Aug. 21, 1962 G. T. COHRON ET AL 3,049,819

EARTH MOVING SCRAPER BOWL CONSTRUCTION

Filed May 13, 1960 4 Sheets-Sheet 1

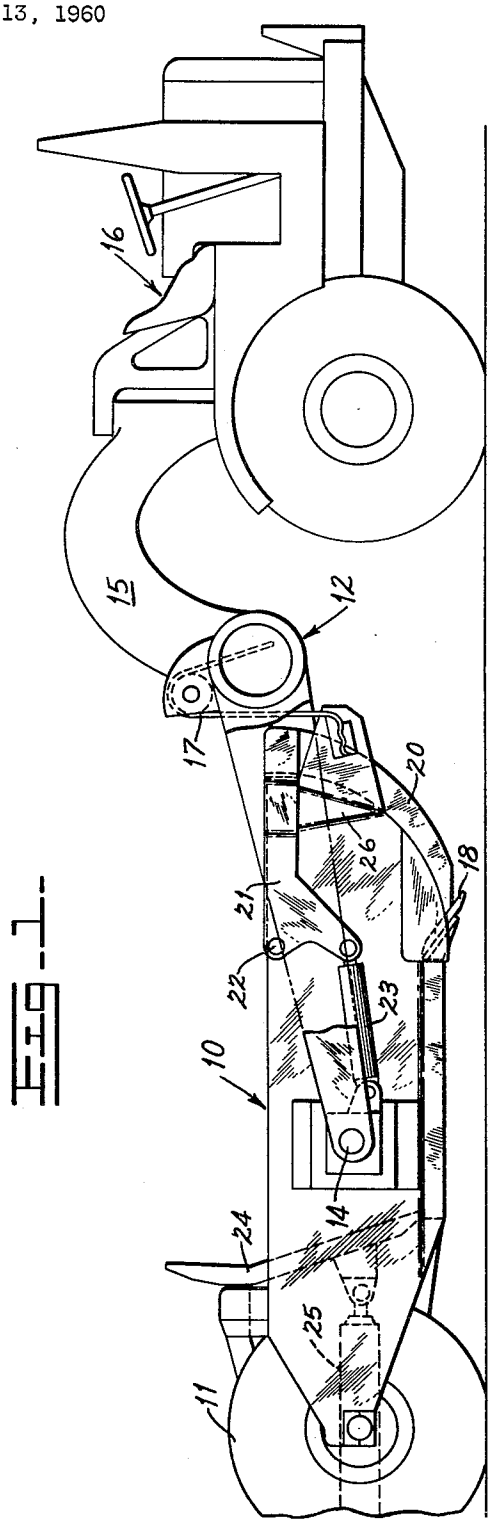


Fig. 1

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Fig. 2.

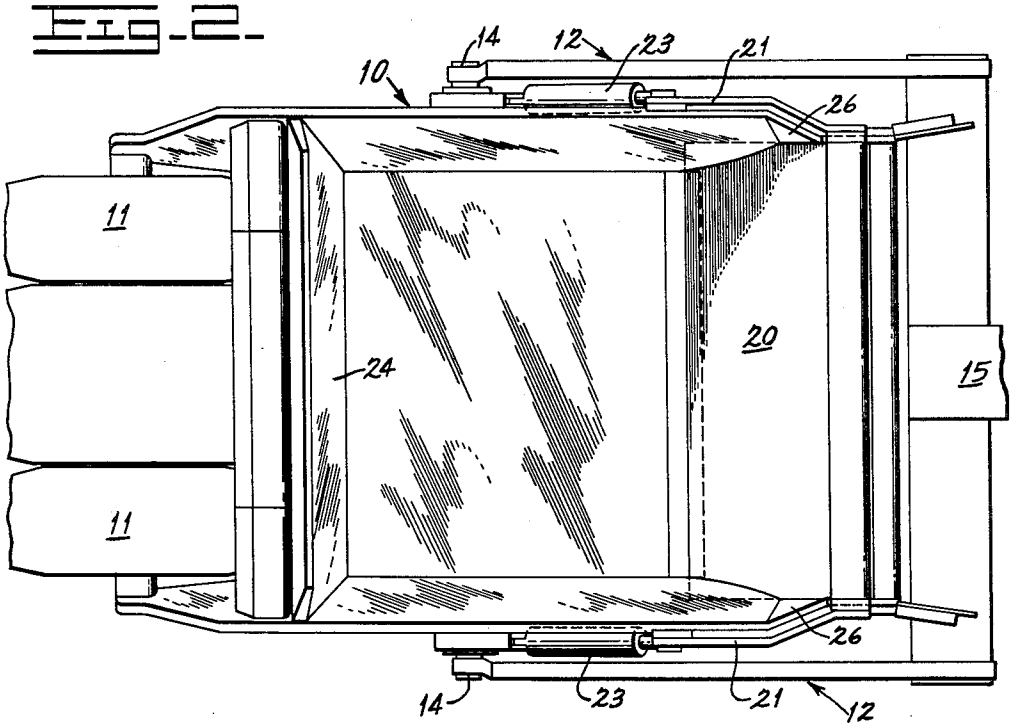
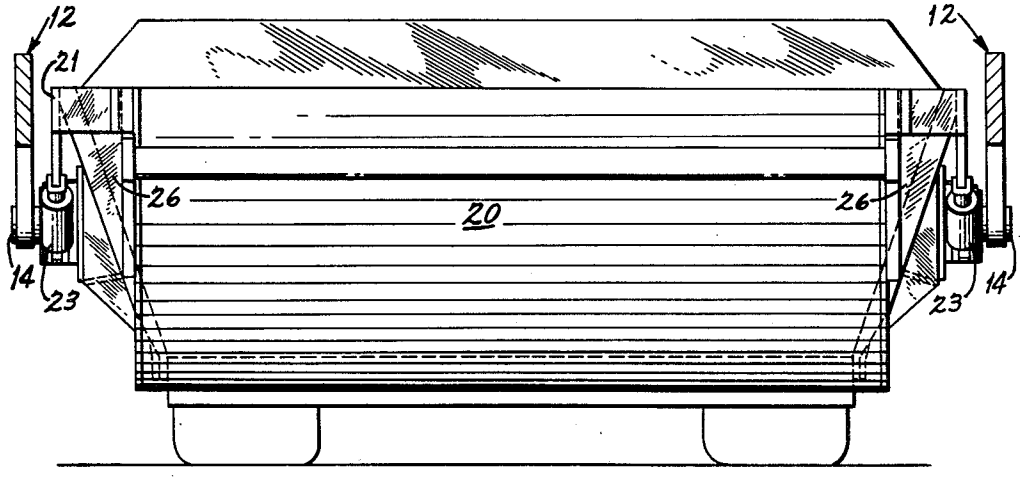


Fig. 3.



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Fig. 4.

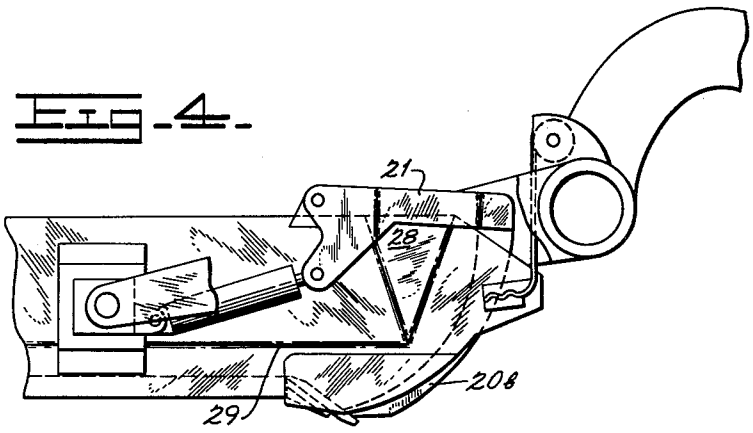
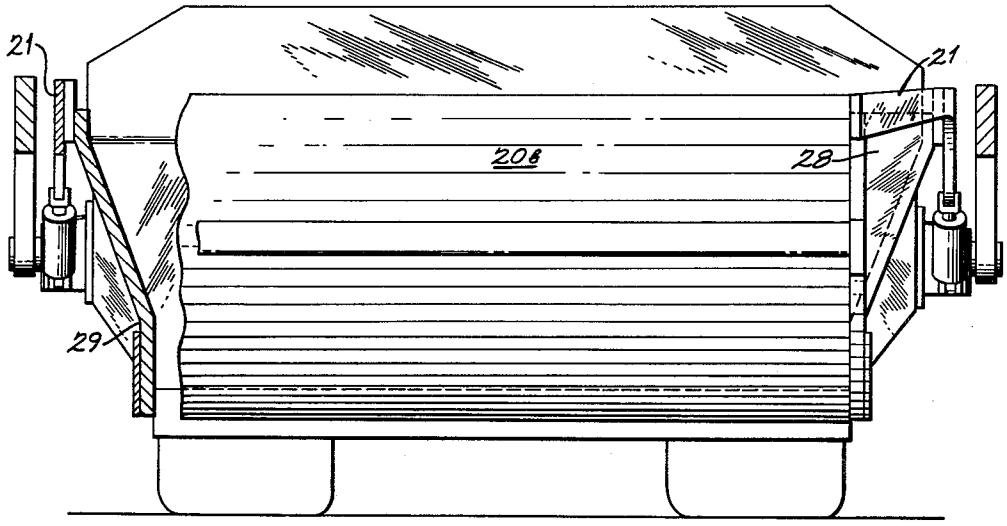


Fig. 5.



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Fig. 6.

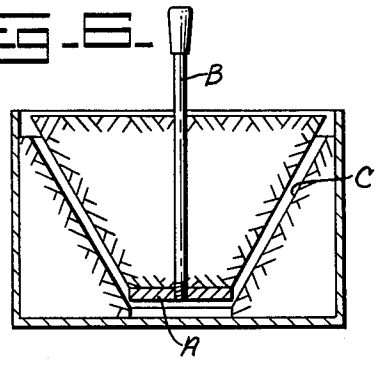


Fig. 7.

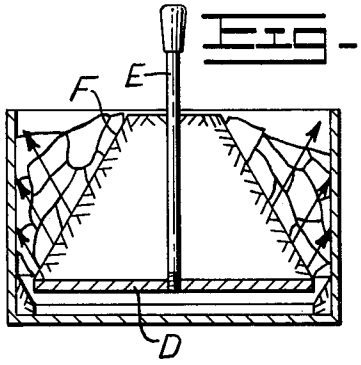


Fig. 8.

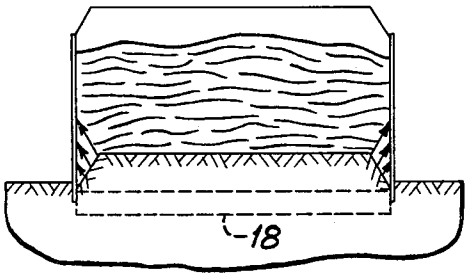


Fig. 9.

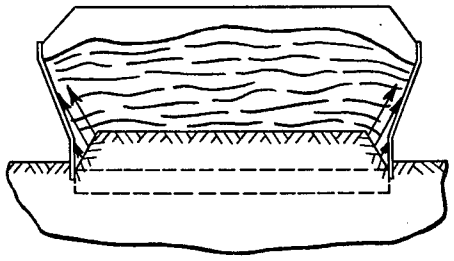


Fig. 10.

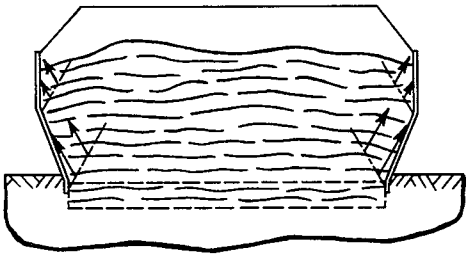


Fig. 11.

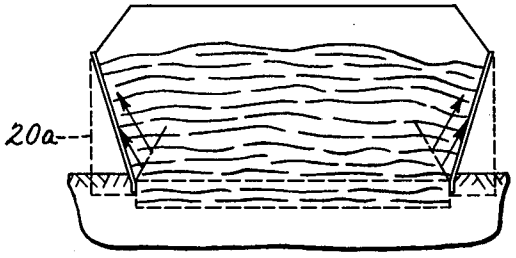
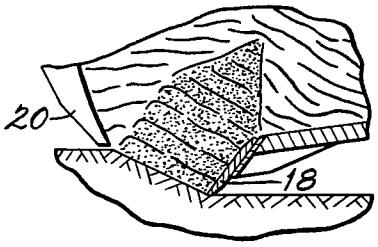


Fig. 12.



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3,049,819

EARTH MOVING SCRAPER BOWL CONSTRUCTION

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Filed May 13, 1960, Ser. No. 28,872
3 Claims. (Cl. 37—129)

This inventon relates to the construction of the bowls of earth moving scrapers and particularly to improvements in such bowls through which the power required to load them with earth is materially reduced.

The loading of a large scraper bowl of a well-known type involves the raising of mass of earth weighing about 55,000 pounds, a distance of 4 feet in approximately 1 minute. According to physical laws, raising of this mass to this distance in this period of time requires about 6.7 H.P. It is common practice, however, in loading a tractor drawn scraper of this capacity to employ two large track-type pusher tractors to aid in the loading operation so that a total of 450 usable drawbar H.P. is employed. The horsepower in excess of that actually required to raise the load is attributable to friction and particularly to the loading resistance encountered by the soil as it enters the scraper bowl.

It is the object of the present invention to provide a scraper bowl of a shape that materially reduces the resistance to loading which is encountered by soil entering during the loading cycle and which thereby reduces the horsepower required for loading the bowl in most cases to within the capacity of a single tractor.

It is a further object of the invention to provide a scraper bowl in which the force required for ejecting or discharging the contents of the bowl is greatly reduced.

A still further object of the invention is to provide a bowl for a scraper having side walls which diverge upwardly and outwardly throughout the major portion of their length but with forward portions contoured to permit efficient closing of the open forward end of the bowl by a pivotally mounted apron.

Further objects and advantages of the invention and the manner in which the invention is carried into practice are made apparent in the following specification wherein a preferred form of the invention is described in detail by reference to the accompanying drawings.

In the drawings:

FIG. 1 is a view in side elevation of a tractor drawn scraper embodying the present invention;

FIG. 2 is a plan view of the scraper unit illustrated in FIG. 1;

FIG. 3 is a front elevation of the scraper shown in FIG. 2 with a portion of the draft frame broken away;

FIG. 4 is a fragmentary view in side elevation illustrating a modified form of the invention shown in FIGS 2 and 3;

FIG. 5 is a view in front elevation with portions broken away and shown in section of the scraper shown in FIG. 4;

FIGS. 6 and 7 are schematic views illustrating results of tests producing soil failure planes under different conditions;

FIGS. 8, 9, 10 and 11 are schematic views representing cross section of scraper bowls having sides of different configuration and showing the direction of forces which create resistance to loading of the bowls; and

FIG. 12 is a schematic view of a cutting edge of a scraper bowl in operation illustrating the manner in which a column of earth passes upwardly into the bowl during filling thereof.

While FIG. 1 of the drawings illustrates a scraper bowl embodying one form of the present invention, this figure

also illustrates the basic parts of a conventional scraper tractor combination which will be described to form a basis for an understanding of the theories underlying the present invention. In this figure a scraper bowl generally indicated at 10 is supported at its rear end by wheels 11 and at its forward end by a draft frame generally shown at 12 which is pivoted as at 14 to the sides of the bowl and supported, through a forwardly extending goose neck member 15, by a tractor 16 herein illustrated as being one of the two-wheel type. An adjustable connection between the draft frame and the bowl which may be a hydraulic cylinder or, as in the case illustrated, a cable 17 leading to power actuated winch mechanism on the tractor, not shown, enables raising and lowering of the forward end of the bowl 10 with relation to the ground for adjusting the depth of a cutting edge 18 in the ground while the tractor is pulling the bowl forwardly during a loading cycle. This adjustable connection is also employed for raising the bowl free of the ground as in the position shown in FIG. 1 for transporting its load. The forward end of the bowl 10 is closed as by an apron 20 the rearwardly extending supporting arms 21 of which are pivoted to the sides of the bowl as at 22. The apron is moved between its closed position shown and an open position by power actuated means such for example as hydraulic jacks one of which is shown at 23 for swinging the apron around the pivotable connections 22. The rear of the bowl 10 is composed of an ejector 24 which is advanceable forwardly through the bowl by means such as a hydraulic jack illustrated at 25 so that with the apron 20 in its open position the contents of the bowl may be ejected forwardly and discharged over its cutting edge 18.

In the operation of loading a scraper bowl, it is customary to raise the apron to a point where it just clears the ground in advance of the cutting edge 18 which has been lowered into the ground and the soil cut upon forward movement of the scraper forms a column which advances upwardly into the bowl under the influence of substantially vertical forces, this action being schematically depicted in FIG. 12 of the drawings. In FIG. 12 the upwardly moving column is depicted by a stippled area to distinguish it from soil already in the bowl.

To observe the effect of friction and other phenomenon tending to oppose the filling of the bowl studies have been made with equipment such as schematically illustrated in FIGS. 6 and 7. In FIG. 6 for example, a small plate A is buried in a container of soil and lifted as by a rod B connected to the plate. An upwardly directed vertical force on the plate A produces shearing stresses of the body of the soil causing failure along a conical or wedge-shaped surface such as shown at C. The angle formed between the surface of the failure cone and a horizontal plane depends upon the type and condition of the soil but has been found to be approximately 45° plus $\phi/2$ where ϕ equals the angle of internal soil friction. The value of ϕ has been determined by experiments with a large number of various types of soils encountered in earth moving operations as varying between 15°–50°.

If the soil on top of the lifting plate A has insufficient internal strength to maintain the conical form or if there is not enough room within the container for the cone to be established, a wedge of soil which may be referred to as dead soil, because it does not have internal movement during upward movement of the plate, is formed on top of the plate. This may be illustrated by burying a larger plate D in a relatively small container as shown in FIG. 7 and applying upward force thereto through a rod E. Since the container in this case is not large enough to permit the formation of a failure cone like that shown in FIG. 6, the frictional resistance between the soil and the container sides cause the soil to fail along lines F forming an

inverted wedge of dead soil above the plate D. Upon continued upward movement of the plate D, the wedge exerts an outward force on the remaining soil in the container, the general direction of which is indicated by arrows in FIG. 7 thus greatly increasing the frictional resistance to upward movement. In this case, the angle of failure which defines the shape of the wedge is again found to be 45° plus $\phi/2$ with respect to a horizontal plane.

FIG. 8 is a schematic view representing a cross section through a conventional scraper bowl, having the usual vertical side walls, during the loading operation wherein a wedge of dead soil corresponding to the wedge of FIG. 7 is being advanced upwardly into the bowl beneath soil already contained therein creating outward forces in the direction of the arrows shown and thus producing tremendous frictional resistance to the loading of the bowl requiring the extremely high tractive effort and horsepower which is exerted during the loading cycle of a conventional scraper.

FIGS. 9, 10 and 11 of the drawings are schematic views similar to FIG. 8 representing three modifications of the present invention which, to varying degrees, relieve the frictional resistance to the upward movement of a column of earth in a scraper bowl. In each of these modifications, the side walls of the bowl are flared or inclined outwardly, at least in part, to an angle which approaches the angle of the soil failure plane represented at C in FIG. 6. While it would be desirable theoretically to have this angle correspond to the angle C for a particular soil being loaded or at least for an average soil wherein the soil failure plane occurs somewhere between the extreme angles of 52½° and 70°, this angularity has the disadvantage that it either reduces the capacity of the bowl or increases its overall width.

The optimum angularity of the bowl sides for an average of all soils tested is an angle of approximately 30° from vertical or an included angle between the bowl sides of 60°. In the interest, however, of maintaining maximum capacity without unduly increasing the width of the bowl, an 18½° angle has been selected for the designs represented in FIGS. 9, 10 and 11.

In the modification of the invention shown in FIG. 9, the sides of the bowl rise vertically from the bottom of the bowl a distance which is at least as great as the deepest cut which should be made by the cutting edge, then the major portion of the sides slope outwardly terminating in a short vertical section adjacent their upper edges. With this construction, as indicated by the arrows in FIG. 9, a great portion of the frictional resistance to the incoming column of soil is eliminated.

In the modification shown in FIG. 10, the sides slope outwardly from the bottom of the bowl to approximately a half way position and then continue vertically upwardly.

FIG. 11 shows the sides of the bowl inclined in an 18½° angle throughout their entire height producing only very small frictional resistance to the upward movement of the incoming column of earth.

All of the bowl designs represented by FIGS. 9, 10 and 11 present a problem in apron design. Ordinarily a scraper apron fits between the inner forward edges of the bowl and since the side walls of the bowl are vertical and parallel as shown in FIG. 8, the apron may be raised a limited distance as for example to the position shown in FIG. 12 to provide an opening above the blade for the admission of earth during the loading cycle. As is apparent from FIGS. 9, 10 and 11, however, an apron fitting between the outwardly sloping side walls would, upon being raised even a short distance be separated from the sloping portions of the side walls and permit escape of earth contained by the bowl. One method which suggests itself for correcting this condition is to provide an apron which swings in front of rather than between the side walls and of a width equal to the widest part of the bowl. This has the disadvantage that the apron in its closed position would project laterally outwardly a substantial distance from the bottom of the bowl as represented for example by dotted lines showing the outline of such an apron **20***a* in FIG. 11.

The manner in which this apron problem is overcome for a bowl with full sloping walls such as shown in FIG. 11 is illustrated in FIGS. 1, 2 and 3 of the drawings wherein the upper forward portions of the bowl sides are shown as deformed inwardly in a triangular area **26** bringing their extreme front edges into parallelism. This transformation area is disposed a considerable distance forwardly of the cutting edge and produces little if any frictional resistance to the uprising column of earth during the loading cycle. It also enables the use of an apron with parallel edges which as most clearly shown in FIG. 4 fits between parallel edges throughout the larger portion of its vertical dimension and overlaps the forward edges of the bowl only at the lower portion thereof so that only the outermost lower corners of the apron extend laterally beyond the width of the bowl for a very short distance.

Apron construction for the type of bowl shown in FIG. 9 is illustrated in FIGS. 4 and 5 of the drawings wherein the sides of the bowl are also shown as inclined inwardly adjacent their forward ends to form triangular transition areas **28**. The lower apex of each of these areas coincides with the upper edge of the lower vertical portions of the bowl shown at **29** in FIGS. 4 and 5 so that the entire forward edge of each side wall is vertical providing space for the reception of a rectangular apron **20***b* fitting closely between the side walls throughout its entire range of movement. In both modifications shown, the arms **21** which support the apron are bent inwardly to conform to the configuration of the upper edges of the side walls as most clearly shown in FIG. 2.

With a bowl shaped as indicated in FIG. 10, the forward portion thereof may be modified in accordance with the teaching of FIGS. 1, 2 and 3 to receive an apron such as that shown at **20** between its forward edges.

Each of the modifications herein described have the further advantage that they reduce the force required to eject a load from the scraper bowl. This results from the fact that sticking or jamming of a load as it is pressed forwardly by the ejector is relieved by free upward movement permitted by the outwardly sloping side walls.

From the foregoing discussion it is apparent that any angle greater than 90° formed by the bowl side and the bowl bottom will reduce the force required to load the scraper.

We claim:

1. In an earth moving scraper having a bowl with a bottom, side walls, a vertically movable apron forming a front wall, and a cutting edge disposed forwardly of the bottom whereby the bowl can be loaded by advancing with the cutting edge in the earth and the apron lowered to the surface of the earth to induce a column of earth to advance upwardly into the bowl, the improvement which includes said side walls being sloped upwardly and outwardly to reduce frictional resistance to the upward movement of said column and having inwardly and forwardly converging forward portions conforming at their forward edges to the parallel edges of said apron whereby the apron may be received between said forward edges as it is raised and lowered.

2. In an earth moving scraper having a bowl with a bottom, side walls, a vertically movable apron forming a front wall, and a cutting edge disposed forwardly of the bottom whereby the bowl can be loaded by advancing with the cutting edge in the earth and the apron lowered to the surface of the earth to induce a column of earth to advance upwardly into the bowl, the improvement which includes said side walls being sloped upwardly and outwardly through at least a portion of their height to reduce frictional resistance to the upward movement of said column, and said sloped portions having inwardly

and forwardly converging forward portions terminating in spaced parallel edges to coincide with parallel edges on said apron.

3. In an earth moving scraper having a bowl with a bottom, side walls, a vertically movable apron forming a front wall, and a cutting edge disposed forwardly of the bottom whereby the bowl can be loaded by advancing with the cutting edge in the earth and the apron lowered to the surface of the earth to induce a column of earth to advance upwardly into the bowl, the improvement which includes said side walls being sloped upwardly and outwardly through at least a portion of their height to

reduce frictional resistance to the upward movement of said column, said sloped portions having inwardly and forwardly converging forward portions terminating in spaced parallel edges to coincide with parallel edges on said apron, said forward portions being disposed forwardly of said cutting edge.

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