July 25, 1961 H. W. ROCKWELL ET AL 2,993,283

EJECTOR RETURN MECHANISM FOR SCRAPER UNIT

Filed Dec. 11, 1958 4 Sheets-Sheet 1

Fig. 1

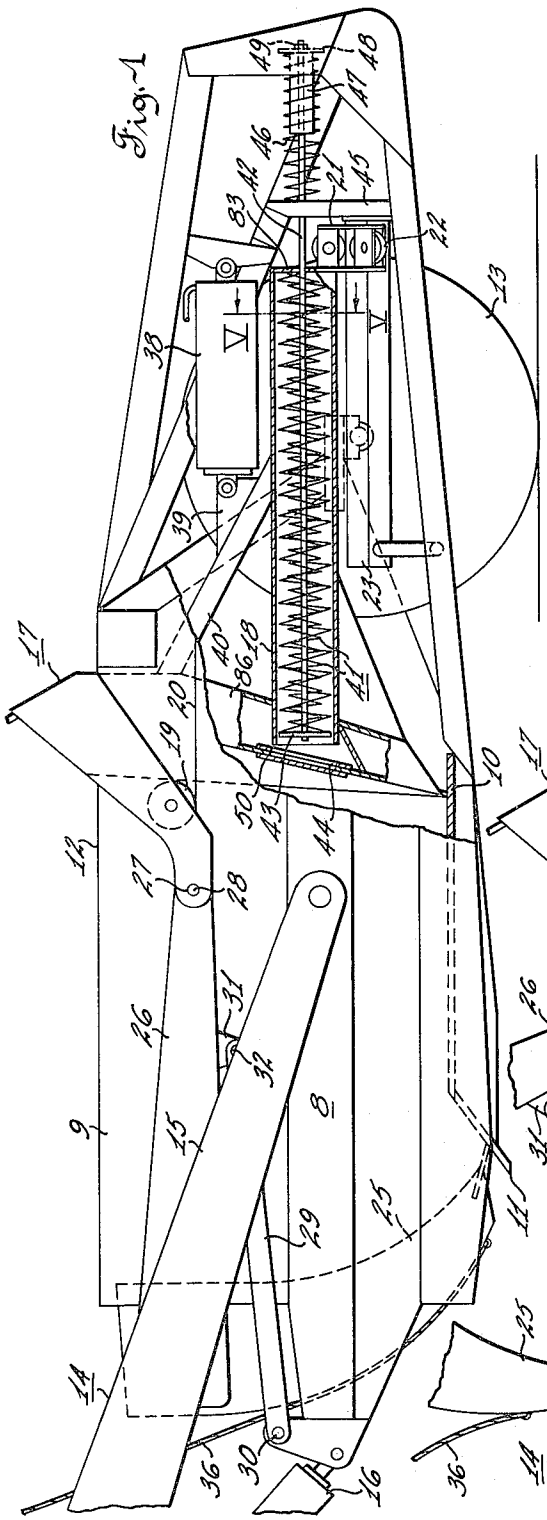
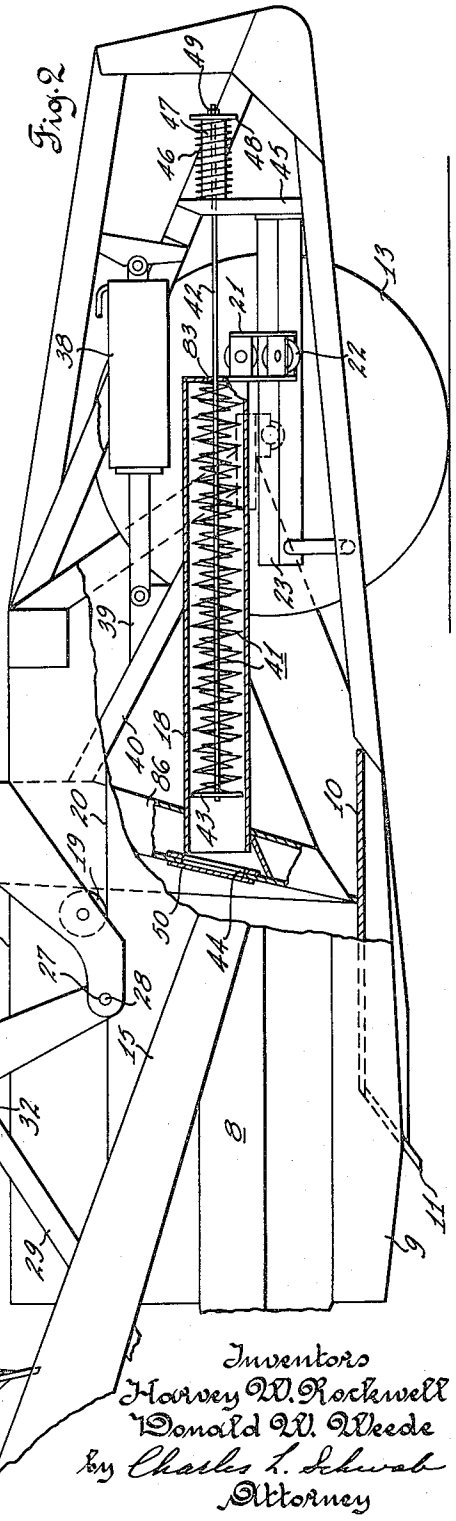


Fig. 2



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EJECTOR RETURN MECHANISM FOR SCRAPER UNIT

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Fig. 5

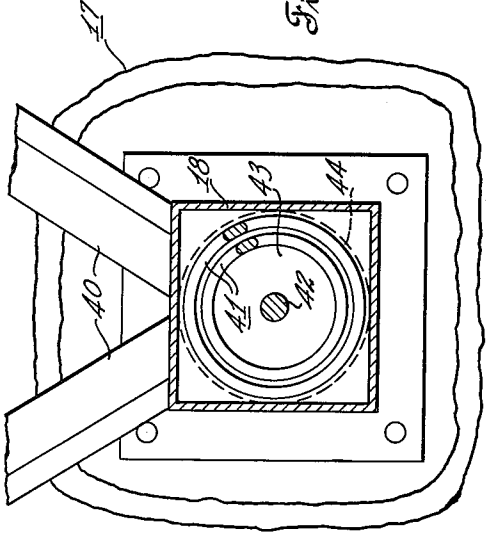


Fig. 3

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EJECTOR RETURN MECHANISM FOR SCRAPER UNIT

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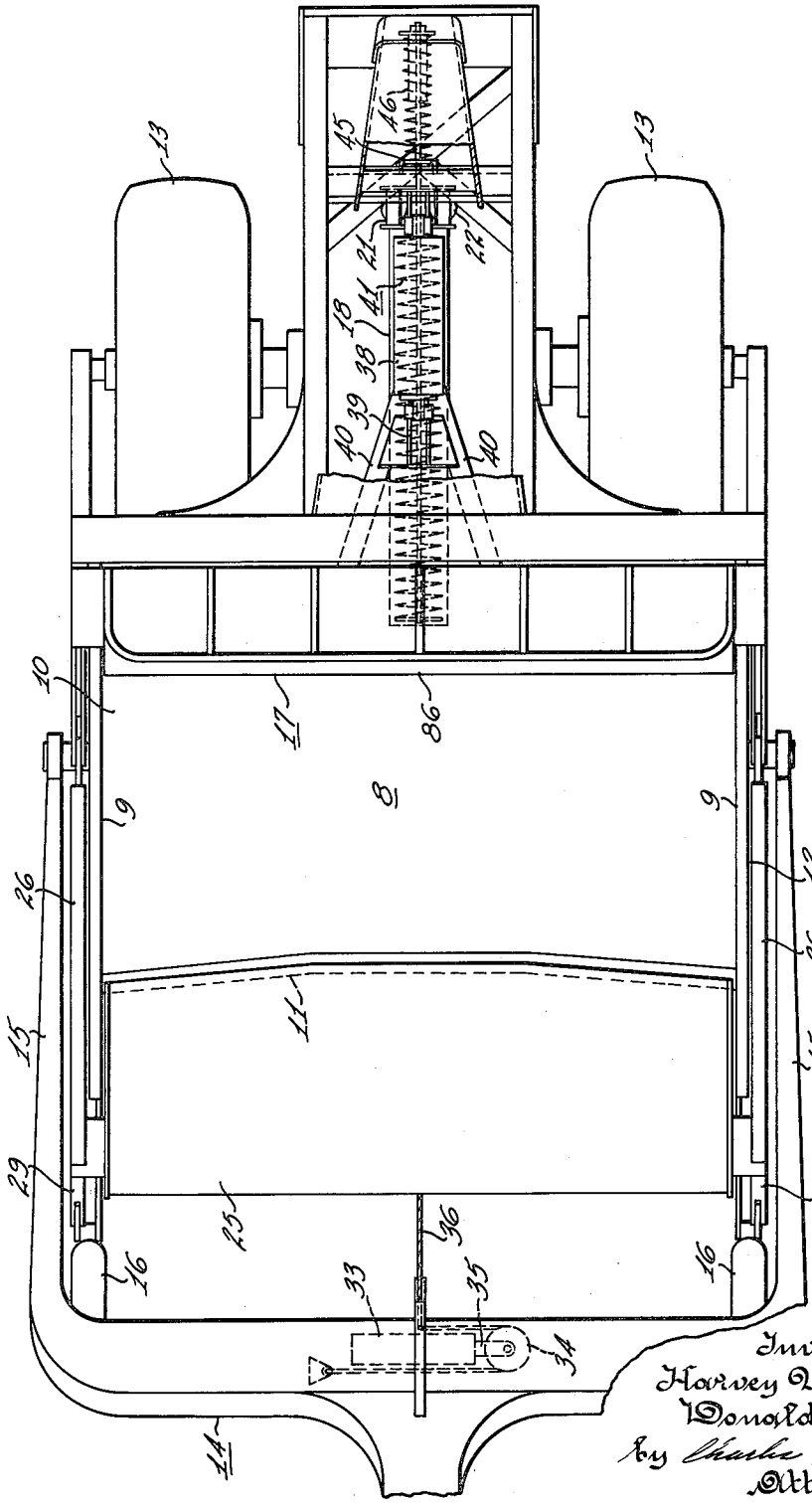


Fig. 4

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EJECTOR RETURN MECHANISM FOR SCRAPER UNIT

Filed Dec. 11, 1958 4 Sheets-Sheet 4

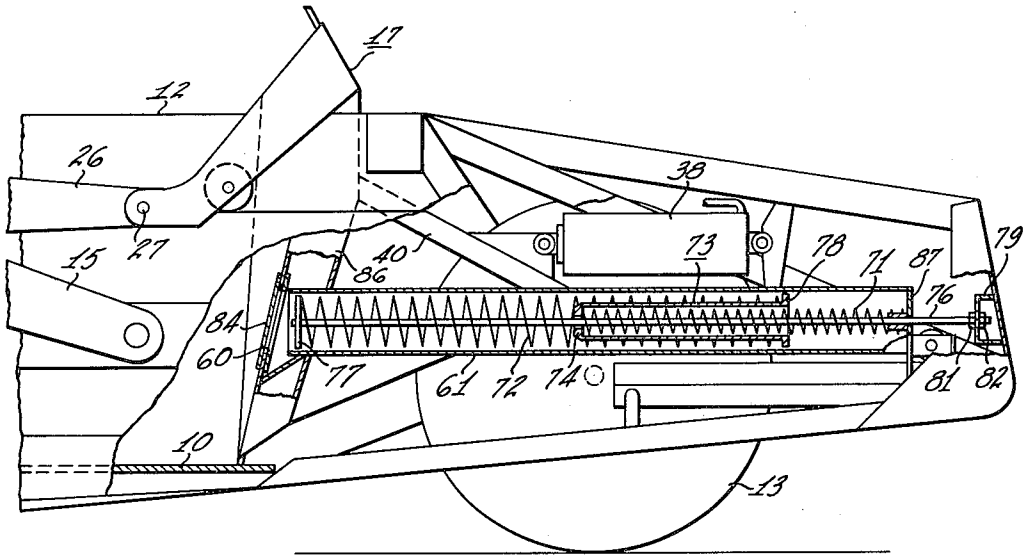


Fig. 6

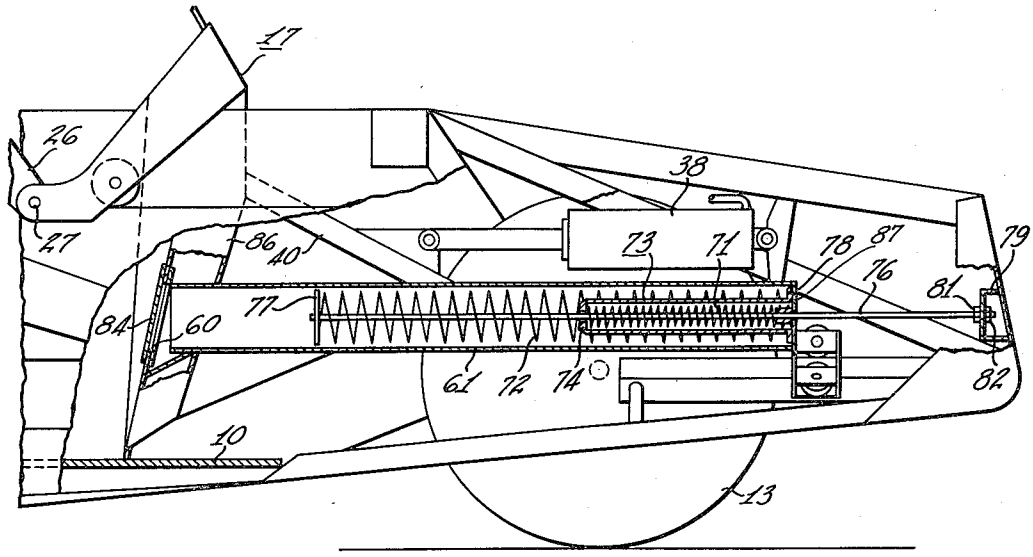


Fig. 7

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United States Patent Office 2,993,283 Patented July 25, 1961

2,993,283
EJECTOR RETURN MECHANISM FOR SCRAPER UNIT

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Filed Dec. 11, 1958, Ser. No. 779,639
18 Claims. (Cl. 37—124)

This invention relates to self-loading scrapers and is more particularly concerned with a spring return mechanism for the aprons and ejectors carried on such scrapers.

The usual scraper includes a wheel supported bowl frame substantially closed at the rear end by an ejector. The ejector is movable through the bowl in a forward direction by a hydraulic ram for discharging earth from the bowl over a cutting edge. Also there is provided a front apron movable initially by a hydraulic jack operated cable from a closed position completing the front end enclosure of the bowl to a scraping position, in which the bottom of the apron is spaced from the cutting edge of the bowl, and thence to an open position in which the apron is spaced a substantial distance from the cutting edge of the bowl.

In the type of scraper with which this invention is concerned, such as shown in the patent to L. L. Hyler, August 28, 1951, U.S. 2,565,851, the apron and ejector are pivotally connected to one another and have a pair of restraining links pivotally connected to the bowl and to the arms of the apron. The resulting interrelated movement of the apron and ejector permits the ejector to move to its forward or discharge position while the apron simultaneously pivots upward about its axis to an open position which affords a relatively large opening through which earth can be spilled from the front of the bowl. The return movement may be visualized by simply tracing the path of the upward movement of the apron and the forward movement of the ejector in reverse.

Various methods have been employed in the scraper industry for returning the apron and ejector to their respective closed and rearward positions. For example, coil springs have previously been used for returning the apron and ejector to their respective positions, such as shown in the patents to L. L. Hyler, U.S. 2,565,851 and U.S. 2,565,499 issued on August 28, 1951.

Although the prior coil spring arrangements have provided a convenient method for returning the apron and ejector, they have not been entirely satisfactory in that they did not take into account the established geometry of the apron ejector linkage. That is, during the initial forward movement of the ejector and after the initial upward movement of the apron the gravity force acting upon the apron creates a substantial force tending to return the apron to the closed position, thereby creating a resistance to the forward and upward movement respectively of the ejector and apron. As the ejector is moved forward by suitable power means such as a hydraulic jack the resistance due to gravity steadily decreases as the apron ejector linkage affords an ever increasing leverage advantage the closer the apron approaches its open position. Upon completely moving the ejector to its forward position, however, the apron has pivoted about its axis beyond an overcenter position whereby the gravity force acting upon the apron no longer tends to return the apron to its closed position, but actually resists such return movement.

During the initial return movement of the apron and ejector the various resistances acting against return of the apron and ejector, such as the gravity force on the apron, mass of the ejector and friction between moving parts, must be overcome. However, once the return movement reaches a point where the apron has pivoted about its axis

to a position forwardly of its overcenter position the gravity force acts to return the apron, thereby assisting rather than resisting the entire return movement.

The return movement, however, must be cushioned as by the resistance of the retracting movement of the pistons of the hydraulic jacks, or such other means as are employed to actuate the apron and ejector, in order to prevent the return movement from accelerating too rapidly, thereby causing serious damage to the system. It will be apparent from the apron ejector linkage geometry just described that the forces tending to return the ejector and apron are variable which necessitates a spring return linkage that takes into consideration the linkage geometry in order to provide a complementary matching force in order to obtain a smooth functioning and completely satisfactory return mechanism.

The lack of the previously used spring return in appreciating the geometry of the apron and ejector linkage is fully evident by analyzing the patent to L. L. Hyler, August 28, 1951, U.S. 2,565,499. In the patent to L. L. Hyler a coil spring having a constant high rate is positioned between the ejector and frame. The initial forward movement of the ejector and simultaneous upward movement of the apron is normally resisted by the mass of the material being discharged from the scraper bowl, friction and the gravity force acting upon the apron. It will also be apparent that the coil spring will resist forward movement of the ejector with a force that is constantly increasing at a high rate, thereby placing an additional load upon the power source in order to initiate such forward movement. The prior art coil spring, however, must be of a high rate in order to supply a closing force of sufficient magnitude to overcome the initial resistance against return movement due to the gravity force of the apron. But, after the initial stage of the return movement the apron will have been pivoted forwardly past the overcenter position and the high rate spring force combines with the gravity force acting upon the apron to rapidly accelerate the return movement, thus creating an overabundance of force effecting return movement. This combined force frequently causes the apron to slam down against the bottom of the bowl. Further, since this returning force is resisted principally by fluid being forced out of the hydraulic jacks, it often happens that a surge of fluid from the hydraulic cylinders is created which has an adverse effect upon the hydraulic system.

It will also be apparent that any preloading of the high rate spring will contribute to these undesirable characteristics, but unless this is done the apron may not completely close at such times, for example, when foreign material becomes lodged between moving parts of the linkage.

Other previously arranged spring returns using low rate springs to minimize the difficulty of excessive spring force have required an installation of a lengthy spring system in order to provide the required spring force for initially overcoming the gravity force of the apron to return the ejector. This has resulted in compromises in design which have not always been desirable, for instance, the scraper length may be greater than would otherwise be necessary.

Therefore, it is a general object of our invention to provide an ejector spring return mechanism that takes into consideration the existing geometry of apron and ejector linkages and overcomes the disadvantages of the prior art devices in an entirely satisfactory manner.

It is a further object of our invention to provide a spring return for ejectors that takes into account the geometry of the ejector linkage together with effects of the gravity force acting upon the apron to return the ejector to its rearward position.

It is a further object of our invention to provide a

spring arrangement supplying a variable rate spring force which combined with the gravity forces acting on the system permits a constant rate of return of the apron and ejector to their respective close and rearward positions.

It is a further object of our invention to provide high and low rate springs acting in series during the forward and return movement of the ejector.

It is a further object of our invention to provide serially acting springs for an ejector return mechanism wherein during initial forward movement of the ejector and simultaneous upward movement of the apron all of the springs compress simultaneously but at least one of the springs reaches a condition of full compression before the other springs of the series so that during the final stage of such movement only the remaining springs will be further compressed, and conversely during the initial return movement of the ejector and apron the springs will be decompressed in the reverse order so that all of the springs undergo decompression in the final stage of the return movement.

It is a further object of our invention to provide a high rate spring force to initially begin the return of the apron and ejector and a simultaneously acting low rate spring force combining with the gravity force acting upon the apron to complete the return of the apron and ejector to their respective rearward and closed positions without causing the apron to slam against the bottom of the bowl.

It is a further object of our invention to provide a coverable opening in the ejector forming an access to the ejector's extension for mounting springs therein.

It is a further object of our invention to provide a spring return having a variable spring rate with a low rate spring force reacting against the initial forward movement of the ejector thereby minimizing the resistance of the spring return system against forward and upward movement of the ejector and apron, respectively, and having a high rate spring force initially acting to return the apron and ejector.

It is a still further object of our invention to provide a spring return that takes into consideration the resistance to return formed by the retracting movement of the piston of the hydraulic jacks which operate the apron and ejector with a view to minimize undesirable surges of fluid into the hydraulic system.

These and other objects and advantages of this invention will become evident when the following description is read in conjunction with the accompanying drawings in which:

FIG. 1 is a view in side elevation, with parts in section, of a scraper embodying the present invention with the scraper shown in a load carrying position;

FIG. 2 is a view in side elevation, with parts in section, of a scraper embodying the present invention illustrating the apron in a partially open position;

FIG. 3 is a view in side elevation, with parts in section, of a scraper embodying the present invention illustrating the apron in its fully open position with the ejector fully advanced;

FIG. 4 is a top view of FIG. 1, with parts in section, embodying the present invention;

FIG. 5 is a sectional view taken along line V—V of FIG. 1;

FIG. 6 is a a view in side elevation, with parts in section, of a scraper unit embodying a modified form of the present invention with the scraper shown in its normal position for transporting a scraper load; and

FIG. 7 is a view in side elevation, with parts in section, of a scraper embodying the modified embodiment of the present invention with the scraper shown in a partially open position.

In FIGS. 1 through 5 of the drawings, a scraper of the type with which the present invention is used is illustrated having a main bowl frame **8** including a pair of laterally opposite side walls **9**, and a bottom **10** which at its forward end is provided with a cutting edge **11**. Adjacent the rear end of the bowl **12**, the scraper is supported by a pair of ground engaging wheels **13**. Intermediate its ends the bowl is supported by a yoke **14** having a pair of side arms **15** pivotally connected to the side walls **9**. Although it is not shown, yoke **14** is provided with a suitable connection by means of which it will be connected to and drawn by a tractor or like vehicle in a conventional manner.

The bowl **12** is adapted to be lowered or raised by a pair of double acting hydraulic jacks **16**, best shown in FIG. 4, thereby positioning the scraper in the loading position or in the transporting position.

The rear of the scraper is normally closed by an end gate **86** of the ejector assembly **17** which also includes a longitudinal hollow section extension **18**. The ejector **17** is adapted to be moved forward through the bowl to discharge the material collected therein. Ejector **17** is supported for this movement by rollers **19** engaging guide rails **20** one of which is secured to each of the bowl side walls, and a carriage **21** connected to the extension **18**, housing rollers **22** which engage a triangular section track **23**.

The front of the scraper bowl is closed by an apron **25** which is provided with laterally spaced rearwardly extending arms **26** pivotally secured by pins **27** to ejector **17**. Apron **25** is adapted to pivot about its pivot axis **28** between a lower position adjacent the leading cutting edge **11** and the open position away from the cutting edge wherein the bowl is open at its forward end. A pair of restraining links **29** are provided having one of its ends connected to the side walls **9** by pivot pins **30** and the other of its ends connected to a bracket **31** on the apron arms by pivot pins **32**.

The restraining links **29** form a toggle with apron arms **26** which permits the apron to be pivoted about its axis **28** affording an opening for scraping earth into the bowl without any appreciable forward movement of the ejector. As shown in FIG. 1, the toggle is in a nearly overcenter position with pivot point **32** positioned slightly below a straight line passing through pivot points **28** and **30**.

To produce movement of the apron to afford an opening for the scraping of earth into the bowl and to break the overcenter toggle which resists forward movement of the ejector a power means in the form of hydraulic jack **33** is provided. Jack **33**, as shown in FIG. 4, is horizontally disposed between the bowl frame **8** and has a pulley **34** mounted on the outer end of the piston rod **35**. A cable **36** is connected to an eye on the apron, passes over the pulley **34** and extends to a suitable tiedown on the yoke frame **14**.

The apron and ejector are interconnected so that they operate as a unit. Thus, when the ejector has moved to its forward position, the apron has simultaneously moved to its open position; and when the ejector has returned to its rearward position, the apron has correspondingly returned to its closed position.

To actuate the ejector **17** forwardly and correspondingly causing the apron to pivot about its axis **28** to its open position a power means in the form of a single acting two stage telescoping hydraulic jack **38** is provided. The jack **38** is connected at one end to the bowl frame **8** and at its other end to a beam **39** disposed between a pair of reinforced structures **40** connected to the rearward end of the ejector. To return the apron and ejector to their respective closed and rearward positions a spring return mechanism incorporating the present invention is provided.

In the preferred embodiment of the spring return mechanism, illustrated in FIGS. 1 through 5, an opening **44** is provided extending through end gate **86** of the ejector and in registration with the forward open end of extension **18** the latter in effect forming a part of the return mechanism. An assembly of helical coil springs **41** including an outer and inner series of coaxially

mounted coil springs are installed through the opening 44 within extension 18. Coil spring assembly 41 is designed to provide a high spring rate or in other words to provide a high reactive force per unit of compressive displacement of the springs. It should be understood, however, that it is not intended to necessarily limit the invention to an assembly of springs since a single spring of desired length having the proper size and number of coils may be selected to obtain the desired spring rate. A rod 42 having a plate member 43 connected to its forward end is installed through the opening and positioned so as to interpose the high rate springs 41 between the rearward end plate 83 of extension 18 and the plate member 43. The rod 42 is positioned in concentric relationship with springs 41 and has its rearward end extending through an opening in the rearward end of the extension. A brace member 45 extending from the bowl frame 8 is positioned between the rearward end of extension 18 and the rearward end of the rod 42. A single helical coil spring 46 acts in series with spring 41, being positioned on the rearward end of the rod in concentric relationship thereto and having its forward end abutting the brace member 45. Spring 46 may be a low rate spring having a lower rate than springs 41 or may be of the same or of a higher rate than springs 41 but being considerably shorter in length than springs 41. The significance of spring 46 will be discussed more fully when the operation of the system is explained. A stop member 47 having a radially flanged end 48 serving as a hold member is positioned on the rearward end of the rod 42 and is retained thereon by a self-locking nut 49 which in effect maintains spring 46 between the brace member 45 and flanged end 48. Upon installation of springs 41 and 46 a cover 50 is bolted to the ejector covering opening 44.

FIGS. 6 and 7 illustrate a modified form of this invention. As illustrated, an opening 60 is provided through the ejector in registration with the forward open end of an extension 61 fixed on end gate 86 of ejector 17. A helical coil spring 71 similar in character to spring 46 acts in series with a high rate spring 72. Springs 71 and 72 are positioned within extension 18 being insertable through the opening 60 and are being placed in thrust transmitting relation to one another by means of tube member 73. Spring 71 is interposed between the rearward end portion 87 of extension 61 and a forward flange 74 of the tube member 73, and in concentric relationship to a rod 76. The spring 71 is also concentrically surrounded by the tube member 73. The high rate spring 72 is interposed between a plate or hold member 77 and the rearward flange 78 of the tube member 73 and concentrically surrounds the tube member 73. In this embodiment the rod is rigidly connected to the push frame 79 of the bowl frame by a nut 81 and a jam nut 82 and resists forward movement of the rod. Upon complete installation of the springs a cover 84 is bolted over the opening 60.

As is well known in the art, most all spring designs including the embodiment of FIGS. 1 through 5 and the embodiment of FIGS. 6 and 7 are founded upon Hook's law which states that within the elastic limit of any material deflection is directly proportional to load. The term load as used herein relates to the force built up by compressing a spring to counteract applied load in a device such as the spring return mechanism.

Serially acting springs 41 and 46 of the spring return mechanism may be thought of as a unitary spring system. Spring 41 has been described as having a high spring rate. This means that the force build-up per unit of compressive deflection of the spring 41 although constant is quite rapid. Stated differently, the load versus deflection curve for spring 41 would be a substantially straight line having a fairly steep slope as compared for instance to a similar curve for spring 46. Spring 46 is described as providing a low spring rate which means that there is a low constant rate of force build-up per unit of compressive deflection of the spring.

It will be readily apparent that as springs 41 and 46 are compressed simultaneously the spring system will have a constant spring rate and the load or force build-up will be directly proportional to the compressive deflection or displacement of the system. After a predetermined amount of displacement, however, a stop member 47 prevents further compression of spring 46 so that the spring rate of the system during further compression will be determined by the spring rate of spring 41 independently of spring 46. Since spring 41 is a high rate spring, the actual spring rate of the system has been increased substantially. In other words, the spring system made up of springs 41 and 46 provides a variable spring rate.

To match a spring system to the particular geometry of the apron and ejector linkage a high rate spring 41 and a low rate spring 46 have been selected. It is to be understood, however, that it is not intended to limit the invention to this arrangement since a variable spring system may be designed with springs 41 and 46 having the same spring rate. This is so because during compression the increase of the spring rate of the system occurs after a predetermined amount of displacement and is actually due to the decrease in the number of active coils of the spring system. This decrease is, of course, brought about by the stop means 47 which prevents further compression of spring 46 during the final stages of compressive displacement of the system. It will be apparent that during decompression of the system from the full compressed condition a high spring rate will be initially provided as spring 41 decompresses independently and that during the final stage a lower spring rate is provided as springs 41 and 46 decompress simultaneously.

It is to be understood also that the serially acting springs 71 and 72 of the embodiment of FIGS. 6 and 7 form a spring system that has a variable spring rate similar to springs 41 and 46. In operation the two systems perform identically.

Operation

The operation of the preferred form of the spring return mechanism is best illustrated in FIGS. 1 through 3. As shown in FIG. 1, the apron and ejector are in their closed and rearward positions, respectively, with the scraper in a load carrying position. When a suitable site has been found for unloading earth contained within the bowl, the apron is raised by cable 36 and hydraulic jack 33 until the overcenter toggle restricting forward movement of the ejector has been broken. Thereafter hydraulic jack is expanded moving the ejector forward simultaneously pivoting the apron to the right about pivot axis 28 toward its open position. This forward movement of the ejector will, of course, begin to compress the spring return mechanism. During initial forward movement of the ejector, the mass of the material collected in the bowl as well as the gravity force acting upon the apron provides substantial resistance against forward movement and together with springs 41 and 46 tends to hold the ejector in its rearward position. Referring now to FIG. 2, as the resistance against forward movement is overcome and ejector 17 begins to move forward through the bowl, springs 41 undergo compression and exert a forward thrust on rod 42 which is transmitted to the hold member 48 thereby compressing spring 46 simultaneously. Assuming now that spring 46 which has a shorter length than springs 41 also has a lower spring rate than the high rate springs 41, forward movement of ejector 17 will tend to compress spring 46 at a much greater rate than springs 41; and when stop member 47 abuts brace member 45 of the bowl frame, the low rate spring 46 will have reached a fully compressed condition. Up to this point of the operation it will be readily apparent that the springs have undergone simultaneous compression and the resultant spring rate of the serially acting spring system of springs

46 and 41 is lower than that of the low rate spring 46 acting alone and a considerable displacement of the ejector assembly has been permitted without an excessively high spring force being built up. It will now be readily apparent that a series spring system having a resultant spring rate lower than the spring rate of any of the springs acting singly may also be obtainable by selecting spring 46 with a spring rate the same as or even greater than springs 41. It is essential, however, that spring 46 be made shorter in length so that it will reach its fully compressed condition prior to spring 41. In carrying out the present invention spring 46 is preferred to be of a lower rate than springs 41 as this provides a convenient arrangement to meet the space and force requirements of the disclosed apron and ejector assembly.

As the ejector continues to move forward through the bowl after spring 46 is fully compressed and stop member 47 is in abutting relationship with brace member 45; member 43 continues to move closer to plate member 83, and springs 41 alone undergo further compression until the ejector reaches its forwardmost position. During this interval of operation the high rate springs 41 will develop a considerably high reactive force per unit of displacement with the maximum force of the serially acting spring system of springs 41 and 46 occurring when springs 41 become fully compressed, as shown in FIG. 3. It will be noted that the resistance against forward movement of the ejector due to the gravity force acting upon the apron steadily decreases as the latter pivots upwardly because the apron ejector linkage affords an ever increasing leverage advantage the closer the center of gravity the apron approaches vertical alignment with pivot axis 28, this vertical alignment being referred to herein as the overcenter position of the apron. It will be noted further that as the apron is pivoted open to the overcenter position in which the gravity force acts through pivot axis 28, it will cease to resist forward movement of the ejector; and as the apron continues to pivot to the right about axis 28 and into the fully open position, the gravity force will actually assist jack 38 to fully compress springs 41, as shown in FIG. 3.

Referring to FIG. 3, the apron and ejector are now in their open and forward positions, respectively; and the full spring force to effect return of the apron and ejector has been developed. In this position the gravity force acting upon the apron tends to resist any return movement of the apron and ejector to their respective closed and rearward positions and to overcome this resistance a high spring rate is essential. To commence the return movement the force exerted upon the ejector by the hydraulic jack 38 is released. Immediately the high rate springs 41 begin to expand, as the resistance due to friction, mass of the ejector, the gravity force on the apron and the resistance of hydraulic fluid in jack 38 is overcome, thereby pivoting the apron to the left about axis 28 toward its closed position which simultaneously moves the ejector toward its rearward position. As springs 41 continue to expand, the apron will pivot to the left, past the overcenter position whereby the gravity force acting upon the apron will begin to assist springs 41 to return the ejector. The return movement at this point is now being resisted principally by the friction of moving parts and the resistance due to hydraulic fluid which must be expelled from the cylinders of jack 38.

Once the apron is pivoted to the left past the overcenter position the gravity force acting to close the apron steadily increases due to the gain in leverage or mechanical advantage afforded by the linkage, which was previously referred to in describing the opening operation; and it will be apparent that during this interval of return movement very little spring force is necessary. In designing the return system this has been fully considered; and as the gravity force very rapidly increases, the spring force will rapidly decrease as the high rate springs 41 decompress. At the point where springs 41 and spring 46 begin to simultaneously decompress the combined reactive force will decrease at a much lower rate per unit of decompression. However, during the final stages of the return movement the combined force exerted by springs 41 and 46 is entirely adequate to complete the return of both apron and ejector. Also, during the return operation when the magnitude of the gravity force acting upon the apron nears its maximum value, the slack in cable 36 will have been taken up and hydraulic fluid being expelled from the cylinder of jack 33 will tend to resist an accelerated return movement of the apron. As high rate springs 41 and low rate spring 46 simultaneously decompress, their combined force together with the gravity force on the apron operates to expel the fluid trapped in jacks 33 and 38 thereby returning the ejector to its rearwardmost position and completely closing the apron against the leading cutting edge of the scraper bowl. From the foregoing description of the return operation it will be apparent that a spring return system has been provided which has a variable spring rate that is matched to the other forces acting upon the apron and ejector linkage. For instance, a high spring force is necessary to initiate the return movement but once the gravity force on the apron begins to assist the return movement very little spring force is required. In the disclosed arrangement, as the gravity force increases, the spring force decreases at almost the same rate, the result being that throughout the entire return operation a nearly uniform return force is maintained which assures complete closing of the apron without slamming it against the bottom of the bowl and without adversely affecting the hydraulic system.

The operation of the modified spring return is illustrated in FIGS. 6 and 7. As shown in FIG. 6, the scraper is in the load carrying position. At a suitable site for unloading the apron is raised by a cable and hydraulic jack arrangement, similar to that shown in FIGS. 1 and 4, until the overcenter toggle restricting forward movement of the ejector has been broken. At this point of the operation hydraulic jack 38 expands moving the ejector forward and simultaneously pivoting the apron upwardly and to the right about axis 28 into its open position. As shown in FIG. 7, during initial forward movement of the ejector, both the high rate spring 72 and spring 71 are compressed simultaneously until the rearward end of the extension abuts the rearward flange 78 of the tube member 73. Continued forward movement of the ejector further compresses only the high rate spring 72 and the spring return reaches its full compression and developes its maximum reactive force when the ejector reaches its forwardmost position and the apron its openmost position. The interreaction of the gravity force and spring force and their influence upon the apron and ejector during the opening operation is the same as that hereinbefore described in connection with the opening operation of the embodiment shown in FIGS. 1 through 5.

The return operation is also accomplished in the same manner as hereinbefore described for the preferred embodiment. That is, as the force exerted upon the ejector by jack 38 is released, the high rate spring immediately expands tending to overcome the resistance against return movement which is due mainly to the gravity force of the apron, friction, the mass of the ejector and the hydraulic fluid trapped in jack 38. The sequence of the interreaction between the gravity force; the low and high rate spring forces; and the reaction of the hydraulic jacks 38 and 33 as the apron is closed simultaneously as the ejector is returned to the rearward position, are also the same as hereinbefore described in connection with the embodiment of FIGS. 1 through 5.

Considering the invention from a general point of view it will be noted that the high rate springs 41 in the preferred embodiment and spring 72 in the modified embodiment serve as a primary spring which is assembled in series with a secondary spring which is exemplified

in the preferred embodiment by spring 46 and in the modification by spring 71. In more closely examining the embodiment of FIGS. 1 through 5 it will be noted that in the respective closed and rearward positions of the apron and ejector, as shown in FIG. 1, one end of the primary spring 41 is disposed in thrust transmitting relationship with the ejector by means of plate 83, and one end of the secondary spring 46 is disposed in thrust transmitting relationship with the bowl frame by means of brace 45 and that rod 42 serves as a means for connecting the other ends of springs 41 and 46 in thrust transmitting relationship with each other. In the embodiment of FIG. 6 one end of the primary spring 72 is disposed in thrust transmitting relationship with the bowl frame by means of rod 76 and hold member 77; and one end of the secondary spring 71 is disposed in thrust transmitting relationship with the ejector by means of end portion 87 and extension 60; and tube 73 serves as a means for connecting the other ends of springs 71 and 72 in thrust transmitting relationship.

During the initial stage of forward movement of the ejector toward the discharge position the primary and secondary springs are compressed simultaneously until the secondary spring is prevented by a stop means (member 47 in FIG. 2 and member 73 in FIG. 7) from undergoing further compression, so that during the final stages of such movement the primary spring will be further compressed independently of the secondary spring until the apron and ejector reaches the discharge position, shown in FIG. 3. In each of the embodiments of this invention during the initial stage of return movement of the apron and ejector, the primary spring will decompress alone and during the final stages both the primary and secondary springs will decompress simultaneously. The interreaction of the primary and secondary springs provides a spring return system having a variable spring rate so that simultaneous compression or decompression is at a rate lower than the spring rate of either of the springs acting singly, and compression or decompression of the primary spring only is at a higher rate. It will also be seen that by properly matching the primary and secondary springs, as to their free length and spring rate, a spring return system is obtainable which matches the force requirements dictated by the geometry of the apron and ejector linkage.

From the foregoing detailed description it will be apparent that the novel spring return mechanism which has been illustrated was designed with the geometry of the apron ejector linkage having been taken into account so as to provide a smooth uniform closing movement of the apron and a smooth and uniform return movement of the ejector. Although only two particular embodiments of the present invention have been illustrated and described in detail, it should be understood that it is not intended to limit the invention thereto and that any patent granted hereon is intended to cover all modifications which would be apparent to one skilled in the art and that come within the scope of the appended claims.

Having now particularly described and ascertained the nature of our said invention and the manner in which it is to be performed, we declare that what we claim is:

1. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms pivotally connected to said ejector assembly; means for connecting said apron to said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means having a variable spring rate reacting between said ejector and said bowl frame, said return means including serially acting springs, said springs being compressed during movement of the ejector toward said forward position, said springs being expanded to effect the return movement of said ejector and apron toward their respective rearward and closed positions, a first constant spring rate being provided during the first stage of said return movement and during the final stages of said return movement a constant spring rate being provided which is lower than said first spring rate.

2. In a wheeled scraper unit including a bowl frame having laterally opposite sides, an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting said apron with said bowl frame whereby forward movement of said ejector assembly imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a pair of springs acting in series, both of said springs being simultaneously compressed during the initial stage of movement of said ejector toward said forward position, and a stop means for limiting the amount of compression of one of said springs so that during the final stages of said movement the other of the springs undergoes further compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

3. In a wheeled scraper unit including a bowl frame having laterally opposite sides, an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting said apron with said bowl frame whereby forward movement of said ejector assembly imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a plurality of springs acting in series, said springs being simultaneously compressed during the first stage of movement of said ejector toward said forward position; means for limiting the extent of compression of one of said springs so that during the final stages of said movement the other of said springs undergoes compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

4. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting said apron with said bowl frame whereby forward movement of said ejector imparts up-

ward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a pair of springs acting in series so that both of said springs are simultaneously compressed during a period of movement of said ejector toward said forward position, one of said springs becoming fully compressed prior to the other of said springs so that during the final stages of said movement said other of the springs undergoes further compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

5. In a wheeled scraper unit including a bowl frame having laterally opposite sides, an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting said apron with said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a primary and a secondary spring coaxially aligned and acting in series, one end of one of said springs disposed in thrust transmitting relationship with said ejector, one end of the other of said springs disposed in thrust transmitting relationship with said bowl frame and the other end of said one spring disposed in thrust transmitting relationship with the other end of said other spring, both of said springs being simultaneously compressed during the initial stage of movement of said ejector toward said forward position, and a stop means for limiting the amount of compression of said secondary spring so that during the final stages of said movement said primary spring undergoes compression independently of said secondary spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

6. The combination set forth in claim 4 wherein one end of said primary spring is disposed in thrust transmitting relationship with said ejector, one end of said secondary spring is disposed in thrust transmitting relationship with said bowl frame, and a means is provided for connecting the other end of said primary spring in thrust transmitting relationship with the other end of said secondary spring.

7. The combination set forth in claim 5 wherein said primary spring has a high spring rate and said secondary spring has a low spring rate.

8. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting one of the arms of said apron and said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a rod having an axis extending longitudinally of said scraper unit and having one end anchored on one of said ejector and bowl frame, a hold member fixed on said rod, a first and a second compressible spring carried in series on said rod, one end of one of said springs disposed in thrust transmitting relationship with said hold member, one end of the other of said springs disposed in thrust transmitting relationship with the other of said ejector and bowl frame, and thrust transmitting means for operatively interconnecting the other ends of the springs, said springs being simultaneously compressed during the initial period of movement of said ejector toward said forward position, said first spring becoming fully compressed prior to said second spring so that during the final stage of said movement said second spring undergoes further compression independently of said first spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

9. The combination set forth in claim 8 wherein said rod is anchored on said bowl frame, one end of said first spring is disposed in thrust transmitting relationship with said ejector, one end of said second spring is disposed in thrust transmitting relationship with said hold member, and said thrust transmitting means serves also as a stop to limit the amount of compression of said first spring.

10. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link for connecting said apron with said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a rod having an axis extending longitudinally of said scraper and having one end anchored on one of said ejector and bowl frame, a hold member fixed on the opposite end of said rod, a first and a second compressible spring carried on said rod, said first spring reacting between said hold member and one end of said second spring, said second spring reacting between the other of said ejector and bowl frame and one end of said first spring, said springs acting in series and being simultaneously compressed during the initial period of movement of said ejector and apron to said forward and open positions with one of said springs becoming fully compressed prior to the other so that during the final stages of said movement said other of the springs undergoes compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

11. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly having

an end gate mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link interconnecting one of the arms of said apron and said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector assembly and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a hollow extension extending longitudinally of said scraper and connected on the end gate of said ejector, said extension having a closed end remote from said end gate, a rod having one end anchored on said bowl frame and extending into said extension through an opening in said closed end, a hold member fixed on the end of said rod disposed within said extension, a tube member within said extension being slidably carried on said rod and having a radially inwardly extending flange in spaced relation from said hold member and radially outwardly extending flange in spaced relation from the closed end of said extension, a first compressible spring carried on said rod in overlapping relation to said tube and reacting between said hold member and said radially outward flange, a second spring carried on said rod, extending within said tube and reacting between the closed end of said extension and the radially inner flange of said tube, movement of said ejector toward said forward position simultaneously compresses both of said springs until said tube is forced into abutting relationship with the closed end of said extension so that during the final stage of said movement said second spring undergoes further compression independently of said first spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

12. The combination set forth in claim 11 including an opening extending transversely through the end gate of said ejector assembly, said extension having an open end in registration with said opening, and a detachable cover means associated with said end gate for closing said opening.

13. A scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position, an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including restraining links for connecting said bowl frame and said arms and forming an overcenter toggle with the latter for pivoting the apron upwardly to its open position and thence downwardly to its closed position as said ejector moves to its forward and thence to its rearward position, said toggle restraining initial forward movement of the ejector while said apron is opened to a loading position; a first means reacting between said scrapper unit and said apron for initially raising the apron and thereby breaking the overcenter toggle; a second means interposed between the ejector and frame for simultaneously moving the ejector and apron to their respective forward and open positions after said initial raising of the apron; and a spring return mechanism for said ejector including a first and a second spring positioned between said ejector and bowl frame to act in series relationship with one another, said springs being simultaneously compressed with said first spring and thence said second spring becoming fully compressed in respective order as said ejector moves to said forward position, said springs being expansible in reverse order for returning said ejector and apron to their respective rearward and closed positions.

14. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link interconnecting one of the arms of said apron and said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame for returning said apron and ejector from said open and forward positions, said spring return means including a rod having an axis extending longitudinally of said scraper and through openings respectively provided by portions of said ejector and bowl frame, hold means fixed respectively on opposite ends of said rod, a compressible spring carried on said rod and reacting between one of said hold means and said ejector, a second compressible spring carried on said rod and reacting between said bowl frame and the other of said hold means, said springs acting in series and being simultaneously compressed during the initial period of movement of said ejector toward said forward position, one of said springs becoming fully compressed prior to the other so that during the final stage of said movement said other of the springs undergoes compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

15. The combination set forth in claim 14 wherein a stop member acts between a hold means and one of said ejector and bowl frame for limiting the amount of compression of said one spring.

16. In a wheeled scraper unit including a bowl frame having laterally opposite sides; an ejector assembly mounted between said opposite sides for reciprocating movement between a forward and a rearward position; an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector assembly; means including a restraining link interconnecting one of the arms of said apron and said bowl frame whereby forward movement of said ejector imparts upward swinging movement to said apron toward an open position and whereby downward movement of said apron toward a closed position imparts rearward movement to said ejector; power means reacting between said ejector and said bowl frame for simultaneously moving said ejector and apron to their respective forward and open positions; and a spring return means reacting between said ejector and said bowl frame, said spring return means including a brace member fixed on said bowl frame, a rod having an axis extending longitudinally of said scraper and extending through openings provided respectively in said brace member and a vertically disposed portion of said ejector, a hold means fixed respectively on opposite ends of said rod, a compressible spring carried on said rod and reacting between one of said hold means and said ejector, a second compressible spring carried on said rod and reacting between said brace member and the other of said hold means, a stop means carried on said rod and associated with one of said hold means, said springs acting in series and being simultaneously compressed during the initial period of movement of said ejector toward said forward position until said stop means presents one of said springs from being further compressed so that during the final stages of said

movement said other of the springs undergoes compression independently of said one spring, said springs being expansible in the reverse order to effect the return movement of said ejector and apron to their respective rearward and closed positions.

17. A scraper unit comprising a bowl frame having laterally opposite sides; an ejector assembly including an end gate mounted between said opposite sides for reciprocating movement between forward and rearward positions, an apron having a pair of rearwardly extending arms; means for pivotally connecting the arms of said apron to said ejector for swinging movement; means including restraining links for connecting said bowl frame and said arms the latter forming an overcenter toggle with said arms for pivoting the apron upwardly to its open position and thence downwardly to its closed position as said ejector moves toward its forward and thence toward its rearward position, said toggle serving to restrain initial forward movement of the ejector while said apron is opened to a loading position; a first means for initially raising the apron just past said loading position and thereby breaking the overcenter toggle; a second means interposed between the ejector and frame for simultaneously moving the ejector and apron to their respective forward and open positions after said initial raising of the apron; and a spring return mechanism for said ejector including a hollow extension extending longitudinally of said scraper and connected at the rear of said end gate, an end plate fixed on the end of said extension remote from said end gate, a brace member connected on said bowl frame, a rod extending longitudinally of said scraper unit and passing through openings provided respectively in said end plate and brace member, a hold element connected on the end of said rod within the extension, a stop member connected on the opposite end of said rod and having a radially outwardly extending flange, a first spring carried on said rod and reacting between said end plate and said hold element, a second spring carried on said rod in overlapping relationship with said stop member and reacting between said radial flange and said brace member, said springs being simultaneously compressed as said ejector moves toward said forward position, until said second spring is compressed to a point where said stop member abuts said brace member after which said first spring undergoes compression independently of said second spring, during the final stage of said forward movement, said springs being expansible in reverse order for returning said ejector and apron to their respective rearward and closed positions.

18. The combination set forth in claim 17 including an opening extending transversely through said end gate, said extension being connected on said end gate and having an open end connected in registration with said opening, and a detachable cover means associated with said end gate for closing said opening.

References Cited in the file of this patent

UNITED STATES PATENTS

2,565,499	Hyler	Aug. 29, 1951
2,573,765	Gustafson	Nov. 6, 1951
2,844,431	Hamlett	July 22, 1958