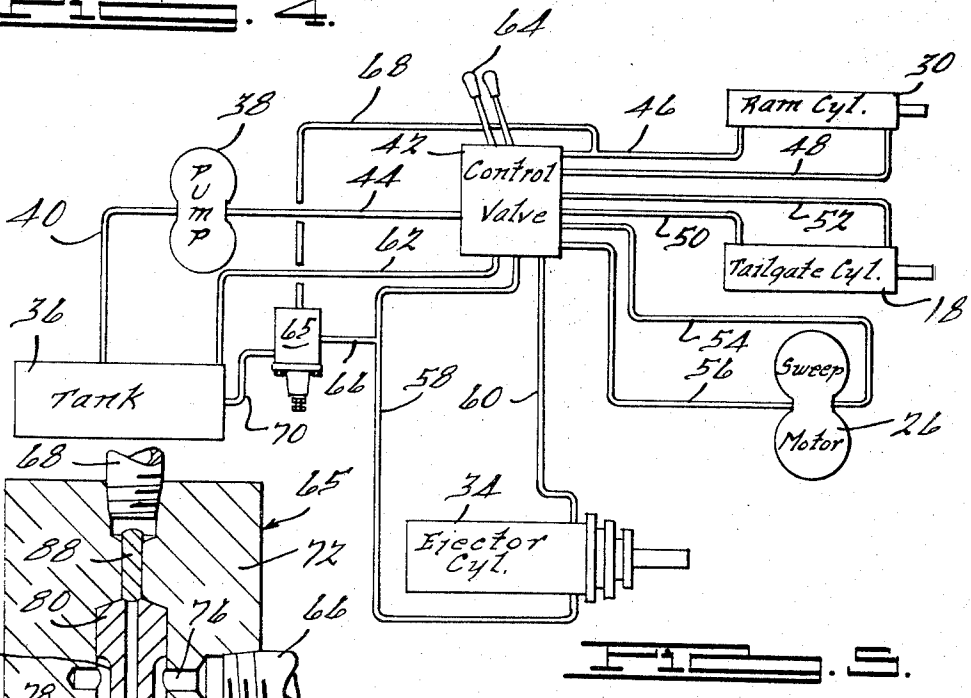


FIG. 5.

FIG. 6.

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3,410,427

REFUSE PACKING SYSTEM

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10 Claims. (Cl. 214—83.3)

ABSTRACT OF THE DISCLOSURE

A refuse packing and storage system in which successive batches of refuse are packed against a longitudinally movable panel within the refuse storage compartment.

The present invention relates generally to refuse packing and storage systems and more particularly to an apparatus including a refuse storage compartment having means located at one end thereof for loading the loose refuse and for then compacting it as it transfers it into the refuse storage compartment. The present system may be used in connection with either stationary or mobile equipment, but for purposes of present description will be described associated with a refuse carrying vehicle having loading and compacting means at its rearward end in the tail gate thereof.

Refuse vehicles having rear end or tail gate loading and compacting mechanisms are well known in the art, and the object of using such compacting mechanisms is to increase the density of the refuse carried by the vehicle so that a maximum quantity of input refuse material may be handled by the vehicle before it must be driven to a dump or other appropriate place and unloaded, often a rather lengthy and time-consuming trip. In stationary equipment the object is to increase storage capacity for a given size unit and thereby lengthen the duration between unloading operations.

Known compacting mechanisms have for the most part included one or more power operated swinging, sliding or reciprocating panels which push the refuse under force into the storage compartment of the unit. The present invention is shown embodied in a system having such a mechanism, specifically one including a pair of swinging panels, but is not so limited. Such a system is shown in U.S. Letters Patent No. 2,879,906.

Certain of the more recent refuse vehicles on the market have increased their compaction efficiency by providing a longitudinally moving panel in the storage compartment against which refuse is packed or compacted from the first load until the storage compartment is filled, and which also is used to eject the load in the vehicle when it is filled and ready for unloading. Such ejector panels, as they are often referred to, are positioned at the rear end of the storage compartment adjacent the compacting mechanism at the beginning of the packing cycle when the truck is empty. Refuse is loaded and compacted against this plate until some degree of fullness or density is reached, whereupon the ejector panel is moved forwardly a relatively small distance. either manually or automatically, to provide room for the loading and compaction of additional refuse. Consequently, each charge of material passing through the compacting mechanism is compacted either against the ejector panel or against earlier charges of the material which have been previously compacted against such panel. Systems of this type, if properly controlled, can give greater compaction density than those which do not pack against such an ejector panel, and it is this ejector panel type system to which the present invention is directed.

As can be appreciated, the manner in which the forward movement of the ejector panel is controlled is a primary factor in the performance of the unit in terms of degree of compaction. One way in which this has been done is to provide means for releasing the ejector panel, whereby it may then be forced forwardly by the expanding refuse and/or pushing force of the compaction mechanism, when a predetermined force is exerted on the rear face of the ejector panel. Such systems, whether they be mechanical or hydraulic, have several disadvantages. One such disadvantage arises from the fact that there is a substantial amount of friction between the refuse and the sides of the storage chamber as the refuse is pushed forwardly therein by the compacting mechanism. The resulting difficulty may be best understood from the following example: Assume that the compacting panel is adapted to exert a compacting force of X lbs. across the cross-sectional area of the storage compartment and that the ejector panel is adapted to be released upon the application against its rear face of 0.9X lbs. (It has to be less or it will never release.) For the first several charges compacted by the compaction panel against the ejector panel, full designed compaction will be obtained and the ejector panel will be released to move forwardly and increase the area of the storage compartment to the rear thereof because the force received on its rear face caused by the compaction panel and transmitted through the relatively small amount of refuse will be greater than 0.9X lbs. However, as the storage compartment becomes increasingly full the exertion of X lbs. of force against the refuse by the compaction panel in a given cycle results in the exertion upon the rear face of the ejector panel of a force which is substantially less than X or even 0.9X lbs. because a progressively increasing proportion of the force exerted by the compaction panel is absorbed or reacted against by frictional forces along the bottom, sides and top of the storage compartment. Consequently, as the storage compartment becomes fuller the amount of movement forwardly of the ejector panel becomes less per compaction cycle, until eventually the compacting panel is unable to cause any further forward movement of the ejector panel and no additional refuse may be loaded without stalling the compaction panel. In systems of this type, whether they be hydraulic or mechanical, this point is often reached before the ejector panel is moved all the way to the front end of the storage compartment, and consequently storage capacity is lost and the total amount of refuse which may be handled by the unit in one filling is reduced. This problem cannot really be avoided by setting the system so that it takes a much smaller force upon the rear face of the ejector panel to cause it to be released, because if this is done the degree of compaction from the very first load on is reduced proportionately and the overall capacity of the unit is then reduced not because the entire storage chamber is not used but because there is a lesser degree of compaction of the refuse material.

In such systems which are hydraulic and utilize telescopic cylinders for control of the ejector panel this problem is compounded because of the differential areas of the respective cylinders. For example, consider a system which is designed so that the ejector panel cylinder is permitted to dump to tank when the pressure therein created by forces on the rearward face on the panel reaches a predeterminded value. When the first loads are compactetd in the unit the ejector panel is at the rear of the storage compartment and the telescopic cylinders fully extended, and the force on the rear face of the ejector panel necessary to cause this predetermined pressure in the ejector cylinder for release will be this predetermined pressure multiplied by the cross-sectional area of the rearmost and smallest cylinder of the telescopic cylinder assembly. As the storage compartment fills

the larger cross-sectional area cylinders of the telescopic cylinder assembly come into use, and again the force necessary to cause the ejector panel to release will be the predetermined pressure in the ejector cylinders multiplied by the cross-sectional area of that stage thereof being actuated at that time. However, since this stage is necessarily larger in cross-sectional area than the previous one, the force necessary to cause the panel to release is also larger. Consequently, the fuller the storage compartment the greater must be the force applied to the rear face of the ejector panel to cause it to release. In designing such a system it is therefore not possible to provide for the application of maximum compaction forces for the early stages of compaction, since as the compartment becomes filled there would be insufficient force available to even move the later larger diameter stages of the telescopic ejector cylinder. As a result, smaller initial compaction forces must be settled for, with the attendant loss of compaction efficiency. It can thus be seen that the aforementioned disadvantages of a system responsive to forces on the rear face of the ejector panel, are greatly amplified when a telescopic cylinder is used for the ejector cylinder.

The problems created by the aforementioned disadvantages are substantially further amplified as the size of the storage compartment is increased in volume and length. This is because larger and longer storage chambers require telescopic cylinder assemblies having a greater number of stages, and because the increased inside surface area of such chambers increases the friction forces resisting movement of the refuse forwardly in the chamber. Since the current trend is towards larger and longer storage units, these problems present design restrictions which are of increasing significance.

Systems which are manual in nature, wherein forward movement of the ejector panel is caused by the manipulation of manual controls, suffer the disadvantage that the efficiency of the system depends upon the ability of the operator to accurately gauge when the ejector panel should be moved forwardly, as well as the amount of movement when so moved, and generally speaking operators of equipment of this nature are relatively unskilled. Systems which provide for a releasing of the ejector panel at the completion of each compaction cycle, or at some other time period, suffer the disadvantage that during the period of time from the completion of one compaction cycle to the initiation of the next compaction cycle the natural expansion of the previously compressed refuse may cause the ejector panel to move forwardly a greater distance than is desired for an optimum degree of compaction, and consequently overall compaction efficiency is reduced.

It is therefore a primary object of the present invention to provide a system of the general type discussed above which is relatively simple in construction and which avoids the aforementioned disadvantages of other known systems, whereby maximum loading of a given storage compartment, both in terms of extent of filling and degree of compaction, may be obtained. It is a related object to provide such a system utilizing a hydraulically driven packing panel and an ejector panel actuated by a hydraulic telescopic cylinder assembly.

These and other objects of the present invention will become apparent from consideration of the specification taken in conjunction with the accompanying drawings in which there are illustrated two embodiments of the present invention, and wherein:

FIGURE 1 is a side elevational view, partially broken away, showing the major portion of a refuse vehicle in which the present invention may be embodied;

FIGURES 2, 3, and 4 are similar to FIGURE 1 but with substantial parts broken away to show an operating cycle of the loading and compacting system of the vehicle;

FIGURE 5 is a diagrammatic view showing a hydraulic control circuit for the system of FIGURES 1–4, embodying the principles of the present invention;

FIGURE 6 is an enlarged sectional view of one of the valves forming a part of the circuit shown in FIGURE 5; and

FIGURE 7 is a diagrammatic view of a portion of the circuit shown in FIGURE 5, illustrating a modification thereof.

The present invention may be embodied in many different types of refuse compacting systems, including both stationary and mobile systems, and those having single as well as double panels in the loading and compacting mechanism; however, for purposes of present illustration it is shown herein embodied in a refuse vehicle of the general type shown in U.S. Letters Patent No. 2,879,906. As can be seen, the unit comprises a conventional truck chassis **10** to which is secured a storage compartment **12** having at the rearward open end thereof a tail gate assembly **14** pivotally secured to the storage compartment, as by hinges **16**, to enable it to be swung upwardly by a tail gate piston and cylinder assembly **18**, secured at one end to the storage compartment and at the other end to the tail gate, when it is desired to unload the refuse compartment. Tail gate assembly **14** includes a lower cylindrical portion **20** defining a trough into which refuse may be loaded, a rotating sweep panel **22** for sweeping the refuse out of trough **20** and bringing it to an elevation substantially in line with the bottom of the storage compartment, and a pivotally mounted ram panel **24** for moving the loaded refuse from the top of the sweep panel and compacting it into storage compartment **12**. Sweep panel **22** may be powered by a rotary hydraulic motor **26** through a conventional sprocket and chain drive mechanism **28**, and ram panel **24** may be powered by a hydraulic double acting piston and cylinder assembly **30** secured at one end to the tail gate assembly and at the opposite end to ram panel **24**. Both sweep panel **22** and ram panel **24** extend substantially the full width of the storage compartment and tail gate assembly, and the latter extends substantially the full width of the storage compartment.

Inside the storage compartment there is provided an ejector panel **32** which has a cross-sectional area substantially the same as that of the storage compartment and which is adapted to move forwardly and rearwardly longitudinally of the vehicle. Ejector panel **32** may be powered by a conventional double acting telescopic piston and cylinder assembly **34** secured at one end to the base of the ejector panel and at its opposite end to the forward wall of the storage compartment.

In FIGURE 5 there is illustrated a representative hydraulic circuit for a refuse system such as shown in the preceding figures. It includes a tank or reservoir **36** for the hydraulic fluid, and a pump **38** the inlet of which is connected to tank **36** by a fluid supply line **40**. The pump may be driven in the usual fashion by the vehicle engine. In a stationary system it could be electrically driven. The outlet of pump **38** is connected to a main control valve **42** by means of a fluid supply line **44**. Control valve **42** is connected to ram cylinder **30** by means of a fluid supply line **46** (for packing stroke) and a fluid return line **48**, to tail gate cylinder **18** by means of a fluid supply line **50** and a fluid return line **52**, to hydraulic sweep motor **26** by means of a fluid supply line **54** and a fluid supply line **56**, and to telescopic ejector cylinder assembly **34** by means of a fluid supply line **58** (for ejection stroke) and a fluid return line **60**. Control valve **42** is connected directly to tank **36** by means of a fluid return line **62**. Control valve **42**, which in the usual system comprises a plurality of valves, is provided with the usual actuating handles **64** for powering the ram cylinder, tail gate cylinder, sweep motor and telescopic ejector cylinder assembly, respectively, in the conventional manner. All of the circuit described up to this point is believed to be typical of known circuits and may be varied numerous ways by

those skilled in the art to achieve the particular function desired since it is not per se a part of the present invention but only one representative circuit to which this invention is applicable.

The primary distinguishing feature of the subject circuit is the provision of a pilot operated dumping valve **65**. This valve, which will be described in greater detail below, is connected by means of fluid line **66** to ejector cylinder supply line **58**, by means of fluid line **68** to ram cylinder supply line **46**, and by means of fluid line **70** to tank **36**. This valve operates to permit the dumping to tank of fluid from the ejection stroke side of the ejector cylinder in response to and upon the reaching of a predetermined pressure in the power or packing stroke side of the ram cylinder.

As can be seen in FIGURE 6, pilot operated dumping valve **64** comprises a body **72** having a valve bore **74** therein. Fluid line **66** communicates with valve bore **74** by means of a passageway **76**, and fluid line **70** by means of a passageway **78**. Disposed within the bore **74** is a valve spool **80** adapted to slide longitudinally therein from a first position in which communication between lines **66** and **70** is blocked (the position shown in FIGURE 6) and a second position wherein line **66** is placed in communication with line **70** by means of a groove **81** in spool **80**. Secured to one end of housing **72** is a cover structure **82** having a bore **84** therein in alignment with bore **74**. Movement of valve spool **80** is caused on the one hand by means of a compression return spring **86** disposed within bore **84** and pushing against one end of spool **80**, and on the other hand by means of a small piston **88** actuated by the pressure in fluid line **68** and engaging the opposite end of spool **80**. Thus, as can be seen, the valve spool is normally maintained in the position shown in FIGURE 6 wherein communication between lines **66** and **70** is blocked. However, upon the application of a predetermined amount of pressure to line **68**, the force exerted on the spool in the downward direction, as shown in FIGURE 6, by small piston **88** will overcome the counteracting force exerted by return spring **86** and the valve spool will move downwardly to place fluid line **66** in communication with fluid line **70**. Return spring **86** is preferably a low rate spring so that the valve will not operate as a metering valve in which the flow into fluid line **70** is to some extent proportional to the pressure in line **68**. On the contrary, if it is desired that the valve operate as an on-off valve which ideally is fully off when the pressure in fluid line **68** is below a predetermined value and which is fully on when such pressure is at or above this predetermined value. The actual pressure at which the spool will shift may be varied somewhat by means of an adjusting screw **90** which engages a stop member **92** supporting the lower end of return spring **86**. Passageways **94** and **96** are provided in the spool and housing respectively to provide an escape for the normally encountered leakage.

The operation of the system is as follows: In FIGURE 2 the storage compartment is shown partially filled and the system in an at rest condition in which ram panel **24** is in its forwardmost position holding the refuse, indicated at **98**, tightly against ejetcor panel **32**, and in which the sweep panel has been rotated to a position clear of hopper **20** so that the latter is ready to receive the next load of refuse. When the hopper has been filled the proper actuating control is operated and sweep panel **22** starts to rotate in a counterclockwise direction. As it clears ram panel **24** the latter starts moving rearwardly, and the sweep panel continues its counterclockwise rotational movement, engaging the refuse and sweeping it up towards the storage compartment. In FIGURE 3 the system is shown just after the sweep panel has engaged the refuse and is starting to push it forwardly and upwardly. This movement of the sweep panel continues until the refuse is raised to a level substantially in line with the bottom of the storage compartment, at which time full power is applied to the ram panel and it sweeps the refuse off the upper surface of sweep panel **22** and pushes it with maximum force into the storage compartment against ejector panel **32**. FIGURE 4 shows the system midway in this step of the cycle.

As will be appreciated, during compaction the pressure on the power side of ram cylinder **30**, i.e., in fluid line **46**, will be substantially proportional to the compacting forces on the refuse in the storage compartment exerted by the ram panel. When this force, and hence ram cylinder pressure, reaches a predetermined value, the pressure in fluid line **46** will cause pilot operated valve **65** to pop open and dump fluid from the power stroke side of ejector cylinder **34**, whereupon the latter will be pushed forwardly by the continued forward movement of ram panel **24**. However, since the dumping of the ejector cylinder reduces the reactive forces acting against the ram panel, the pressure in the ram cylinder decreases and when it drops below the predetermined value valve **65** closes and further forward movement of the ejector panel is arrested. Control valve **42** will have no influence on this operation because the ejector cylinder is not being actuated, during the compaction cycle, and therefore fluid lines **58** and **60** will be closed in the control valve, in the usual manner. In addition, any safety relief valve provided in the ejector cylinder circuit will be set at a pressure higher than any encountered during the campacting cycle, so that it also will not influence this operation.

It has been found that in actual operation of the present system the ejector panel tends to index forwardly in small rapid increments. Since its movement is arrested whenever the ram cylinder pressure is below the predetermined value the refuse is substantially continually subjected to at least the compacting force created by the ram panel under the influence of this predetermined pressure. This provides an advantage over systems which permit a complete releasing of the ejector panel after the ram panel has completed its packing stroke since in such systems the refuse is allowed to expand to a lower degree of compaction, pushing the ejector panel further forwardly than desirable.

It has been discovered that very good results are obtained when valve **65** is designed and adjusted so that it will open when the pressure in the ram cylinder supply line is approximately 80% of the maximum pressure reached in that line, as determined by the usual relief valve. This figure of 80% provides a consistently high degree of compaction and yet is sufficiently below the pressure setting of the relief valve (100%) that no fluid is likely to dump across the relief valve, with the attendant losses in power and efficiency, as well as heating of the hydraulic fluid. In other words, it has been found that a 20% safety factor will give excellent compaction without getting too close to the dumping pressure of the ram cylinder relief valve, which as will be appreciated will vary somewhat in an actual production valve due to manufacturing tolerances and hysteresis. It also accounts for any time lag or hysteresis in the operation of pilot operated dumping valve **65**.

As can thus be seen, substantially uniform and constant compacting forces are exerted against the refuse from the very first load to the last load, regardless of friction between the refuse and the walls of the storage compartment, regardless of the actual forces on the ejector panel, and regardless of the number of stages of the ejector telescopic piston and cylinder assembly which are extended. Furthermore, in the present system the telescopic piston and cylinder assembly does not exert increasingly greater reactive forces as the compartment becomes more filled.

In the circuit shown in FIGURE 5, fluid line **68** is shown connected to the supply line for the ram cylinder. This arrangement is preferable in systems where there is a possibility that one of the other hydraulic functions performed by the overall system will require the use

of pressures in excess of the predetermined pressure setting of dumping valve 65, which might cause the dumping valve to dump fluid from the ejector cylinder during some other cycle of the system, such as when the ejector cylinder is being used to eject the load from the storage compartment, or when the tail gate is raised, or the like.

In systems where this is not likely to occur, it has been found that the line for control fluid to dumping valve 65 may be connected directly to the main supply line from the pump. Such an arrangement is shown in FIGURE 7, wherein dumping valve 65 is shown connected to fluid supply line 44 by means of fluid line 68*a*. As can be seen, this figure is identical in all respects to FIGURE 5, except that the dumping valve is connected to supply line 44 rather than supply line 46, and therefore the same reference numbers are used. Since in many systems the maximum pressure encountered, for all the hydraulic functions contemplated, is the pressure used to actuate the ram panel to compact the refuse into the storage compartment, a circuit of the type shown in FIGURE 7 is often perfectly satisfactory.

When the storage compartment is full unloading is accomplished by raising the tail gate, using piston and cylinder assembly 18, and actuating ejector panel 32, which is in its forwardmost position when the compartment is filled, to cause it to move rearwardly to eject or push the refuse out of the compartment. In circuits of the type shown in FIGURE 7 there is virtually no risk that the dumping valve will be opened by the supply of fluid under pressure to the ejector cylinder for ejecting the load, since it has been found that pressures required for this purpose are substantially below the pressures encountered in the ram cylinder during packing, as well as substantially below the predetermined pressure setting.

Thus, there are disclosed in the above description and in the drawings several exemplary embodiments of the invention which fully and effectively accomplish the objects thereof. However, it will be apparent that variations in the details of construction may be indulged in without departing from the sphere of the invention herein described, or the scope of the appended claims.

What is claimed is:

1. A refuse packing system comprising: a refuse storage compartment having an opening at one end; panel means mounted in said compartment for movement away from and towards said one end thereof; holding means for holding said panel against movement away from said one end; powered packing means for packing refuse into said compartment at said one end thereof and against said panel means; motor means for powering said packing means; sensing means for sensing the compacting force exerted by said motor means on said packing means and control means controlled by said sensing means for causing said holding means to permit said panel means to move away from said one end when said force reaches a predetermined value sufficient to provide the desired compaction, said control means functioning at the same said predetermined force independently of any variation in forces exerted on or by said panel means.

2. A refuse packing system as claimed in claim 1, wherein said motor means includes a hydraulic motor and said sensing means senses said compacting force by sensing the pressure of the hydraulic fluid input to said motor.

3. A refuse packing system comprising: a refuse storage compartment having an opening at one end; a first panel mounted in said compartment for movement away from and towards said one end; a hydraulic piston and cylinder assembly for controlling movement of said first panel in said compartment, said assembly having a pressure side in which the presence of fluid under pressure would cause said assembly to move said first panel towards said one end; a second panel at said one end of said compartment for packing refuse thereinto at said one end against said first panel; hydraulic fluid motor means powering said second panel; a powered hydraulic pump for supplying fluid under pressure to said fluid motor; a reservoir providing a supply of fluid for said pump; and valve means in fluid communication with said motor means and being responsive to the pressure of fluid supplied said motor for blocking the flow of fluid to and from said pressure side of said piston and cylinder assembly when said second panel is packing refuse into said compartment and said fluid pressure is below a predetermined value, and for dumping fluid from said piston and cylinder assembly to said reservoir when said second panel is packing refuse into said compartment and said fluid pressure reaches said predetermined value, whereby said first panel will be permitted to move away from said one end of the compartment, said predetermined pressure being sufficient to provide the desired compaction.

4. A refuse packing system as claimed in claim 3, wherein means is provided for supplying hydraulic fluid under pressure to said pressure side of said piston and cylinder assembly when said second panel is not packing to move said first panel towards said opening to eject refuse from said compartment.

5. A refuse packing system as claimed in claim 3, wherein said valve means operates at the same said predetermined fluid pressure independently of any variation in forces exerted on or by said first panel.

6. A refuse packing system as claimed in claim 3, wherein said piston and cylinder assembly is a multi-stage telescopic piston and cylinder assembly in which the different stages are operative to control movement of said first panel in different positions thereof as it moves in said compartment from said one end to the opposite end thereof, said valve means operating at the same said predetermined fluid pressure independently of the particular stage of said piston and cylinder assembly then operative.

7. A refuse packing system comprising: a refuse storage compartment having an opening at one end; a first panel mounted in said compartment for movement away from and toward said one end; a multi-stage hydraulic telescopic piston and cylinder assembly for controlling the movement of said first panel, different stages of said piston and cylinder assembly being operative to control movement of said first panel in different positions thereof as it moves in said compartment from said one end to the opposite end thereof; a second panel at said one end of said compartment for packing refuse thereinto at said one end against said first panel; hydraulic fluid motor means for powering said second panel; a powered hydraulic pump for supplying fluid under pressure to said fluid motor means; a reservoir providing a supply of fluid for said pump; and valve means controlling the flow of fluid to and from said multi-stage telescopic piston and cylinder assembly, said valve means being in fluid communication with said fluid motor means and being responsive to the pressure of the fluid supplied said fluid motor means during packing to permit movement of said first panel away from said one end of said compartment only when said fluid pressure reaches a predetermined value sufficient to provide the desired compaction, said valve means operating at the same said predetermined fluid pressure independently of the particular stage of said piston and cylinder assembly then operative.

8. A refuse packing system as claimed in claim 7, wherein means is provided for supplying hydraulic fluid under pressure to said piston and cylinder assembly when said second panel is not packing to cause said first panel to move towards said opening to eject refuse from said compartment.

9. A refuse packing system as claimed in claim 7, wherein said valve means operates at the same said pre-

determined fluid pressure independently of any variation in forces exerted on or by said first panel.

10. A refuse packing system as claimed in claim **7**, wherein said valve means permits movement of said first panel away from said one end of said compartment by dumping fluid from said piston and cylinder assembly to said reservoir in response to the pressure of the fluid supplied said fluid motor means.

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