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[54] **REFUSE COMPACTOR CONTROL ARRANGEMENT**
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[52] **U.S. Cl.** ..... **100/35,** 100/45, 100/49, 100/52, 100/53, 100/218, 100/229 A, 100/269, 141/12, 141/71
[51] **Int. Cl.** **B30b 13/00**
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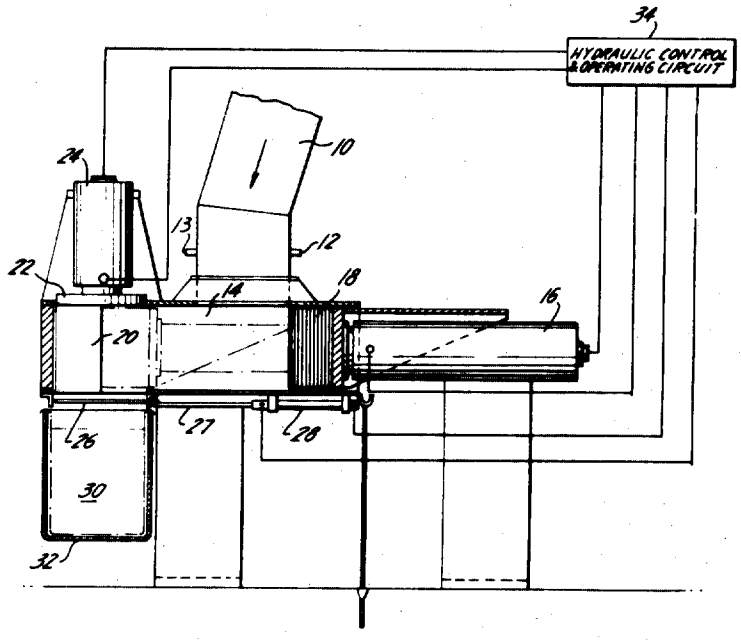
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ABSTRACT: A control arrangement for a refuse compactor in which a photocell cooperates with a time delay device to determine when refuse is being accumulated or has been accumulated in an accumulating chamber for eventual compaction into a bale. A hydraulic cylinder and piston is actuated thereupon to compact the refuse. After the compacted mass is realized, an ejecting door is opened and a hydraulic cylinder and piston ejects the compacted mass from the refuse compactor. The control arrangement coordinates the timing and sequence of operations of a compacting cycle during which a bale is formed and transferred from the compacting machine.



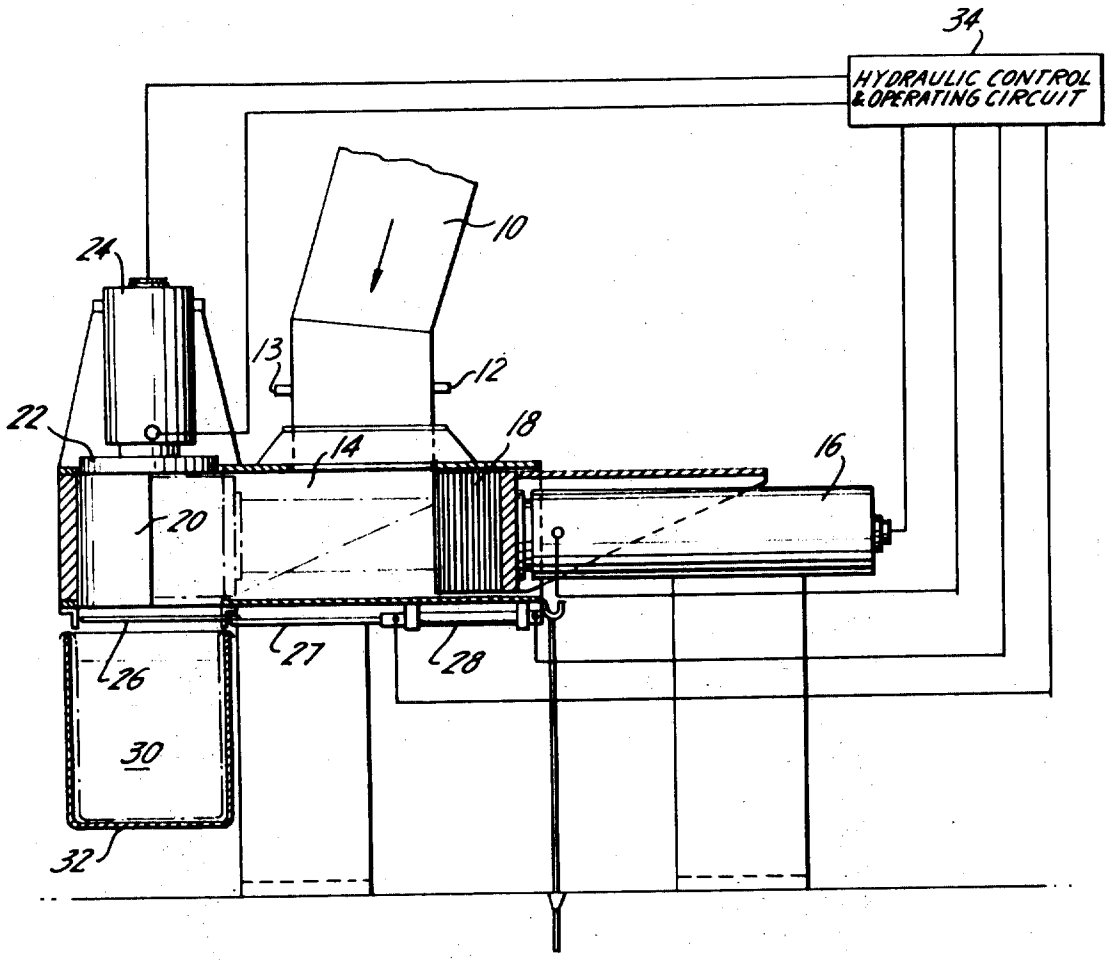
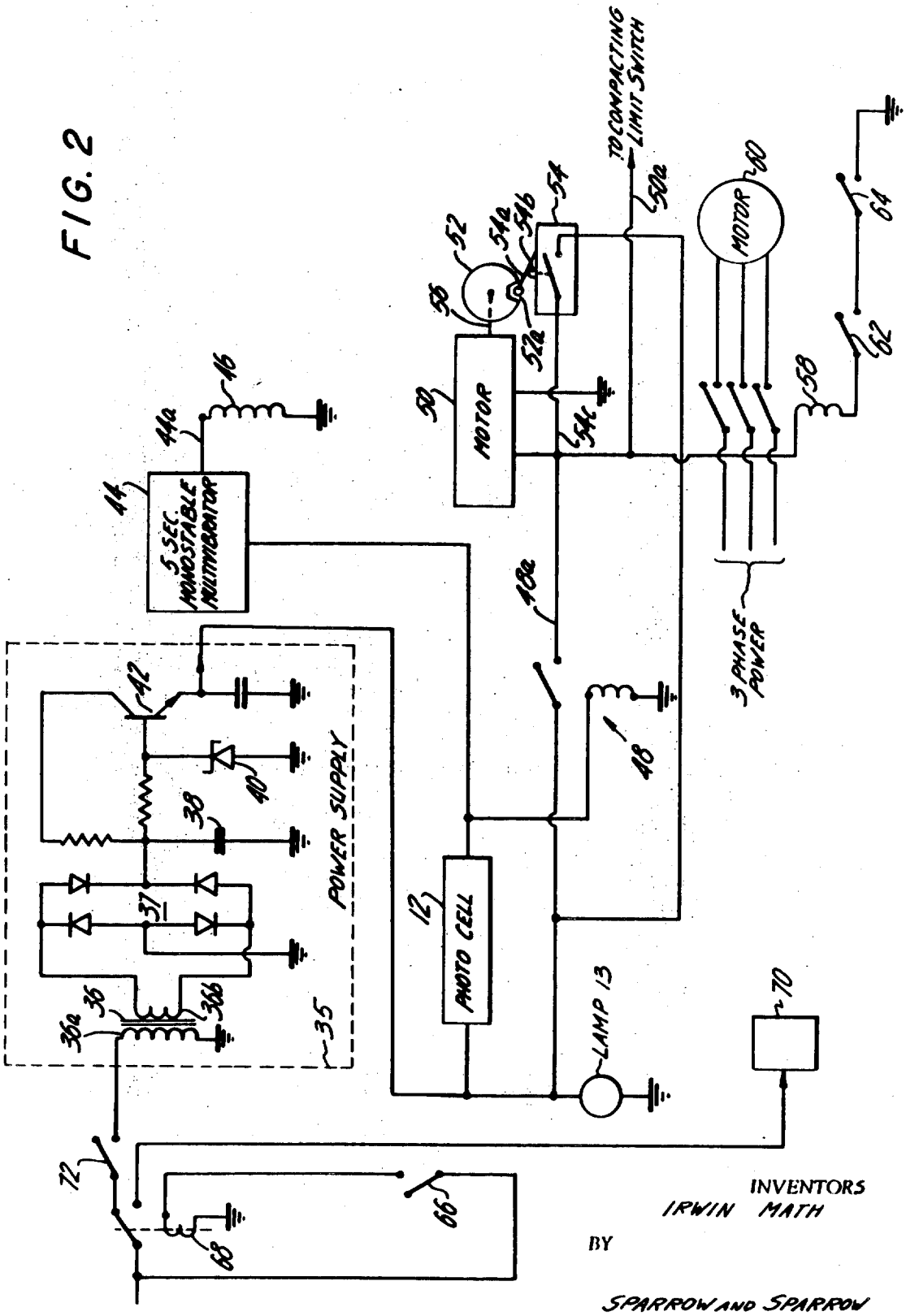


FIG. 1

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FIG. 2


TO COMPACTING LIMIT SWITCH
MOTOR
MOTOR
5 SEC. MONOSTABLE MULTIVIBRATOR
POWER SUPPLY
PHOTO CELL
LAMP 13
3 PHASE POWER
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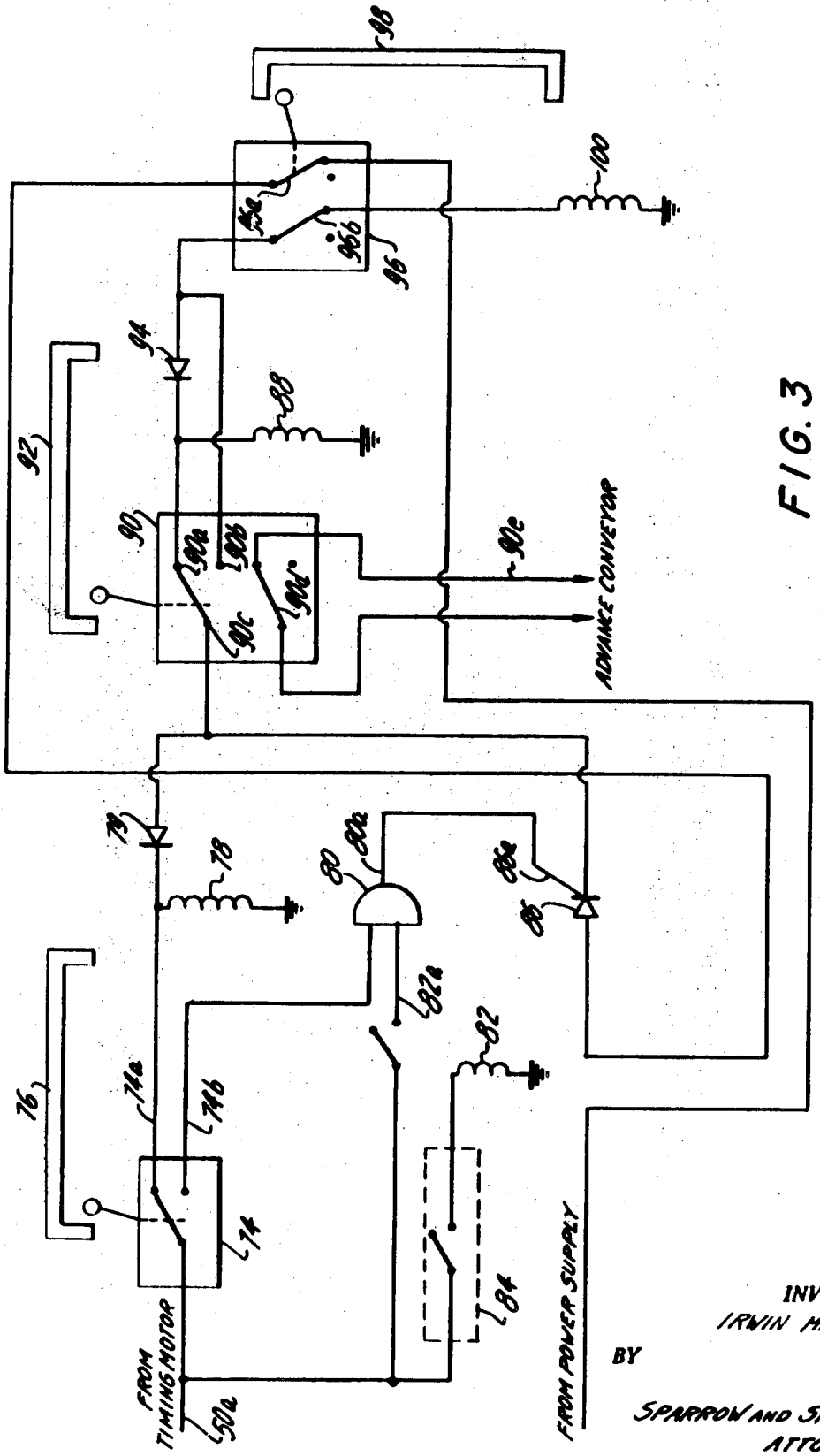


FIG. 3

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REFUSE COMPACTOR CONTROL ARRANGEMENT

BACKGROUND OF THE INVENTION

In the application of compactors to dispose of garbage and waste, it is essential that a reliable control system be used to sequence and time the various operations which are performed by the machine used for the compacting process. Accurate sequencing and timing in the operation of compacting machines, are essential for the protection of the machine and the operator. Thus, the commencement of ejection of the refuse prior to or after it has been fully compacted, may result in low-density bales, or in oversized bales which cannot be fitted into the container or bag for transporting the bale.

It is, furthermore, essential to ascertain that ejection not be commenced, until the ejection door of the machine has been fully opened to admit the compacted bale therethrough. Should the door not be fully opened before the ejection piston begins to eject the compacted bale, it is possible that the door may become fractured, bent or damaged in other respects.

Accordingly, it is a desideratum of the present invention to provide a control arrangement for refuse compactors, in which the compacting piston, the ejection piston, and the ejection door are controlled reliably in sequence and with the proper timing.

SUMMARY OF THE INVENTION

A control arrangement for refuse compactors in which electronic circuitry provides the proper sequence and timing of the operating elements of the machine used for the compacting process. When sufficient refuse has accumulated within a storage bin or other accumulating means of the compactor, a photosensitive device emits a signal which gives rise to actuating the compacting hydraulic cylinder for a predetermined time interval. After the refuse has been adequately compacted, as determined by a compacting pressure switch, the hydraulic cylinder remains in the extended position while the ejection process is initiated. During this process, the ejection door beneath the compacted bale is removed from an opening through which the bale is forced from the machine by an ejecting cylinder. Limit switches cooperating with control circuitry and the pistons of the various hydraulic cylinders are used for carrying out the cycle of operations of the machine. Accurate and reliable sequencing and timing of the operation are realized.

It is an object of the present invention to provide a control arrangement for refuse compactors, in which the compacting piston, the ejection piston, and the ejection door are controlled reliably in sequence and with the proper timing.

It is also an object of the present invention to provide sensing means such as the aforementioned control arrangement with the characteristic that it initiate a cycle of operation in cooperation with a photosensitive device after sufficient quantity garbage is available for compacting.

It is also a specific object of the present invention to provide a control arrangement for refuse compactors in which the operation of the compacting machine is immediately stopped when a predetermined compacting pressure level is exceeded or a dangerous state in the operation of said compactor is reached.

A further object of the present invention is to allow high pressures to be produced in the refuse compactor to break otherwise noncompactable materials while still only compacting compactible material to a proper, predetermined degree.

Various further and more specific purposes, features and advantages will clearly appear from the detailed description given below taken in connection with the accompanying drawings which form part of this specification and illustrate merely by way of examples embodiments of the device of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following description and in the claims, parts will be identified by specific names for convenience, but such names

are intended to be as generic in their application to similar parts as the art will permit. Like reference characters denote like parts in the several figures of the drawings, in which

FIG. 1 is a sectional elevational view of a refuse compactor used for compacting and disposing refuse through the actuation of hydraulic cylinders in proper sequence and timing;

FIG. 2 is a schematic diagram of an electronic control arrangement through which the compacting process for the refuse compactor of FIG. 1 is initiated;

FIG. 3 is a schematic diagram of an electronic control arrangement operating in conjunction with limit switches on the hydraulic cylinders of the garbage compactor of FIG. 1, for the purpose of establishing the correct sequence and timing of operation of the refuse compactor, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings and in particular to FIG. 1, a typical refuse compactor controlled by the arrangement of the present invention, has an accumulating means in the form of a storage bin **10** through which refuse is admitted or passed to the compactor, when generated. A photosensitive device **12** communicating with a light beam source **13**, both mounted within the chute or storage bin **10**, emits a signal whenever refuse passes through the bin or chute for the purpose of spraying said refuse with a disinfectant/rodent repellant. After the refuse has passed through the chute or bin, generally by gravity, and has been sprayed, it is accumulated within a compacting base or chamber **14** within the compacting machine.

After a sufficient amount of refuse or garbage has accumulated within the chamber **14**, the photosensitive device **12** emits another signal and a compacting hydraulic cylinder **16** is actuated for the purpose of ramming a corresponding hydraulic piston **18** against the refuse within the chamber **14**. The piston **18** forces the refuse against an abutting member **20** at the opposite end of the chamber **14**. The piston **18** and abutting member **20** may have a circularly shaped profile for the purpose of forming a cylindrically shaped compacted mass. After the piston **18** has been actuated a sufficient number of times by being reciprocated back and forth within the chamber **14**, the refuse is compacted to the desired mass density, and is ready to be ejected or removed from the machine.

After compacting by the piston **18**, the bale, cake or compacted mass resides beneath the piston **22** of an ejection hydraulic cylinder **24**. The latter is used to eject a compacted mass from the machine. Prior to actuation of the hydraulic cylinder **24**, however, an ejection door **26** is removed from beneath the bale.

The door **26** covers an opening in the machine beneath the piston **22**, and supports the bale while being compacted through repeated action of the piston **18**. The ejection door **26** is removed from beneath the bale, through the hydraulic cylinder **28**. When the latter has been actuated to the extent which assures that the opening beneath the bale is fully uncovered, the ejection cylinder **24** is actuated and the piston **22** forces the compacted mass through the opening normally covered by the door **26**. The compacted mass drops into a container or can **32** which may be lined with a disposable bag or container **30** used for the purpose of transporting the compacted bale.

The electronic and hydraulic control circuit **34** used to control the sequence and timing of the operation of the hydraulic cylinders is shown in FIGS. 2 and 3. A low-voltage operating supply for the electronic circuitry is realized through the transformer **36** which has its primary winding **36*a*** connected to the conventional commercially available power, whereas the secondary winding **36*b*** drops this commercially available voltage to a safe lower level suitable for operating solid-state electronic circuitry, in accordance with the present invention. This assures that all voltage levels on the various limit switches are low enough to prevent harm to persons coming in contact with said switches.

A rectifying bridge 37 composed of four diodes converts the AC power provided by secondary winding 36*b*, into corresponding DC power. The filter compacitor 38 at the output of the rectifying bridge 37, serves to smooth the DC power, whereas the zener diode 40 regulates the power with respect to a predetermined voltage level. The output transistor 42 supplements the zener diode 40 feeding the required regulated voltage to the electronic control circuitry. Thus, the power supply 35 provides low-voltage-regulated DC power for the solid-state components used in the control arrangement of the present invention.

As refuse is dropped through the chute or bin 10 into the chamber 14, the photosensitive device or photocell 12 emits a signal whenever its light path, produced by lamp 13, is interrupted by the falling refuse. This signal is applied to a monostable multivibrator 44 designed to have a short timing cycle, for example, on the order of 5 seconds. Thus, after being triggered by a signal from the photocell 12, the monostable multivibrator 44 will provide at its output 44*a*, a signal of short duration of, for example, 5 seconds. At the end of this interval, the monostable multivibrator resets itself automatically by returning to its stable state. The 5-second interval corresponds to the unstable state of the multivibrator.

The output signal of the monostable multivibrator 44 is applied to an electromagnetically controlled spray valve 46 which sprays disinfectant and/or rodent repellants into the refuse accumulating within the chamber 14. The 5-second interval was chosen to assure that the incoming refuse is well coated with the disinfectant spray.

As refuse is dropped through the chute 10 and accumulates within the chamber 14, the level of the refuse rises eventually to the location of the photocell 12, to the extent that the light path produced by the lamp 13 and communicating with this photocell becomes interrupted and remains in this interrupted state. When the light path is thus maintained interrupted for longer than typically 15 seconds, a time delay relay 48 becomes actuated through the output signal of the photocell 12. The time delay relay is a conventional element which becomes actuated when an applied signal is maintained for a predetermined time interval as, for example, 15 seconds.

Accordingly, when the time delay relay 48 is operated through the signal from the photocell 12, a timing motor 50 is energized. The latter is an electromechanical element which becomes operated for a predetermined time interval established through the combination of a cam 52 and switch 54. The cam 52 is mechanically coupled to the shaft of the motor and is rotated through the rotation of that shaft. The cam 52 has, furthermore, a notch 52*a* into which one end of the switch-actuating arm 54*a* may enter. The switch 54 is a spring-operated momentary contact type of switch which becomes closed when the actuating button 54*b* is depressed. The arm 54*a* will maintain this button 54*b* depressed, for as long as the end of the arm lies outside of the notch 52*a*, while being in contact with the exterior rim surface of the cam 52. In the stationary or nonoperating state of the motor 50, the end of the arm 54*a* resides within the notch 52*a* of the cam 52. In this manner, the switch 54 is open, and power is not supplied to the motor.

When, however, the time delay relay 48 becomes actuated, the contact of that relay closes and applies power to the motor through the line 48*a*. The motor 50 thereby commences to turn with the result that the end of the actuator arm 54*a* is forced out of the notch 52*a* to the extent that the button 54*b* is depressed and the switch 54 is closed. With the closure of the switch 54, in this manner, power is supplied to the motor through the switch 54 for as long as the switching arm 54*a* rides against the exterior rim of the cam 52. The latter is mechanically coupled to the shaft of the motor through a gear arrangement 56, shown schematically in the drawing by broken lines, so that the motor is held in the operating state for an interval of approximately 5 minutes. At the expiration of this interval, the actuating arm 52*a* resides again within the notch 52*a* and the switch 54 is opened, whereby power is removed from the motor. Accordingly, through the use of the motor 50 in combination with the cam 52 and switch 54, a 5 minute interval is generated when relay 48 becomes actuated.

The motor 50 will continue to rotate and generate the 5 minute interval, even through the relay 48 becomes released or deenergized soon after it was actuated. Such release of the relay 48 occurs after the refuse within the chute 10 has dropped below the level of the photocell 12 in the course of being compacted. The time motor 50 is used to generate the typical **minute time interval for the purpose of actuating the entire hydraulic system during that time to completely clear refuse from within the storage area** 10. **The signal** 50*a* connected to the motor and appearing for as long as the motor rotates, thereby represents a 5 **minute signal. The signal** 50*a* is in addition applied to the valve of the hydraulic cylinder 16 for the purpose of actuating the latter for a period of 5 minutes to clear the bin 10 and compact the refuse into the form of a bale or cake suitable for ejection from the machine and disposal. For the purpose of operating the timing motor 50, in the aforementioned manner, the motor is connected to the line 48*a* of the relay 48 as well as the line 54*c* of the switch 54.

The line 54*c* of the switch 54 is also connected to a relay means 58 which, when energized, closes the circuit to a motor 60 which provides the total hydraulic power for the cylinders used in the garbage compactor. Thus, the motor 60 drives a pump which maintains hydraulic fluids under pressure for the purpose of actuating the various hydraulic cylinders. The motor 60 is operated from three-phase power, for example, and the relay 58 will apply this power to the motor 60 when energized. Other types of power can of course be employed in the same manner.

Connected in series with the coil of the relay 58, are switches 62 and 64. The switch 62 will be in the open state whenever the access doors of the compacting machine are not fully locked to prevent possible injury to the operator of the machine. The switch 64 will, at the same time, be in the open state whenever the oil pressure within the hydraulic line is below a predetermined level. Thus, the switch 64 is an oil pressure switch which is open, for safety reasons, when the oil pressure is too low. The switches 62 and 64, therefore, serve as safety devices which prevent the motor 60 from operating and consequently the entire compactor from operating when a predetermined set of safety conditions do not prevail. It should be noted that other switches can also be connected in series with 62 and 64 for additional safety devices as required.

During the compacting process it is quite possible that an incompressible object becomes intermixed with the refuse and offers a high resistance to the piston 18 during compacting. To prevent injury or damage to the machine through the generation of excessive compacting pressures as a result of such incompressible objects, a maximum pressure switch 66 is provided in communication with the hydraulic fluid used for the compacting process. When the maximum permissible hydraulic pressure is exceeded, the switch 66 becomes closed and as a result the relay 68 is energized. With the actuation of relay 68, all power to the machine is removed, and a signal is applied, at the same time, to an audible alarm device 70 such as a bell, for example. Thus, the contact of the relay 68 removes power from the power switch 72 which, when closed, supplies power to the machine and feeds the transformer 36 of the power supply 35. The alarm device 70 may be in the form of a suitable indicator including a flashing lamp and is not restricted to being an audible device. Thus, lamps or other indicating means may also be used in conjunction with or in lieu of the audible bell that may be used for this purpose.

The signal 50*a* generated as a result of the action of the timing motor 50, is applied to a limit switch 74 constructed in the form of a toggle switch. The latter is actuated by a limit switch bar 76 connected to the piston 18 of the compacting hydraulic cylinder 16. The limit switch bar 76 actuates the toggle switch 74 at the two extreme positions of the piston 18 in its forward and return motions. Once actuated at an extreme position of the piston 18, the toggle switch 74 remains in that actuated position until it becomes switched to the opposite state when

the piston has arrived at the opposite extreme position. Accordingly, when the piston has reached the extreme position on its return stroke, the toggle switch **74** is actuated to that state in which the circuit is completed to the electromagnetically actuated valve **78**. The latter is associated with the hydraulic cylinder **16** and will, when energized, cause forward motion of the piston **18** for the purpose of producing pressure against the refuse within the chamber **14**. Once the piston reaches the extreme forward position, the limit switch bar actuates the toggle switch **74**, so that the signal **50***a* is removed from the valve **78** and is, instead, applied to the input **74***b* of a gate **80**.

The valve **78** is a DC solenoid-operated spring-return valve which will cause the piston **18** to return when the valve is deenergized. The other input **82***a* of the gate **80** is derived from a time delay relay **82**. The coil of the latter is connected in series with a compacting pressure switch **84** also leading to the signal line **50***a*. The compacting pressure switch **84** becomes closed whenever the compacting pressure within the cylinder **16** has attained a predetermined level, for a predetermined length of time, indicating that the desired density of the compacted mass or bale has been achieved.

When the compacting pressure switch is maintained in the closed position for an excess of time, typically 5 seconds, the time delay relay **82** becomes actuated and a signal **82***a* is applied to the gate **80**. The relay **82** is used to ascertain that the refuse is fully compacted into a bale or cake, and that the switch **84** was not just actuated through the presence of an incompressible object which actuated the switch momentarily as it was being broken during the compacting process. Thus, the assumption is made that if the switch **84** is in closed position for a period of at least 5 seconds, a fully compacted refuse bale or cake has been obtained. The gate **80** is an AND gate which provides an output signal **80***a* only if signals appear simultaneously at both of its inputs. Accordingly, the gate **80** is a conventional, logic gate with its output connected to the gate-triggering electrode **86***a* of a semiconductor silicon-controlled rectifier **86**.

The output of the gate **80** will trigger the silicon-controlled rectifier **86** when its two inputs **74***b* and **82***a* are present simultaneously. This situation occurs when the piston **18** just finishes its forward compacting stroke actuating limit switch **74** into the return position and, at the same time, the compacting pressure switch **84** has been closed for a period of time exceeding 5 seconds indicating a fully compacted bale or cake has been obtained. The piston **18** is, when the silicon-controlled rectifier **86** is triggered, prevented from retracting prior to ejecting the compacted mass through the diode **79** connected between the cathode of the rectifier **86** and the valve **78**. Thus, when the controlled rectifier **86** is fired, the conducting path through the diode **79** maintains the valve **78** energized, and as a result the piston **18** is held stationary at its extreme forward position and is prevented from executing the return stroke. With this arrangement, the compacted mass is fully supported between the piston **18** and the cooperating member **20**, during the ejection process. Such support of the compacted mass is essential during the ejection process to prevent buckling, breaking or crumbling of the bale ejection and in addition maintaining a bale suitably shaped to fit in the refuse container **30**. This necessary support would be absent if the piston **18** were retracted from its forward position prior to carrying out the ejection process.

With the firing of the control rectifier **86**, the valve **88** associated with the cylinder **28** for the ejection door **26** becomes energized. The anode-cathode path of the controlled rectifier is connected in series with the valve **88**, so that when the rectifier is fired or triggered, the valve **88** is energized by way of the switch **90** with the result that the hydraulic cylinder **28** becomes actuated. The cylinder **28** thereby functions to draw upon the piston **27** so that the ejection door **26** is removed from underneath the compacted mass within the compacting area of the chamber **14**.

The switch **90** is momentary contact switch which is actuated through a limit switch bar **92** mounted upon the piston **27** of the door **26**. The limit bar **92** will actuate the switch **90** whenever the piston **27** has attained one of its two extreme positions in its reciprocating path of motion. The switch **90**, of the momentary contact type, has the contact **90***c* connected to the contact **90***a* when the ejection door **26** is in the closed position blocking the chamber **14**. When in the open position uncovering the opening in the chamber **14**, the contact **90***c* is connected with the contact **90***b*.

A diode **94** is connected between the two contacts **90***a* and **90***b*. The valve **88** controlling fluid for the hydraulic cylinder **28** is connected to the junction of the contact **90***a* and the cathode of the diode **94**. The anode of the diode **94** is connected to the contact **90***b* and the valve **100** for the ejection cylinder **24**, by way of the switch **96**. The latter is of the toggle switch type and is actuated by a limit switch bar **98** connected to the ejecting piston **22**. The toggle switch **96** becomes actuated at the two extreme positions of the piston **22**. One contact **96***a* of the switch **96** is connected in series with the anode-cathode path of the silicon-controlled rectifier **86**, whereas the contact **96***b* is connected in series with the valve **100** for the hydraulic ejecting piston **24**.

In operation, the ejection door **26** becomes open through energizing of the valve **88**, as a result of firing of the silicon-controlled rectifier **86**. When the door **26** attains its open position, the switch **90** becomes actuated through the limit bar **92**. With such actuation of the switch **90**, however, the valve **88** continues to remain energized by receiving power through the conducting path of the diode **94**. With the energizing of the valve **88**, the door **26** remains in the open position. At the same time, the ejection valve **100** is energized, since the switch **90** is in the position in which the contact **90***c* is connected to the contact **90***b*. As a result of such energizing of the valve **100**, the ejecting piston **22** moves downward and ejects the compacted mass. When the piston **22** has attained its extreme downward position, the toggle switch **96** becomes actuated through the limit switch bar **98**. This actuation of the toggle switch **96** opens the contact **96***b* and thereby interrupts the circuit to the valve **100**. With the removal of the power from the valve **100**, in this manner, the ejecting piston **22** returns to its upward position where the toggle switch **96** is reactuated to its initial state by the limit bar **98**. When the ejection valve **100** is deenergized through opening of the contact **96***b*, the contact **96***a* is simultaneously opened, and this resets the silicon-controlled rectifier **86**.

Accordingly, when the toggle switch **96** is returned to its initial state upon arrival of the ejecting piston **22** at its upper most position, power is no longer applied to the valve **88**, and as a result the door **26** becomes closed through the action of the hydraulic cylinder **28**. At this point, an entire compacting cycle has been completed and the compacting machine is in a state of readiness for carrying out a subsequent cycle. The momentary contact switch **90** is also provided with a contact **90***d* which provides a signal **90***e* to a conveyor for advancing a fresh and empty container **30** beneath the door **26** in advance of a new cycle.

It should also be understood that where various time intervals are stated, they are only stated for the purpose of clarifying the description and in actual practice, the values may substantially vary from the stated values.

While the invention has been described and illustrated with respect to a certain preferred embodiment, it will be understood by those skilled in the art after understanding the principle of the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A refuse compactor comprising in combination, a housing; compacting means in said housing for compacting a predetermined amount of refuse into a compacted mass by applying pressure to said refuse; pressure-sensing means for sensing said pressure and emitting a signal when said pressure

exceeds a predetermined magnitude; means connected to said pressure-sensing means and operatively coupled to said compacting means for ceasing operation of said compacting means after said pressure exceeds said predetermined magnitude; ejecting means for ejecting said compacted mass from said compactor after attainment of said predetermined pressure magnitude and cessation of operation of said compacting means; and timing means connected to said pressure-sensing means and inhibiting transmission of said signal from said pressure-sensing means until the expiration of a predetermined time interval after said pressure exceeds said predetermined magnitude so that said compacting means is operative during said time interval, said timing means allowing breakage of normally noncompactible material.

2. The refuse compactor as defined in claim 1, including accumulating means for accumulating refuse within said compactor prior to compacting through said compacting means; accumulator-sensing means for sensing when refuse is transferred to said accumulating means; and disinfecting means actuated by said accumulator-sensing means for applying disinfectant to said refuse prior to compacting through said compacting means.

3. The refuse compactor as defined in claim 2 including timing means actuated by said accumulator-sensing means for determining when said accumulating means is filled with a predetermined amount of refuse for compacting.

4. The refuse compactor as defined in claim 2 including auxiliary timing means for timing the duration of operation of said compacting means to assure that said accumulator means will be cleared of accumulated refuse.

5. The refuse compactor as defined in claim 4 wherein said duration of operation of said compacting means is sufficient to clear said accumulating means of accumulated refuse.

6. The refuse compactor as defined in claim 2 wherein said accumulator-sensing means comprises photosensitive means within said accumulating means.

7. The refuse compactor as defined in claim 1 including protective means connected to said compacting means for transferring said compactor to an inoperative state when said pressure exceeds a predetermined safe pressure limit and when access doors of said compactor are open, said protective means also including means for rendering said compactor inoperative when said pressure is below a predetermined level.

8. The refuse compactor as defined in claim 1 including ejecting door means through which said compacted mass is ejected from said compactor, said ejecting door means covering an opening of said compactor during operation of said compacting means and being actuated by said pressure-sensing means for uncovering said opening prior to ejecting said compacted mass therethrough.

9. The refuse compactor as defined in claim 8 including means for sensing when said ejection door has uncovered said opening and actuating thereafter said ejecting means for ejecting said compacted mass from said compactor.

10. The refuse compactor as defined in claim 9 including means for sensing when said compacted mass has been ejected through said opening and actuating said ejecting door for covering said opening after ejection of said compacted mass.

11. The refuse compactor as defined in claim 10, including means for advancing a conveyor to replace a filled refuse container with an empty one at the completion of said ejecting means.

12. The refuse compactor as defined in claim 1 wherein said compacting means and said ejecting means comprise hydraulically operated cylinders and pistons.

13. The refuse compactor as defined in claim 12 wherein said pressure-sensing means measures the hydraulic pressure of said compacting means.

14. A method for compacting refuse materials comprising the steps of: accumulating a predetermined quantity of uncompacted refuse which when compacted constitutes a compacted mass of refuse of predetermined density and volume; applying pressure to said predetermined accumulated quantity of uncompacted refuse for compacting said refuse into predetermined shape within the confines of a predetermined space; removing said pressure from said refuse after the intensity of the applied pressure attains a predetermined level, said refuse being compacted into said compacted mass when the applied pressure has attained said level; timing the interval during which said pressure exceeds said level and continuing applying said pressure to said predetermined quantity of uncompacted refuse when said interval is below a predetermined magnitude for allowing breakage of normally noncompactible material, the application of said pressure being discontinued after said predetermined magnitude of said time interval has expired; opening said spaced to expose said compacted mass; ejecting said compacted mass from the confinements of said space; closing said space for compacting a subsequent predetermined quantity of refuse; and advancing a conveyor system to replace a filled refuse container with an empty one at the completion of said ejection cycle.