United States Patent [19]

Barron et al.

[11] **3,913,756**

[45] **Oct. 21, 1975**

[54] **LADLE SKIMMER**

[75] Inventors: **George E. Barron; Harry Pavone,** both of Verona, Pa.

[73] Assignee: **Louis A. Grant, Inc.,** Pittsburgh, Pa.

[22] Filed: **Feb. 11, 1974**

[21] Appl. No.: **442,006**

Related U.S. Application Data

[62] Division of Ser. No. 216,997, Jan. 11, 1972, Pat. No. 3,800,965.

[52] **U.S. Cl.** **214/32;** 214/141

[51] **Int. Cl.** **B66c 23/04**

[58] **Field of Search** 214/23, 32, 33, 141; 212/55; 52/118, 121; 266/37

[56] **References Cited**

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2,949,201	8/1960	MacAlpine	212/55
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Primary Examiner—Robert G. Sheridan
Attorney, Agent, or Firm—Buell, Blenko & Ziesenheim

[57] **ABSTRACT**

The specification discloses a skimming mechanism used in steel mills for removing slag from the surface of the molten metal in a ladle, the mechanism comprising an extensible boom assembly pivotally mounted on a turntable and power means arranged for rotating the turntable and for pivotally moving the boom assembly in a vertical plane relative to the turntable. The boom assembly comprises telescoping tubular sections, adjustable anti-friction means supporting the inner tubular section within the outer tubular section, a power-actuated driving mechanism comprising cooperating sprocket wheels and roller chains for extending and retracting the inner boom section with respect to the outer boom section, and a skimming paddle comprising a scoop portion separably attached to a mounting bracket portion that is mounted on the outer end of the inner boom section.

2 Claims, 11 Drawing Figures

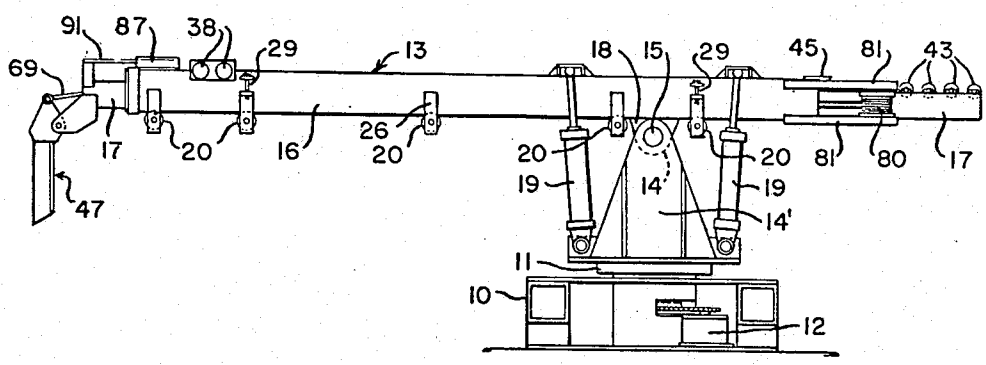


Fig. 1.

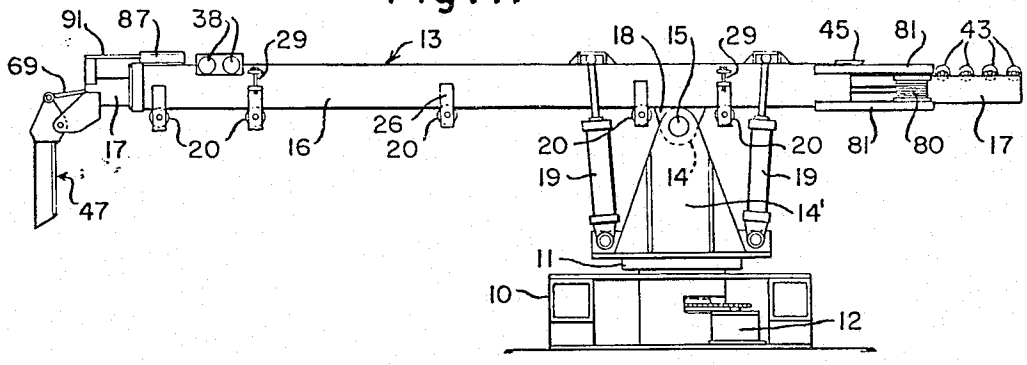


Fig. 7.

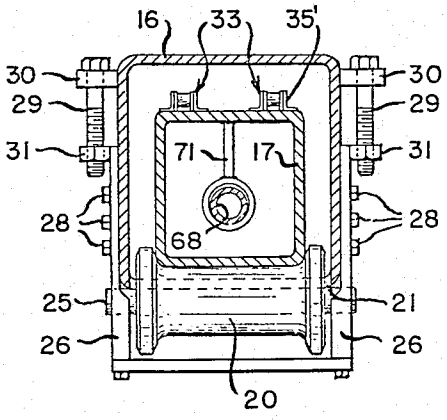


Fig. 9.

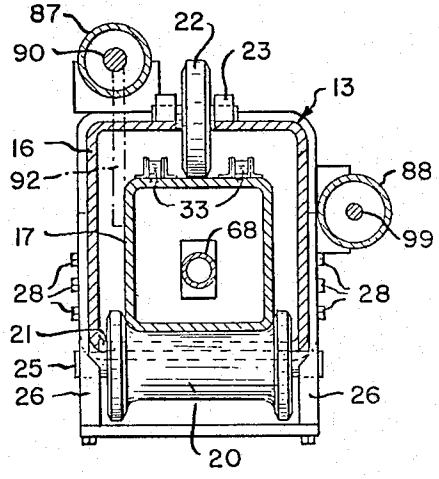


Fig. 8.

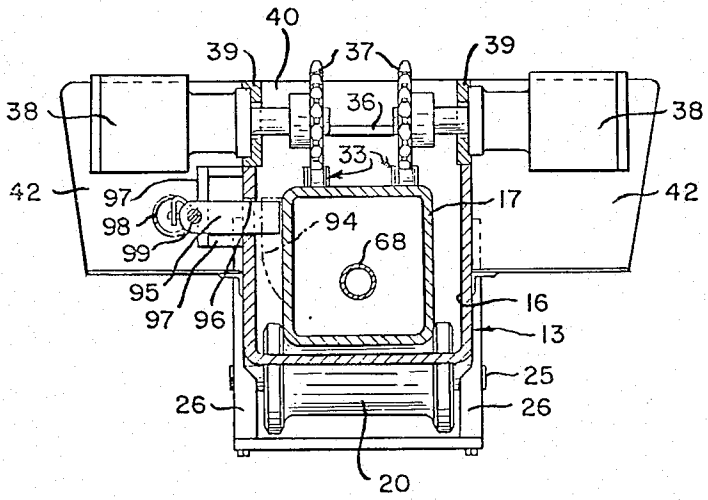
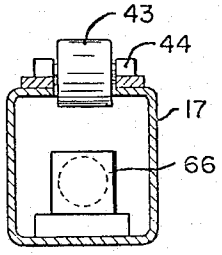


Fig. 10.



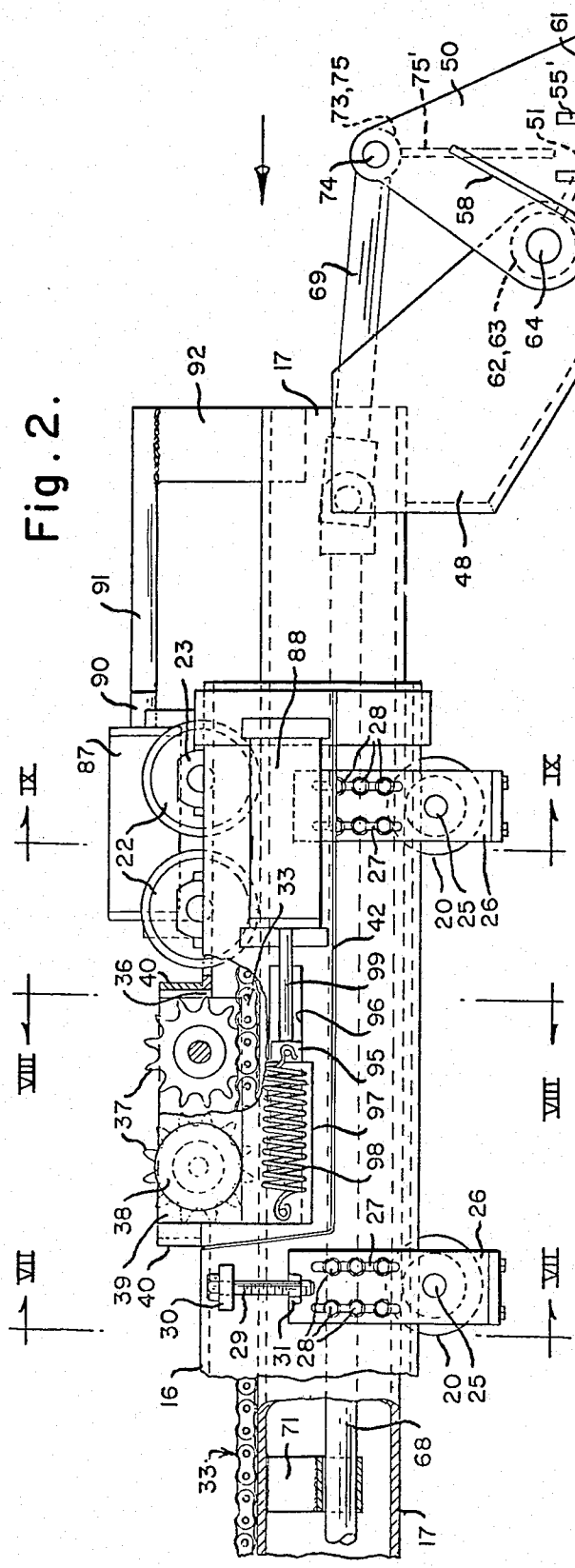


Fig. 2.

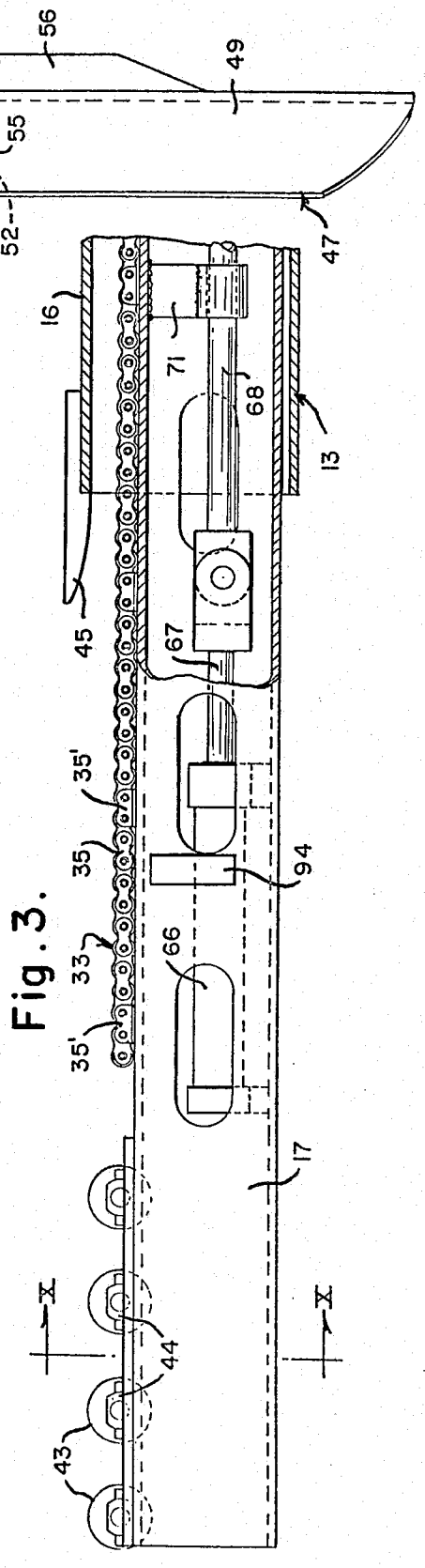


Fig. 3.

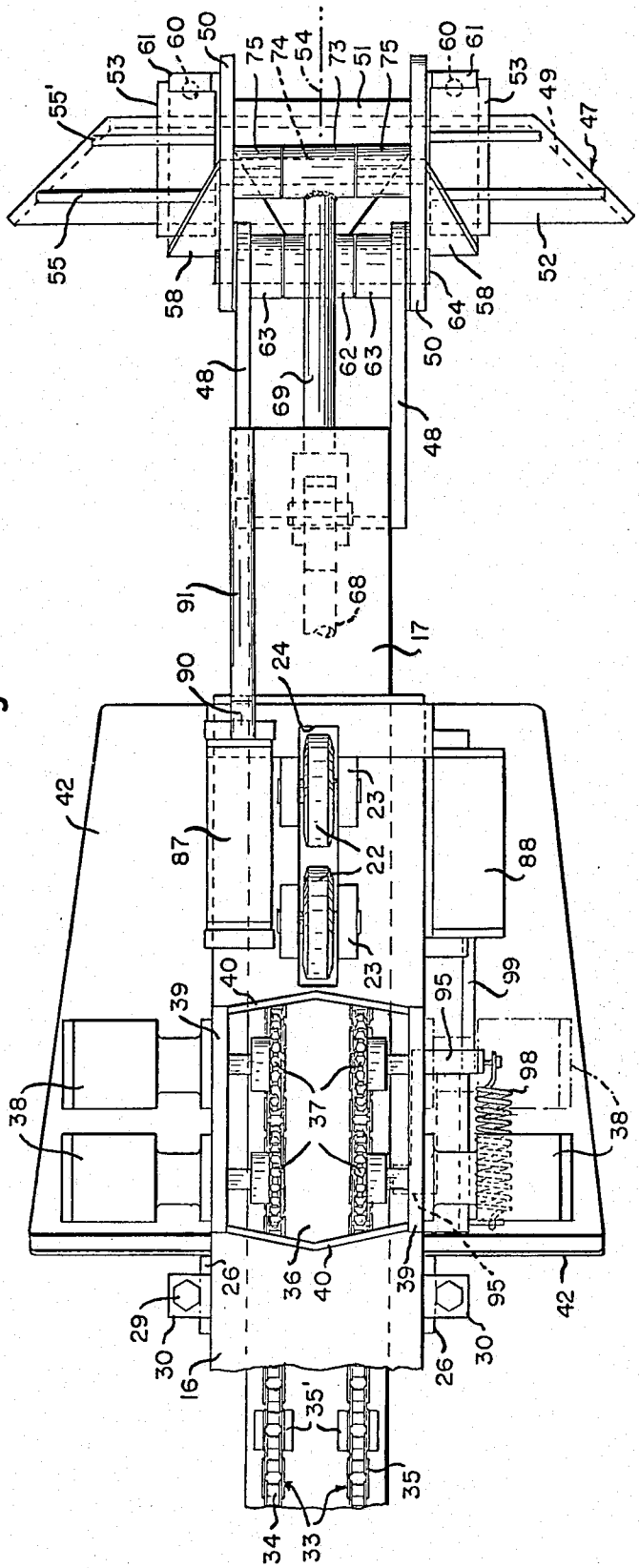

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Fig. 4.

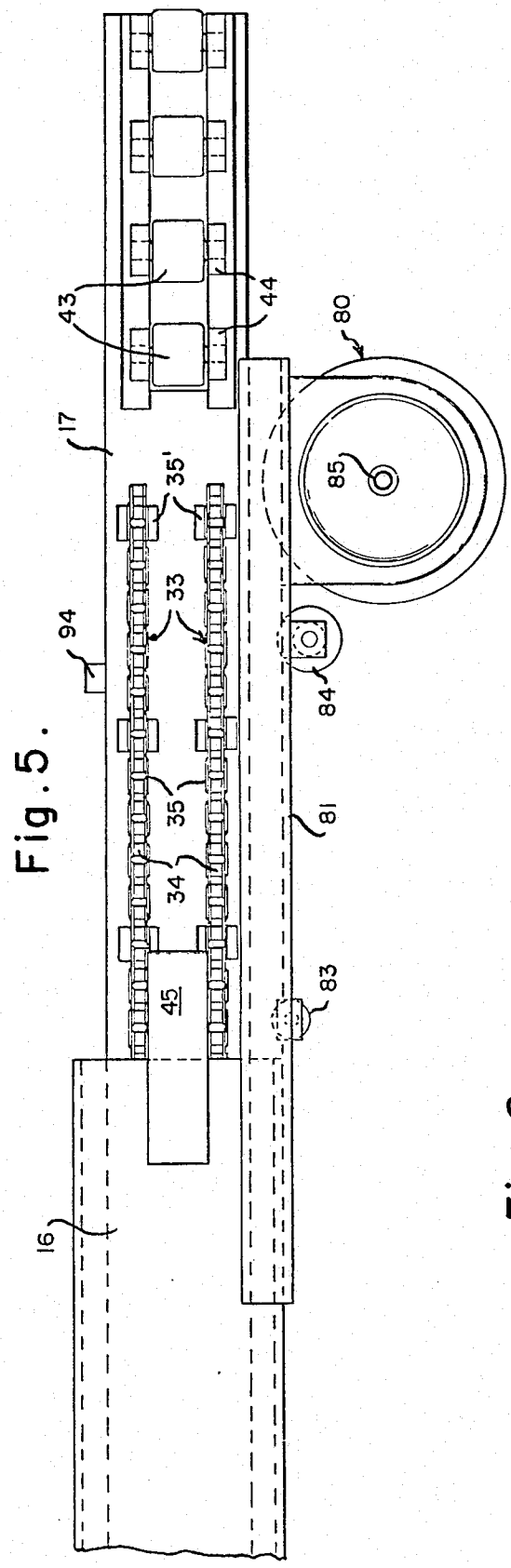

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Fig. 5.

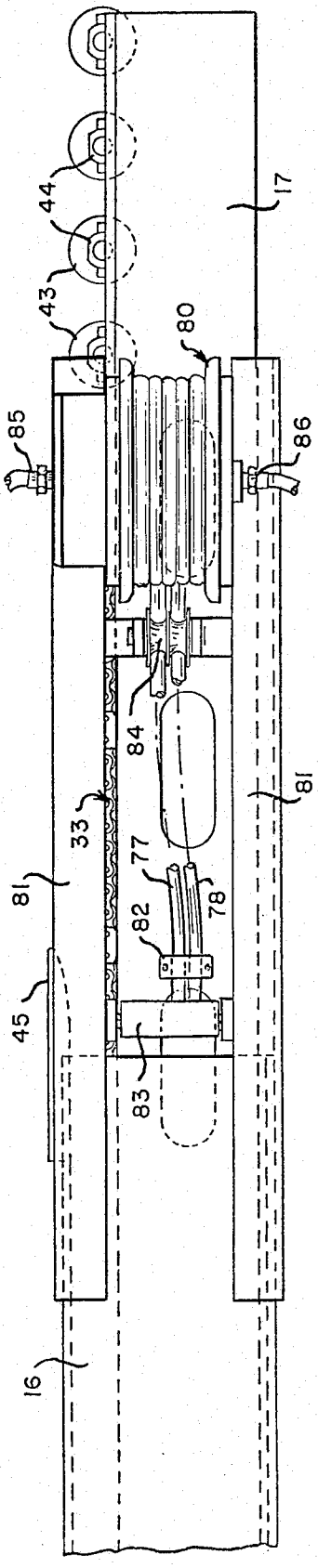
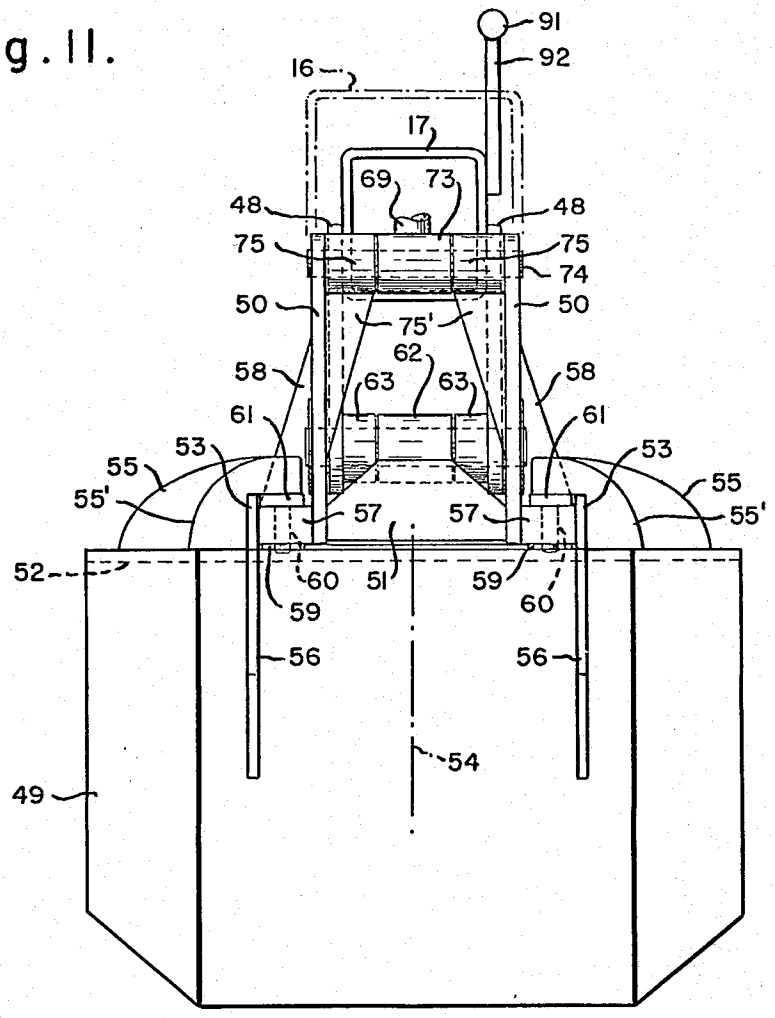

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Fig. 6.

Fig. 11.


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LADLE SKIMMER

This is a division of application Ser. No. 216,997, now U.S. Pat. No. 3,800,965, issued Apr. 2, 1974.

The present invention relates to a skimming mechanism for liquids, and more particularly to a skimming mechanism of the type for removing an overlying layer of slag or kish from molten metal. Our invention is primarily intended for, but not necessarily limited to, the removal of a molten slag layer from molten metal in various types of ladles, furnaces and other vessels employed in steel making operations.

In the prior copending application, Ser. No. 107,676, filed Jan. 19, 1971, of Louis A. Grant, now U.S. Pat. No. 3,659,833, which patent is assigned to the assignee of the present application, there is disclosed and claimed a skimming mechanism for skimming the surface layer of slag or kish from the molten metal in ladles, furnaces and the like. The aforesaid skimming mechanism comprises an extensible boom, pivotally mounted on a turntable and having on its outer end a pivoted skimming blade or paddle which is power-actuated to flip the accumulated slag or kish over the lip of the ladle into a receiving vessel.

The extensible boom of the said application comprises outer and inner telescoping tubular boom sections, the inner boom section being guidably supported within the outer boom section by anti-friction rollers carried on the bottom and side walls of the outer boom section.

The extension and retraction of the inner boom section relative to the outer boom section is effected by a drive mechanism comprising a rack and pinion arrangement in which a plurality of parallel longitudinally extending rack members fixed on the upper face of the inner boom section are individually engaged by corresponding hydraulic-motor-driven pinion gears carried on the outer boom section.

The boom assembly is supported in a desired pivotal position on the turntable, or rocked up and down as desired, by a plurality of hydraulic cylinders on opposite sides of the pivotal connection of the outer boom section to the turntable.

A double-acting cylinder is located within the inner boom section remotely from the skimming blade and has a piston rod which extends through the inner boom section to a pivotal connection with the skimming blade displaced from the fulcrum thereof for pivotally actuating the blade. Hydraulic pressure connections to the double-acting cylinder are established via a pair of flexible hoses carried on a reel mounted adjacent the rear end of the outer boom section. The hoses extend through the rear end of the inner boom section and the reel automatically allows the hoses to lengthen and shorten as necessary to follow the extension and retraction of the inner boom section.

The skimming mechanism of the aforesaid application has functioned satisfactorily under service conditions but is open to certain disadvantages from the standpoint of maintenance and service life. For example, the manner in which the inner boom section is guidably mounted within the outer boom section on rollers is not flexible enough in view of the warping of the inner boom section due to exposure to heat. Unless the inner boom section remains straight, some binding occurs on the guiding rollers and this increases the friction to the point where the load on the driving motors for the pinions of the rack and pinion drive becomes excessive. Also the rack and pinion drive employed makes no provision for dirt elimination. Consequently, the collection of dirt in the grooves between the teeth on the racks ultimately packs hard and this prevents proper mating of the pinion gear and rack. In some instances, stresses have occurred due to the packing of the dirt in the rack which have resulted in fracture of the rack, or pinion, or both. Repair of the rack is difficult and time-consuming, with resulting loss of operating time of the skimming mechanism. Also, the method and manner of connection of the pressure hose from the rear to the double-acting cylinder actuating the pivotal skimming blade, results in wear and abrasion of the hose due to rubbing on the exposed rear edge of the outer boom section when the inner boom section is extended. In addition, the skimming blade collects deposits of slag which harden and interfere with effective skimming performance, as well as pivotal action of the blade. Replacement of the entire blade is thus necessitated which is costly.

In order to overcome and avoid the aforesaid disadvantages of the skimming mechanism of the aforesaid application, we have devised an improved design of skimming mechanism.

More specifically we have provided a boom assembly of the type having outer and inner tubular boom sections, the inner boom section being guidably supported on its bottom surface which rests on flanged rollers, in turn suspended by brackets adjustably attached to the outer boom section. The rollers extend through holes in the bottom wall of the outer boom section and the inner boom section is centrally guided within the outer boom section between the end flanges on the rollers.

We have also provided an improved driving mechanism for extending and retracting the inner boom section, which comprises a plurality of lengths of roller chains the links of which are secured at intervals along the length of the chains as by welding certain links to the upper wall of the inner boom section, in longitudinally extending parallel relation, and a plurality of individually motor-driven sprocket wheels mounted on the outer boom section and extending through the wall thereof into engagement with the chains on the inner boom section. The adjustable guiding rollers supporting the inner boom section concurrently serve to adjust to the appropriate meshing or driving relation between the sprocket wheels and the roller chains.

We have also provided an improved arrangement for feeding the pressure hose from the hose reel to the blade-actuating cylinder within the inner boom section. This arrangement comprises mounting the hose reel on a rear end extension and feeding the hose through an opening in the side wall of the inner section to the cylinder. The provision of greater clearance space between the walls of the outer and inner boom sections accommodates the hose therebetween as the inner boom section reciprocates between retracted and extended positions relative to the outer boom section.

We have further provided a new design of skimming paddle comprising separable scoop and mounting bracket portions, thus making it possible to replace the scoop portion without replacement of the mounting bracket portion.

The above features, as well as other features and structural details of the presently preferred embodiment of the invention will be elaborated upon in the

forthcoming description, in connection with the accompanying drawings, wherein:

FIG. 1 is a general elevational side view of the skimming mechanism comprising the presently preferred embodiment of the invention,

FIG. 2 is a fragmentary elevational side view of the skimming mechanism on enlarged scale, showing front end details of the pivotal blade, the driving mechanism and the adjustable guide rollers,

FIG. 3 is a fragmentary elevational side view of the skimming mechanism on the same scale as FIG. 2, showing rear end details,

FIG. 4 is a fragmental plan view of the front end of the skimming mechanism,

FIGS. 5 and 6 are, respectively, plan and side elevational views of the rear end of the skimming mechanism showing mounting details of the hose reel and the hose connections to the inner boom section,

FIGS. 7, 8, 9, and 10 are cross-sectional views, taken on lines VII—VII, VIII—VIII and IX—IX of FIG. 2 and X—X of FIG. 3, respectively, and

FIG. 11 is a front end view, looking in the direction of the arrow in FIG. 2, showing additional details of the skimming paddle and the manner in which it is mounted.

Referring to FIG. 1 of the drawings, the embodiment of skimming mechanism shown is generally similar to that shown and described in the copending application Ser. No. 107,676 of Louis A. Grant, now U.S. Pat. No. 3,659,833, insofar as the mounting platform, turntable and power cylinders for holding and moving the boom assembly are concerned. Since reference may be had to the said copending application for a description of these details, they will be identified briefly herein without a detailed description.

As shown in FIG. 1, the skimming mechanism comprises a support structure or platform 10 fabricated of hollow-square girders which may be extensible for accommodating the platform for mounting in a building structure or for otherwise anchoring this platform in position. A horizontal turntable 11 is rotatably mounted on the platform 10 and is rotated by motor 12 through a suitable drive mechanism, such as a chain drive. U.S. Pat. Nos. 3,471,888 and 3,458,396 to Grant et al. and to Grant issued Oct. 14, 1969, and July 29, 1969, show arrangements suitable for mounting and rotating the turntable 11.

An extensible boom assembly 13, is pivotally mounted on the turntable 11 for pivotal movement in a vertical plane in a manner generally similar to that described for the boom assembly in U.S. Pat. No. 3,659,833 of Louis A. Grant. Briefly, a pair of bearing members 14 formed at the upper ends of spaced brackets 14' attached to the turntable serve to support opposite ends of a shaft 15 constituting a fulcrum for the boom assembly 13.

As evident from FIG. 1, and particularly shown in FIGS. 7, 8, and 9, the boom assembly 13 comprises two telescoping tubular members, illustratively shown as of square or rectangular cross-section, hereinafter referred to as the outer boom section 16 and the inner boom section 17. The boom assembly 13 is fulcrummed on the shaft 15 by a pair of spaced bearing brackets 18 attached as by welding to the bottom wall of the outer boom section.

In a manner similar to that described in U.S. Pat. No. 3,659,833 No. of Louis A. Grant a plurality of power cylinders 19 of the double-acting type are disposed symmetrically on opposite sides of the shaft 15 for supporting the boom assembly 13 in a desired position in a vertical plane and for effecting pivotal movement thereof to a desired position. It will be seen that the lower ends of the cylinders 19 are pivotally attached to the turntable 11 and the distal ends of the piston rods are pivotally attached by brackets to the wall of the outer boom section 16.

One of the salient improved features of the present invention is provided by an improved mounting arrangement for the inner boom section 17. This arrangement is shown generally in FIG. 1 and comprises a plurality, illustratively shown as five in number, of flanged rollers 20, disposed in spaced relation along the outer boom section 16 as presently more fully described, and extending through openings 21 in the bottom wall of the outer boom section. As evident in FIGS. 7, 8, and 9, the width of the inner boom section 17 conforms closely to the distance between the flanges at the ends of the rollers 20, thereby being guided for reciprocative movement relative to the outer boom section, without the necessity for roller guides in the opposite side walls of the outer boom section 16. In order to prevent the inner boom section 17 from rising up and separating from the rollers 20, a pair of longitudinally aligned rollers 22 (FIGS. 4 and 9) are mounted in bearing brackets 23 attached to the outer surface of the front end of outer boom section and extend through a centrally located longitudinal slot 24 (FIG. 4) in the upper wall of the outer boom section into rolling contact with the upper smooth surface of the inner boom section.

Each roller 20 is rotationally mounted, as by antifriction bearings at opposite ends, on a shaft 25 which is in turn supported and secured at its opposite ends in circular holes provided in a pair of brackets 26. Brackets 26 are adjustably attached to the opposite side walls of the outer boom section 16, as shown in FIG. 2. For this purpose the brackets have a pair of vertically extending parallel slots 27 (FIG. 2) through which a plurality of screws 28, illustratively shown as three in number, extend to screw into corresponding tapped holes in the wall of the outer boom section.

Certain remotely spaced brackets 26, as shown in FIG. 1, are arranged for vertical adjustment by a screw 29 for a purpose presently to be explained. As seen in FIG. 2, a laterally extending lug 30 is provided on the wall of the outer boom section for each screw 29. The lug has a hole through which the screw extends with the head of the screw resting on the top of the lug. A nut 31 is welded to the upper end of the bracket 26, in line for screw-threaded engagement by the lower end of the screw.

Adjustment of the rollers 20 to provide proper positioning of the inner boom section 17 in the outer boom section 16 is effected by first adjusting the rollers 20, which can be adjusted by the screws 29, so as to properly align and level the inner boom section within the outer boom section. Then brackets 26 for the adjusted rollers 20 are locked in position by tightening screws 28. The remaining rollers 20 are subsequently adjusted into contact with the bottom surface of the inner boom section and locked in position by tightening screws 28.

This method of adjustment of the position of rollers 20 is particularly important for reasons which will be explained presently in connection with the driving

mechanism for reciprocating the inner boom section in the outer boom section.

The driving mechanism for effecting reciprocation of the inner boom section is a particularly important feature of the invention and will now be described by particular reference to FIGS. **2, 4,** and **8.** As shown, a pair of lengths of roller chain **33** are fixed in parallel longitudinally extending relation to the top surface of the inner boom section **17** for substantially the entire length thereof. Chains **33** comprise rollers **34** and connecting links **35.** The attachment of the chain **33** to the inner boom section is preferably effected by providing angle links **35'** (FIG. **3**) at spaced intervals along the chain **33** to facilitate welding thereof to the inner boom section. This allows a certain flexible movement to the rollers **34** of the chain which is desirable.

Adjacent the front end of the outer boom section is a transverse slot **36** (FIG. **2**) to provide access to the chains by a plurality of sprocket wheels **37,** each individually driven by a suitable hydraulic motor **38.** The mounting arrangement for the sprocket wheels **37** and motors **38** comprises two side bracket plates **39** of greater thickness than the wall of the outer boom section inset into the wall slot **36** and welded to the wall. Transverse struts **40** of shallow V-shape are welded at opposite ends to the side plates **39** to provide reinforced support thereto and an enclosure for the sprocket wheels.

Two motors **38** are attached as by screws to each of the opposite side plates **39** in longitudinal spaced relation, so that they are in substantial transverse alignment. The sprocket wheels **37** which are removably attached to the shafts of the motors **38** are positioned transversely so as to mesh appropriately with a corresponding chain **33.**

The functional importance of the adjustable brackets **26** for rollers **20** should now be apparent in relation to establishing the appropriate relative positions of the sprocket wheels **37** and the chains **33** for proper transmission of driving forces from sprocket wheels to chains.

It will be understood that the motors **38** at opposite sides of the boom assembly are necessarily actuated concurrently in opposite directions in order to provide a unidirectional thrust force on the inner boom section, either for extension or for retraction with respect to the outer boom section. Moreover, by providing a plurality of individually power-driven sprocket wheels, there is assurance that operation of the inner boom section may be effected notwithstanding possible failure of one or more of the motors.

In view of the exposure to very high temperatures radiant from the molten metal in a steel mill environment and also for safety purposes, a so-called heat shield **42** is provided on each side of the outer boom section in surrounding relation to the motors **38.** As will be seen in FIGS. **2, 4,** and **8** each of the shields **42** extends longitudinally outside and underneath the motors **38** and is attached as by angle brackets to the wall of the outer boom section **16.**

In order to provide additional support while the inner boom section **17** is in extended position, a plurality of supporting rollers **43** are mounted in suitable bearing brackets **44** attached to the rear end of the inner boom section as shown especially in FIGS. **3** and **5.** A cam plate **45** is attached as by welding to the top wall of the outer boom section at its rear end for engagement by the rollers **43** to insure entrance into the rear opening of the outer boom section **16.**

A skimming blade or paddle **47** is mounted on a U-shaped bracket **48** attached as by welding to the outer or forward end of the inner boom section **17,** as particularly shown in FIGS. **1, 2,** and **11.** The paddle **47** is fabricated of sheet steel plates and comprises a separable and replaceable lower three-sided scoop section **49** and an upper mounting bracket section comprising two spaced mounting plates **50** joined by an intervening angularly disposed generally triangular plate member **51.** The scoop section **49** is closed at the top edge by a transverse plate member **52,** integrally attached as by welding. To the top surface of the plate member **52,** a pair of angle brackets **53** are attached in parallel spaced relation symmetrically on opposite sides of the longitudinal center line **54** (See FIG. **4**) of the scoop section, thereby providing longitudinal slots. A pair of spaced gusset plates **55** and **55'** are welded to the top plate member **52** and to each of the angle brackets **53** to support them in position. A pair of gusset plates **56** are also attached to the front face of the scoop section and to the overhanging end of the angle brackets **53** to further support the angle brackets in position.

A bar **57** is attached as by welding to the outside surface of each mounting plate **50** along the bottom portion thereof. A triangular gusset plate **58** is attached between the inner end of each bar **57** and the mounting plate **50** for reinforcement. The scoop section **49** is attached to the mounting section by sliding the scoop section inwardly so that the bars **57** telescope inside the corresponding groove or slot formed between each angle bracket **53** and the top plate **52** of the scoop section. A wear plate or strip **59** (FIG. **11**) is preferably attached to the surface of the top plate **52** to provide appropriate clearances without lost motion between each bar **57** and the corresponding angle bracket.

In order to lock the scoop section to the mounting bracket section, each bar **57** is provided with a hole **60** therethrough adjacent the front end, and after the scoop section is mounted on the bar, a T-bolt **61** is inserted in the hole. The cross bar of the T-bolt is offset from the center line of the bolt, thus providing an exposed portion of the upper end of the bolt. Under operating conditions, the angle brackets **53** shift back into position covering the exposed portions of the end of the T-bolt as shown in FIG. **4,** thus locking the bolt in position against accidental removal or dislodgement.

The paddle **47** may be attached to the bracket **48** in a fixed position, if desired. However, in the preferred form thereof the paddle is pivotally mounted on the bracket **48.** To provide the pivotal mounting, a sleeve bearing **62** is attached, as by welding, to the inner edge of the triangular plate member **51** midway between the mounting plates **50.** Attached to the inside of each of the side walls of the U-shaped bracket **48** is a sleeve bearing **63,** the two bearings **63** being in transverse alignment. A pin **64** extending through the bearings **62** and **63** and secured in position by end washers or pins, forms the fulcrum or pivot for the paddle **47.**

Pivotal movement of the paddle **47** is effected by a cylinder **66** of the double-acting type (see FIG. **3**) located inside the inner boom section **17** near the rear end thereof. Cylinder **66** is suitably attached to the bottom wall of the inner boom section. Cylinder **66** has a piston rod **67** the distal end of which is hingedly connected by a clevis and pin type of joint to a long rod **68**

which extends longitudinally through the inner boom section to a point adjacent the outer end of the inner boom section where it is, in turn, hingedly connected by a clevis and pin type of joint to a relatively short link rod **69**. The rod **68** is supported at intervals through the length of the inner boom section by sleeve type bearing brackets **71**, shown in FIGS. **2** and **3**, which are dependingly attached to the upper wall of the inner boom section. Link rod **69** has a sleeve bearing **73** at its outer end by means of which a pivotal connection to the mounting plates is provided. For this purpose a pin **74** (FIGS. **2** and **11**) is supported at opposite ends in aligned sleeve bosses **75** attached to the inside of the mounting plates **50** and extends through sleeve bearing **73** which is disposed between the bosses **75**. Triangular gusset plates **75'** provide reinforced support to the bosses **75**.

Hydraulic pressure is supplied selectively to the pressure chambers on opposite sides of the double acting piston of cylinder **66**, for effecting reciprocative movement of the piston rod **67**, through a pair of hoses **77** and **78** (FIG. **6**). Reciprocative movement of the piston rod **67** effects corresponding pivotal action of the paddle **47**, through the intervening rod **68** and link **69**.

Hoses **77** and **78** are wound on a reel **80** carried on two angle brackets **81** forming an extension support at the rear end of the outer boom section **16**. As shown in FIGS. **5** and **6**, the hoses enter the interior of the inner boom section **17** through an opening in the side wall thereof, the hoses being firmly secured to the outer surface of the side wall by a clamp **82** prior to entry into the interior of the inner boom section. Inside the inner boom section hoses **77** and **78** are connected to fittings on the cylinder **66** via which communication is effected to the pressure chambers on opposite sides of the piston in the cylinder.

It will thus be seen that since opposite ends of the hoses are fixed relative to the inner boom section **17**, no abrasion or wear on the hoses due to reciprocation of the inner boom section can occur. Of course, the portion of the length of the hoses between the clamp **82** and the reel **80** is under tension as the inner boom section is extended, that is, moves to the left as viewed in FIG. **6**. Reel **80** is a conventional type in which the hoses are under constant tension and which allows the hoses to unwind to extend in length and automatically re-wind on the reel as the inner boom section **17** is retracted, that is, moves to the right as viewed in FIG. **6**.

As is evident in the cross-sectional views, FIGS. **7**, **8** and **9**, there is adequate clearance space between the side walls of the inner and outer boom sections to accommodate the hoses **77** and **78** therebetween as the inner boom section **17** is extended outwardly. However, a roller **83** (FIG. **6**) is mounted in a vertical position on the angle brackets **81** to insure that the hoses do not rub on the rear end of the outer boom section. Also a double-grooved pulley **84** is mounted on the angle brackets **81** to guide the hoses on the reel **80**.

Hydraulic pressure is supplied to the reel **80** from pressure sources mounted in the platform **10** through external hose connections **85** and **86**.

It will be apparent that if the paddle **47** is attached in a fixed position to the bracket **48**, there is no need for the actuating cylinder **66** and the accessory hoses and hose reel and they may, in that circumstance, be omitted.

In order to prevent overtravel of the inner boom section **17** relative to a predetermined ambit in outer boom section **16**, and thereby prevent disengagement of the sprocket wheels **37** from the chains as well as damage to the skimming paddle **47** and other parts of the mechanism, cushioning limit stops comprising cushioning cylinders **87** and **88** are provided. As seen in FIGS. **2**, **4**, and **9**, cushioning cylinder **87** is mounted by a suitable bracket on the top wall of the outer boom section **16** adjacent the front end thereof. Cylinder **87** has a piston rod **90** which projects forwardly in longitudinal alignment with a rod **91** that is attached by a bracket **92** to the front end of the inner boom section **17**.

When the inner boom section is retracted to its inner limit of travel, the rod **91** engages the piston rod **90** and further travel of the inner boom section **17** is limited by the amount of cushioning travel of the piston cylinder **87**. When the inner boom section is extended again, biasing means in the cylinder acts to restore the piston and piston rod **90** to the normal position in which it is shown in the drawings.

Cylinder **88** is similar to cylinder **87** and is mounted by a suitable bracket on the side wall of the outer boom section **16** adjacent the front end thereof. As shown particularly in FIGS. **3** and **8**, a lug **94** attached on the side wall of the inner boom section **17** near the rear end thereof is arranged to engage a Z-bar **95** (FIG. **4**) slidably mounted in a slot **96** in the side wall of the outer boom section **16**, as the inner boom section approaches the limit of its outward extension. Z-bar **95** is supported externally of the slot **96** by a channel member **97** attached in a horizontal position to the outside surface of the side wall of the outer boom section **16**. The outwardly projecting end of Z-bar **95** is biased to the left, as seen in FIG. **2**, by a coil spring **98** into contact with the end of the channel member **97**.

Piston rod **99** of cushioning cylinder **88** extends longitudinally back toward and contacts the projecting end of the Z-bar **95**. Thus, as the inner boom section approaches its limit of outward extension, lug **94** engages the inner end of the Z-bar **95**, which in turn exerts a compressing force on the piston rod **99** of cushioning cylinder **88**. Upon retraction of the inner boom section, coil spring **98** restores Z-bar **95** to its normal position and the piston rod **99** of cylinder **88** is restored concurrently therewith by biasing means embodied in the cylinder.

For simplicity, the control system by which operation of the turntable motor **12**, the cylinders **19** for pivotally moving and holding the boom assembly, the hydraulic motors **38** for extending and retracting the inner boom section **17**, and cylinder **66** for pivoting the paddle **47** is coordinated is not shown. However, it should be understood that a small hand-held control device of the push-button type may be employed for convenient centralized and rapid coordinated remote control of the various operations of the skimming mechanism.

In general, the operation of the skimming mechanism for removing slag or kish from the top surface of the molten metal in a ladle is similar to that described in the aforementioned U.S. Pat. No. 3,659,833 of Louis A. Grant.

It will be understood, therefore, that the ladle containing the molten metal is tilted from the vertical until the level of the molten metal is such as to almost run out over the lip of the ladle. In such position, the opera-

tor extends the inner boom section **17** over the top of the ladle and causes the paddle **47** to assume a position inclined forwardly from the vertical so as to parallel the slope of the back wall of the ladle. Thus it is possible for the operator to dip the tip of the paddle **47** into the molten metal at the rear of the ladle and by retracting the inner boom section draw an accumulation of slag back toward the lip of the ladle. Repeated extension and retraction of the inner boom section, as well as turning of the turntable so as to reach the entire surface area of the molten metal in the ladle, enables the operator to quickly clear the slag from the surface of the metal back over the lip of the ladle into a collecting vessel or bucket.

The pivotally mounted paddle **47** is advantageous in several respects. Firstly, if it is desired to employ the paddle in a fixed position, the cylinder **66** may be employed to change the position of the paddle over a wide angle from a vertical position to any forwardly inclined position suitable to the slope of the back wall of the ladle, which will change during the skimming operation with a change in the inclined position of the ladle. Secondly, the cylinder **66** may be employed to quickly change the inclination of the paddle back toward the vertical as the inner boom section is retracted toward the lip of the ladle to flip or toss an accumulation of slag over the lip of the ladle into a collecting vessel.

The particular design of paddle and manner of mounting also has certain advantages over heretofore known constructions. Firstly, because the scoop section is designed to be separable from the mounting section, replacement only of the scoop section of the paddle will be effected while retaining the mounting section. Because of the accumulation of molten slag, which over an extended period of skimming operation, adheres to the scoop section of the paddle, the effective skimming ability of the paddle is impaired. In such cases, it has heretofore been necessary to replace the entire paddle including the mounting bracket portion thereof. By eliminating the necessity for replacing the mounting bracket portion of the paddle, an appreciable reduction in operating cost is effected. Moreover, the design of the mounting section of the paddle guards against the accumulation of slag deposits around the area of pivotal support of the paddle which would, in the course of time, intefere with the pivotal operation of the paddle. It will be noted that the closed bottom of the U-shaped bracket **48** and the skimming plate member **51** between the side members **50** prevents the deposit and accumulation of slag around the fulcrum pin **64** and sleeve bearings **62** and **63**, thus increasing the service life of the mounting bracket section and making it possible to retain the mounting section when the scoop section of the paddle is replaced.

A particular advantage of the invention resides in the sprocket wheel-roller chain type of drive for extension and retraction of the inner boom section. This type of drive is self-cleaning, thereby eliminating the accumulation of dirt in the parts, in contrast to the previous rack and pinion type of drive. Moreover, repair or replacement of individual links or rollers of the chain reduces the maintenance expense as well as the time required to effect repair in the event of the breakage of parts compared to the rack and pinion type of drive.

Furthermore, the manner and means for adjustably mounting the rollers **20** is advantageous in that it concurrently makes possible the relative adjustment of sprocket wheel **37** and the roller chains for appropriate driving effectiveness without additional means for this purpose.

It should be observed also that the manner of mounting the hose reel **80** and the connection of the hoses **77** and **78** to the paddle-operating cylinder **66** eliminates difficulties and breakdown due to wear and breakage of hoses in prior designs of skimming mechanism.

In summary, it will be seen that the skimming mechanism which we have provided has numerous advantages over prior designs, all of which contribute to a more effective skimming operation, as well as to longer intervals between shutdowns for overhaul or maintenance operations of the apparatus. Moreover, the cost of operation and maintenance is reduced over prior designs of skimming mechanism.

While the presently preferred embodiment of the invention has been described and disclosed herein, it will be apparent that variations in the embodiment and in the manner of its use are possible, within the terms of the appended claims.

We claim:

1. In a skimming mechanism having a supporting structure, a boom assembly movably mounted on said structure, said boom assembly having telescoping outer and inner boom sections, anti-friction means guidably supporting said inner boom section for reciprocative movement within said outer boom section, a skimming paddle carried on the forward end of said inner boom section, and power drive means for effecting reciprocative movement of said inner boom section within said outer boom section, the improvement comprising a pair of cushioning cylinders fixed externally at the front end of said outer boom section, one of said cylinders having a forwardly projecting piston rod and the other of said cylinders having a rearwardly projecting piston rod, rod means on said inner boom section in coaxial alignment with the piston rod of said one cylinder engageable therewith adjacent the extremity of retraction of said inner boom section to define the limit of retractive movement thereof, and means including means fixed on said inner boom section adjacent the rear end thereof for cooperatively engaging the rearwardly projecting piston rod of said other cylinder adjacent the extremity of extension of the inner boom section to define the limit of extension of the inner boom section.

2. A skimming mechanism according to claim **1**, wherein said means comprises a lug fixed adjacent the rear end of said inner boom section and a Z-bar slidably mounted in a slot in the side walls of the outer boom section, the inner end of said Z-bar being engaged by the said lug and the outer end engageable with the rearwardly projecting end of the piston rod of the other of said cylinders adjacent the outer extremity of travel of the inner boom section, and wherein means is provided for biasing said Z-bar toward the rear extremity of the slot in the wall of the outer boom section.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,913,756

DATED : October 21, 1975

INVENTOR(S) : GEORGE E. BARRON and HARRY PAVONE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 67, after "3,659,833" delete --No.--.

Column 9, line 47, "skimming" should read --slanting--.

Signed and Sealed this

twenty-third Day of *March 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks