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Longo

[11] **3,802,335**

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[54] **SYSTEM FOR CONTROLLING THE HYDRAULIC RAM OF A REFUSE COMPACTOR**

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[52] **U.S. Cl.** ..... **100/35,** 100/49, 100/50, 100/53, 100/250, 100/269 R

[51] **Int. Cl.** **B30b 13/00**

[58] **Field of Search** ..... 100/49, 249, 250, 53, 218, 100/269 R, 229 A, 50, 51

[56] **References Cited**

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Primary Examiner—Billy J. Wilhite

Attorney, Agent, or Firm—Murray Schaffer

[57] **ABSTRACT**

A system for controlling the hydraulic ram of a refuse compactor comprising actuating the forward movement of the ram to effect the compacting and limiting the actuation to a first predefined time. Simultaneously sensing the pressure in system as a result of the compaction and on sensing of a predetermined level limiting the continued actuation to a second time period less than the first.

7 Claims, 2 Drawing Figures

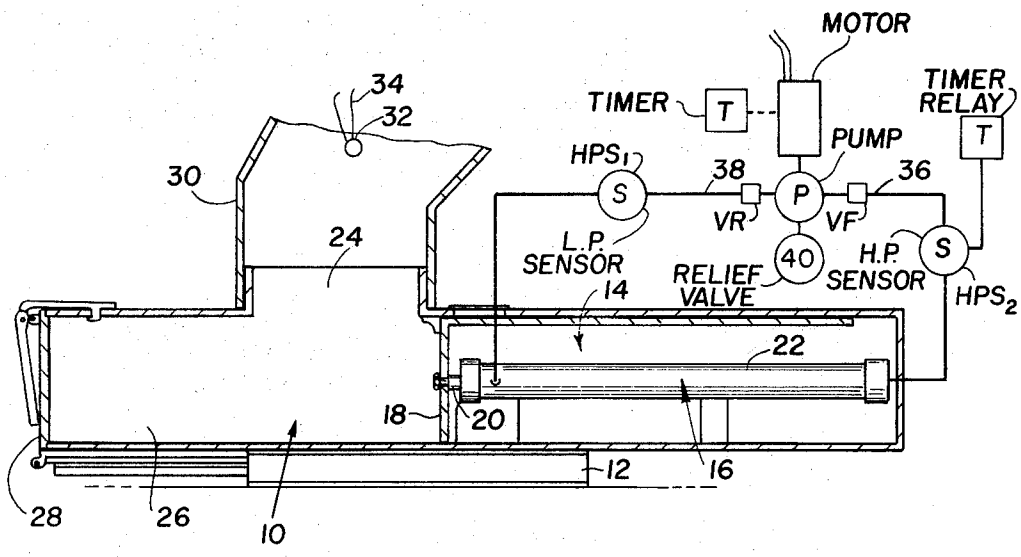
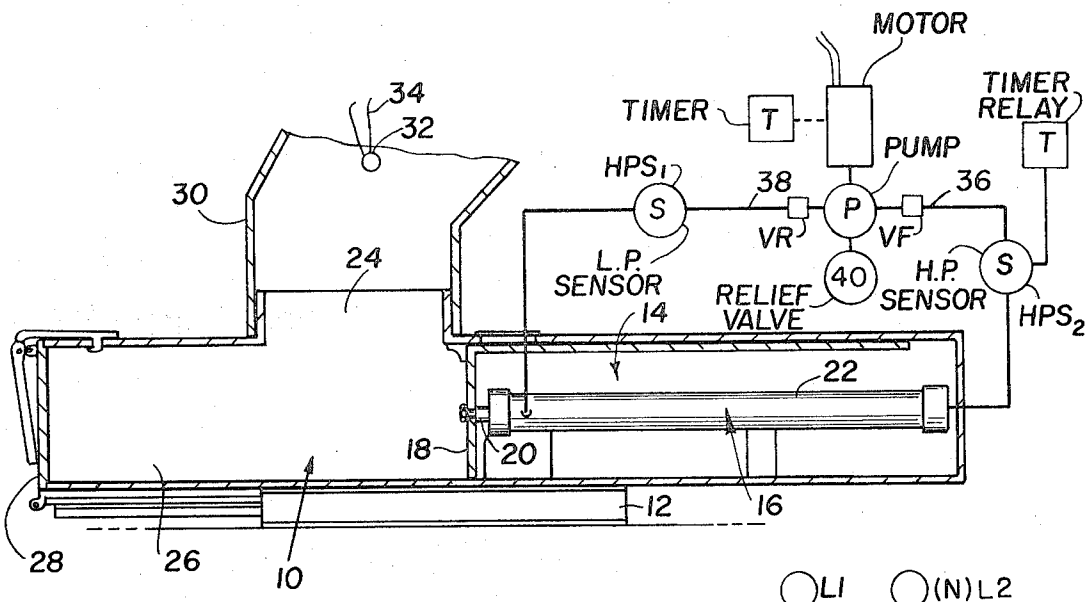


FIG.1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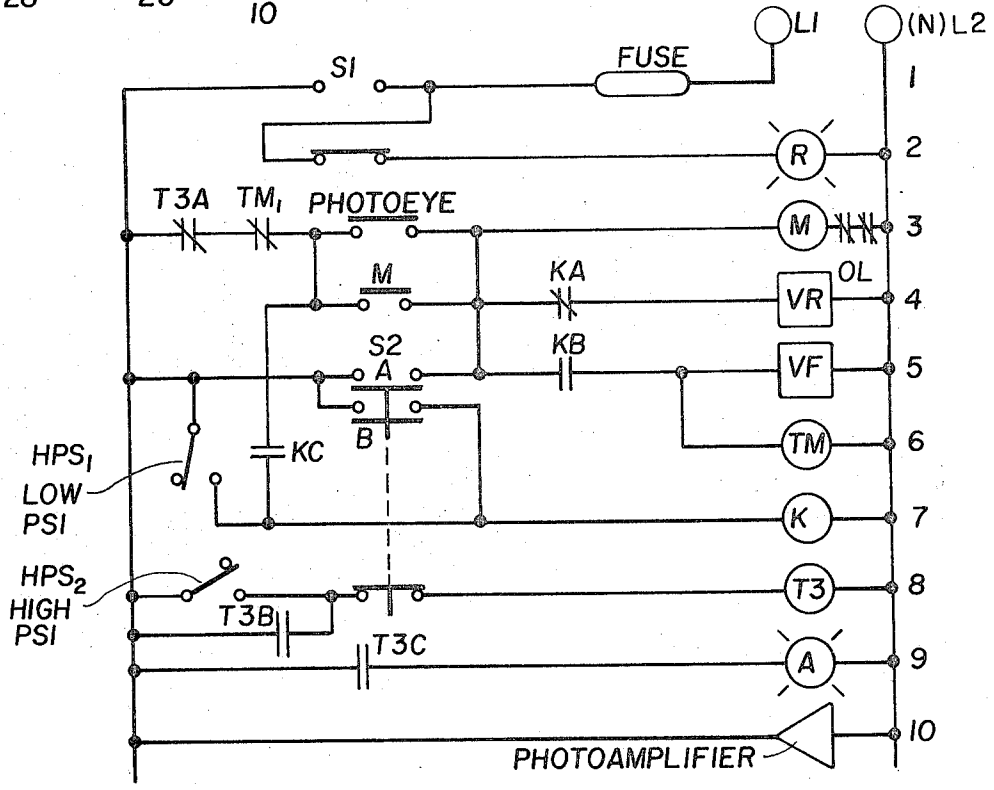
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PHOTOAMPLIFIER
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FIG.2

SYSTEM FOR CONTROLLING THE HYDRAULIC RAM OF A REFUSE COMPACTOR

BACKGROUND OF INVENTION

The present invention relates to apparatus and method for compacting refuse, garbage and the like.

Various devices for compacting refuse, garbage, trash and the like are now well known. One such device is described in my U.S. Pat. No. 3,580,166, dated May 25, 1971.

In brief, the device comprises a longitudinally extending compression chamber having a discharge opening at its leading end and a feed opening at its trailing end. Mounted to reciprocate, within the compression chamber is a hydraulically operated ram designed to compact, to a predetermined density and pressure, refuse fed into the chamber through the feed opening. Mounted at the discharge opening of the chamber is a manually pivotal door movable between an open and closed position, against which, when closed the refuse is compacted. In other machines, the door may be at an angle and the refuse compacted against an end plate or member. In general, such devices are complex and require a number of controls, switches to effect compaction. Largely, the complexity results from the desire to compact trash to a given volume, density and/or weight without taking into account the nature of the trash itself.

It is the object of the present invention to provide an improved system for compaction of refuse and the like which is simpler and more economical than those heretofore known.

It is another object of the present invention to provide a system wherein control of the compaction cycle occurs without the use of mechanical switches and the like.

It is a further object of the present invention to provide a system for compaction of refuse which takes into account the nature of the refuse and desired compaction load in order to control the cycle.

It is also an object of this invention to provide for control of the compaction system based solely on the differences and levels in the hydraulic system.

SUMMARY OF INVENTION

It has been found that refuse has a feature of spring back or resiliency which, under a compacting force, exerts a back pressure in the system which is, of course, measurable. According to the present invention a method is provided which controls the compaction cycle on this back pressure and as a consequence one is able to compact varying loads of refuse under different conditions of density, weight and volume.

Full details of the present invention follow herein, and will be seen from the accompanying drawing.

BRIEF DESCRIPTION OF DRAWING

In the drawing,

FIG. 1 is a longitudinal section of a compactor employing the present invention, and

FIG. 2 is a schematic diagram showing the method of operation.

DESCRIPTION OF PREFERRED EMBODIMENTS

As seen in FIG. 1, the present invention is applied to a compactor apparatus comprising a tubular compression chamber 10 of round or polygonal section, as desired, mounted on a suitable base 12. The chamber has a rear or trailing end 14 in which a hydraulic ram assembly 16 comprising a ram head 18, conforming in cross section to the chamber, a piston 20, and double acting cylinder 22 are arranged. Forward of the trailing end is an inlet section 24 for refuse of any type and still more forward is a compaction zone 26 wherein the refuse is actually compacted. The forward end of the compaction zone is closed by a pivotal door 28 which also conveniently forms the bulkhead against which the refuse is compacted. Arranged above the inlet 24 is a hopper 30 in which an electric eye or photo sensor 32 is arranged. In general, the arrangement is similar to that shown in the aforementioned patent to which reference can be made.

The electric eye is connected by leads 34 to an on-off switch S_1 which merely supplies electric current from a suitable source $L_1 - L_2$ to the system. When depressed the switch S_1 activates a light R indicating the actuation of the mechanism. The photo eye 30 is adapted to sense the presence of a sufficient amount of refuse in the inlet for compaction. The photo eye includes switching means which in response to the sensing of the refuse closes completing a circuit between the leads L_1 and L_2 to a motor which operates a conventional hydraulic compressor P connected via conduits 36 and 38 to the forward working and reversing sections of the cylinder 32 respectively. Simultaneously, current passes through a normally close contact KA of a two pole relay K to a hydraulic valve VR arranged in conduit 38. The valve VR is adapted to provide flow to the reverse section of the cylinder to cause the cylinder to retract the piston to the rear or trailing end. As the ram is under no external load, only low pressure is supplied to it by the pump compressor. However, when it reaches its most rear dead head position the load increases, increasing the pressure in conduit 38. This increase in pressure is sensed by a low pressure hydraulic switch HPS_1 which is normally open and is adapted and pre-set to switch over or close on the reaching of a predetermined pressure level. On closing of the switch HPS_1 circuit is completed through the two pole contact K, reversing the contacts KA which when open causes the reverse movement of the ram to be stopped and since, contact KB now closes a circuit is completed acuating a valve VF in the conduit 36 connected to the forward working section of the cylinder 22. The valve VF permits flow of hydraulic media causing the ram to move forward. Simultaneously, contact KB completes a circuit through a timing device TM which may be a conventional clock or timer. The timing device is set for a predetermined time period. At the end of the predetermined period set in the timer, the timer TM causes a contact TM_1 normally closed in the line with the photo eye to open, breaking contact with the motor M immediately ceasing operation of the hydraulic system. The ram is thus stopped in its forward most position, pushing the refuse that was in the inlet toward the bulkhead door 28.

It will be obvious from the foregoing that the forward movement of the ram, or its compaction stroke extends for a period equal to the period set by the timer. The stroke is in a single cycle, extending only during that period. The length of the compression chamber and the speed at which the ram moves is of no consequence provided, however, that the ram moves sufficiently for-

ward of the inlet to push the refuse. The compaction density, volume and weight are determined by the following technique.

Arranged within the conduit **36** delivering working pressure to the cylinder is a high pressure switch HPS_2 normally open. The switch HPS_2 is set at a predetermined pressure level, of sufficient height to determine a full compaction load as will more fully be described later. It will be understood that under compacting loads, i.e. when the ram is pushing refuse against the bulkhead, a reaction force is applied against the ram face. This backward force creates a back pressure in the working or forward operating section of the cylinder which increases the pressure level of the fluid media. It has been determined that under certain conditions the increase in pressure, when sustained for a given period of time, is indicative of the compaction of any given refuse to a desired density.

Thus the high pressure switch HPS_2 is connected to a time delay relay T_3 set to operate after the elapse of a given time interval. The relay T_3 is provided with three contacts T_{3a}, normally closed and in line with the photo eye; T_{3b} bridging the switch HPS_2; and T_{3c}, operating a lamp A. The latter two contacts are normally open. Thus, when switch HPS_2 senses the predetermined high back pressure, it actuates relay T_3, only after the elapse of the predetermined time delay period; this satisfied the pressure time relationship indicative of a given density compacted load. Thereafter, T_3 switches and opens contact T_{3a} stopping the motor, similar as if the photo eye or timer TM, were opened. T_{3b} bridging the switch HPS_2 insures the operation of the timing relay T_3 even if the pressure should suddenly drop thereafter. T_{3c} signals via lamp A the completion of the compaction load.

In order to set the predetermined pressure on the switch HPS_2 a relief valve **40** is inserted in the conduit **36.** The relief valve is set a predetermined level, above that of the high pressure switch HPS_2 to "blow" or relieve the pressure in the forward or working section of the cylinder **22.** It also functions as a safety valve. By arranging the pressure setting of the switch HPS_2 and that of the relief valve at a given differential, the ram continues, during the delay inherent in the relay T_3, to push or compact the load up to the level of the pressure set in the relief valve **40.** Preferably, the pressure differential and time delay are set so that the relief pressure setting is reached just an instant before the time period expires. This insures that the refuse load is compacted to a fixed pressure determined by the relief valve.

When the refuse is fully compacted, as determined by the cooperative operation of the pressure switch HPS_2, the relief valve **40** and the timing sequences of Timer TM and the delay action relay T_3, the load is ready for removal. The door **28** is then opened and a second manual switch S_2 is depressed. Switch S_2 has a contact A closing a circuit between the forward operating hydraulic valve VF, a contact D reversing the relay K_1 and a contact C normally closed in line with the high pressure switch HPS_2 and the delay relay T_3. When switch S_2 is depressed the ram is moved forward the full limit of its capable stroke ejecting the compacted refuse from the compaction zone.

Lastly, a safety switch M_1 for shutting off the motor is provided. This switch is also connected in line with the reversing hydraulic valve VR and thereby causes reversal of the ram automatically.

In operation, refuse is fed to the inlet and the compaction zone is closed. As soon as sufficient refuse has been accumulated the electric eye starts the machine, the ram is caused to first reverse until the low pressure switch HPS_1 causes it to then move forward, at which time the timer TM cuts in. The ram pushes forward until the expiration of the predetermined period set by the timer TM unless, within that period, the high pressure switch senses a fully compacted load for a given period of time.

Thus, if during the forward motion of the ram, the ram is arrested, or retarded in its movement by the back pressure of the refuse, at a given pressure level for more than the given time, the motor is stopped no matter what position the ram is in, and the unloading signal is obtained. The second time period (i.e. the interval of the relay T_3) must fall within the total predetermined time period set by the timer TM otherwise the ram stops as if only a partial load has been made, having not sensed a full load compacted at a given pressure for a given period of time. During the time interval of the of the relay T_3 the timer TM is in control and the ram continues moving forward at a pressure reaching toward that of the relief valve pressure setting. It is only after the given interval elapses that the relay T_3 trips and takes over control.

It is preferable to have the high pressure switch HPS_2 set at a level only slightly, a few hundred PSI, less than that of the setting on the relief valve. Thus, the actual pressure on a compacted load will be only slightly less than the maximum available, so that during the interval of the relay T_3 the load pressure could be easily increased to the maximum. Furthermore, preferably, the second time interval (T_3) is such that its length is sufficient to allow the building of the pressure in the system to the maximum. The final load on the refuse will, therefore, be substantially equal to that set by the relief valve.

It has been determined that each class of refuse has a different spring rate. Thus, household refuse differs from industrial refuse and household refuse itself differs in the general amount of solid, liquid, organic and inorganic matter it contains. By knowing the spring rate, or rate of expansion of the refuse, the density of the refuse as a function of its back pressure under compaction can be easily determined. Thus the pressure maximum level of the relief valve can be determined, the pressure level of the high pressure switch HPS_2 and time required to reach the maximum pressure are easily found. These can be set into the HPS_2 and relief valve **40** as previously described. The interval of the first timer TM controls only the position when the ram stops relative to the bulkhead. It thus, may be adjusted to vary the length of the load. The density of the load is not effected by the timer TM since the same applied pressure acts on the refuse from the combination of the high pressure switch HPS_2 and the relay T_3, less of course, frictional drag created by the walls of the compaction zone. The length of the load will thus, also influence its total weight.

Density may be changed by varying the pressure differential between the high pressure switch HPS_2 and the relief valve **40.**

As an example of the parameters which may be applied to the present system in a compaction chamber of

approximately 3½ feet from the face of the retracted ram to the bulkhead door, 12 inches from the forward ram face to the bulkhead door and a ram diameter of approximately 17 inches, the timer TM may be set at 17 seconds, the relay T_3 at 3 seconds, the relief valve **40** at 3,000 PSI, the high pressure switch at 2,700 PSI. Consequently the pressure differential of 300 PSI triggers the load sensing system, for a period of 3 seconds at which time the load approaches a 3,000 PSI level. Translated to the face of the ram, a pressure of approximately 35 lbs./sq. in. is developed on the refuse; sufficient to compact ordinary household refuse at a 4 or 5 to 1 ratio.

This is merely an example, other parameters will, of course, be determined based on the type of refuse to be compacted based on the spring rate of each.

Various modifications may be made. For example, the relay T_3 may be replaced by another timer or clock mechanism and separate relay. The hydraulic valves may be separate or combined, for example, in a three position four way valve. Other modifications will be obvious.

An advantage of the present invention other than in the simplified method described is that fact that no mechanical switches are used. Thus, all the control elements may be removed from the compactor proper and housed in a remote control panel. The only control lines necessary for operation which need be connected to the compaction apparatus, are the conduits for the hydraulic cylinder and the lead connections from the electric eye.

It will thus be seen that a simple, system and method has been developed by which hydraulic compaction can be obtained to a degree controlled solely by the hydraulic pressure system itself.

What is claimed is:

1. Apparatus for controlling the operation of a compactor formed of a longitudinal compression chamber, having an inlet at its rear end for delivery of material, a compaction zone, an outlet at its forward end for the expulsion of material, and a hydraulic ram adapted to reciprocate within said compression chamber, comprising means responsive to the delivery of said material for actuating said ram to move forward from said inlet toward said compaction zone, said means including timer means for extending the forward movement of said ram within a first predetermined time interval and thereafter retracting said ram, means for sensing the pressure on said hydraulic ram effected by the movement of said refuse during said first time interval, and means responsive during said first time interval to the sensing of a predetermined level of pressure for determining a second predetermined time interval less than said first predetermined interval, and means for arresting the forward movement of said ram within said first predetermined time interval on the expiration of said second time interval.

2. Apparatus according to claim **1** wherein said hydraulic ram includes a piston and a cylinder, a source of hydraulic fluid under pressure connected to said cylinder and valve means for delivering fluid to said cylinder to retract or extend said piston, and wherein said means for actuating said ram includes a photo sensor responsive to the delivery of a predefined quantity of material to actuate said valves.

3. The apparatus according to claim **2,** including valve means for the relief of said hydraulic fluid, said valve means being set to relieve hydraulic pressure in said cylinder at a predetermined level greater than said sensed predetermined level of pressure.

4. The apparatus according to claim **3** wherein said means for sensing the pressure level comprises a pressure switch connected with said cylinder, and said means for determining said second time interval comprises a time delay relay.

5. A method for controlling the operation of a hydraulic ram in compacting apparatus comprising the steps of actuating said ram in response to the delivery of material to said apparatus to move forward against said delivered material, extending the forward actuation of said ram for a predetermined time period, sensing the pressure in said ram in response to the compaction of material during said predetermined time period, determining a second time period upon sensing of a predetermined pressure level during said predetermined time, limiting said second time period to an interval less than said first time period and ceasing actuation of said ram in the event said predetermined pressure level is maintained for said second time period before expiration of said first time period.

6. The method according to claim **5** including the step of limiting the pressure on said ram to a fixed level, said fixed level being greater than said predetermined pressure determining the start of said second time period.

7. The method according to claim **6** including the step of determining the differential in pressure between said fixed level and said predetermined level and the second time period to limit said ram to continue actuation during said second time period to raise the pressure on said ram to the fixed pressure level.

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