# United States Patent

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## [54] SLAG SCAVENGER FOR FLAME BURNING TABLE


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[51] Int. Cl. ..... F23j 1/02

[58] Field of Search ..... 263/45; 110/170; 214/23, 25, 214/85.1, 85.5, 17.82; 198/164, 171, 172, 168, 204, 221; 266/23 R



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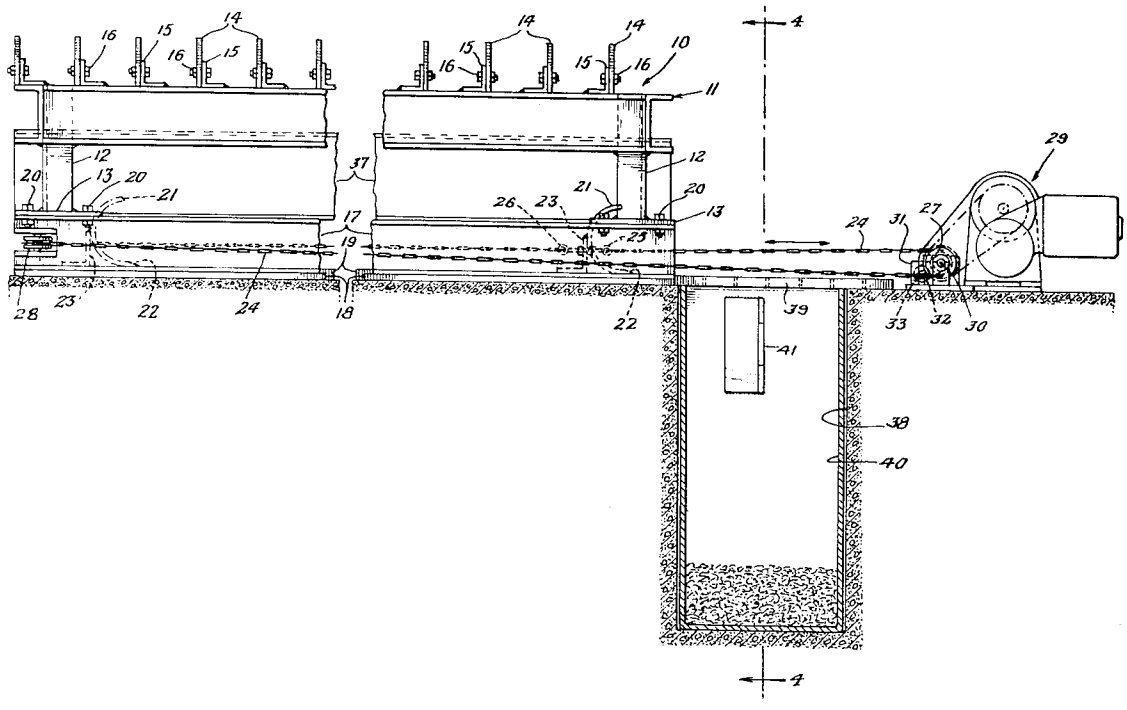
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[57] ABSTRACT

Reciprocating scoop scraper for removing slag from below a flame burning table for cutting steel plate. Synchronized chain drives for scraper are sheltered by flanges of table bed rails and move scraper over warp and heat resistant level bed, discharging slag into lift-out bucket in slag pit. Power drive includes automatic reversing feature, and manual cycling for sequential cycles.

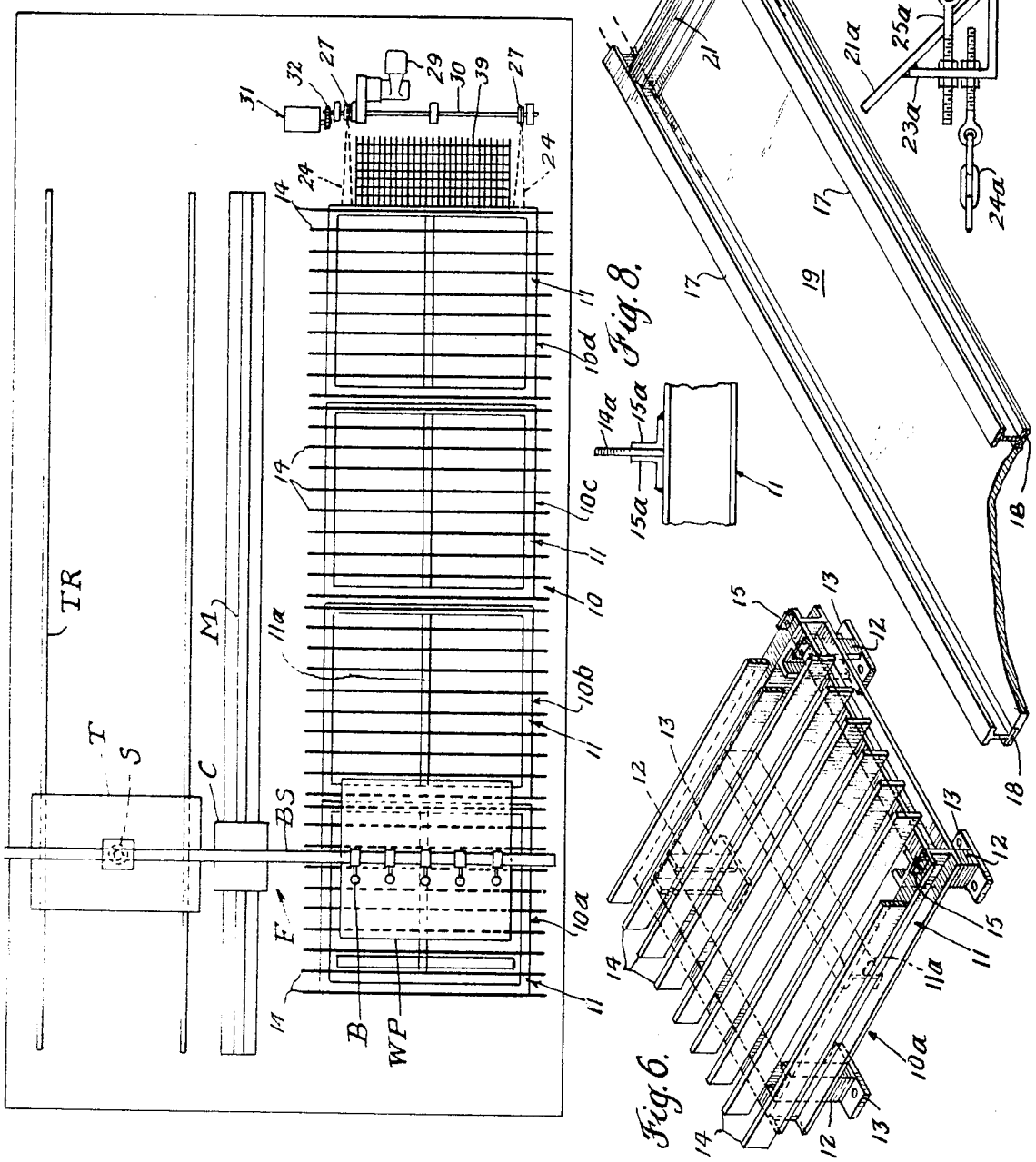

**11 Claims, 9 Drawing Figures**



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SHEET 1 OF 4



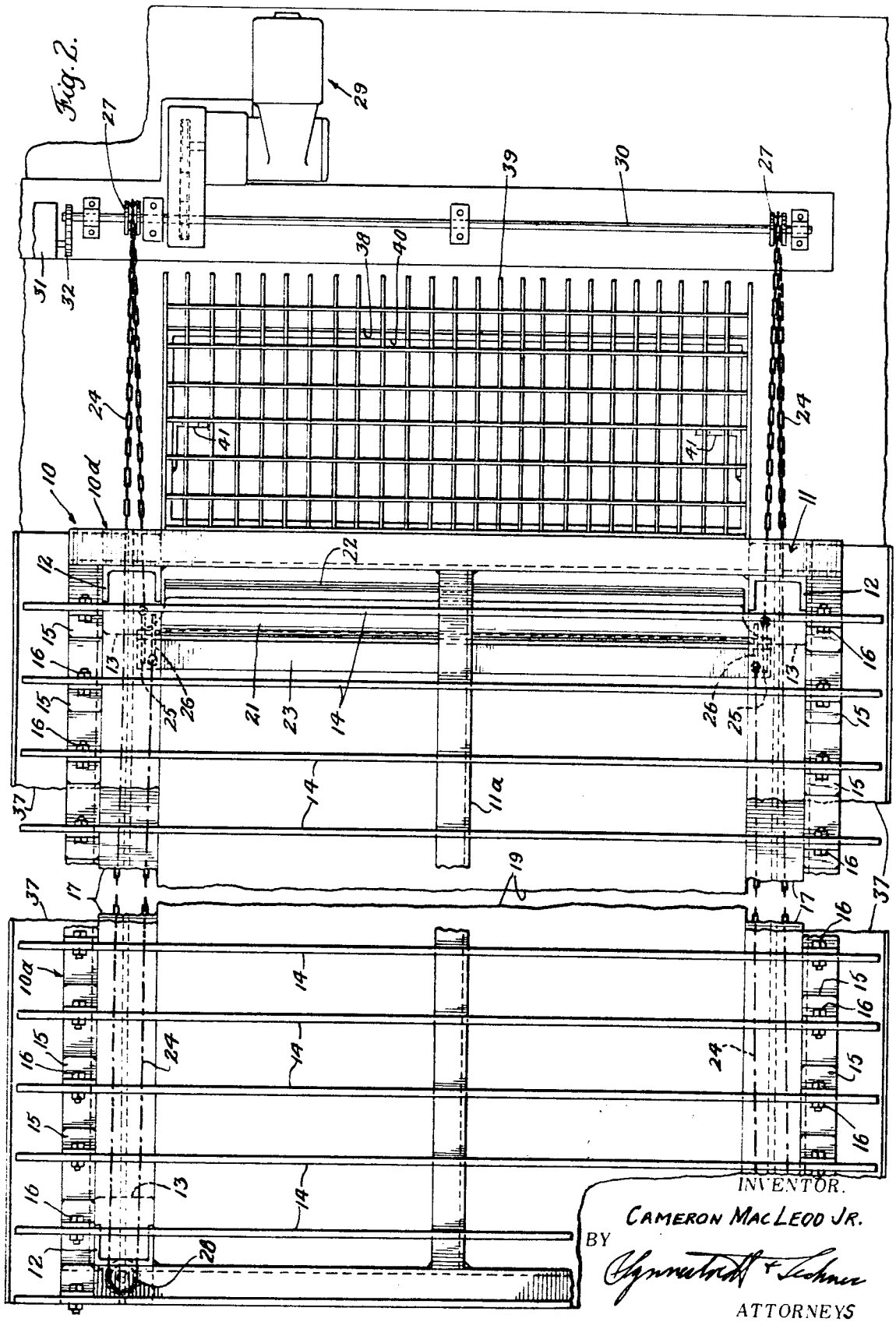

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Fig. 2.




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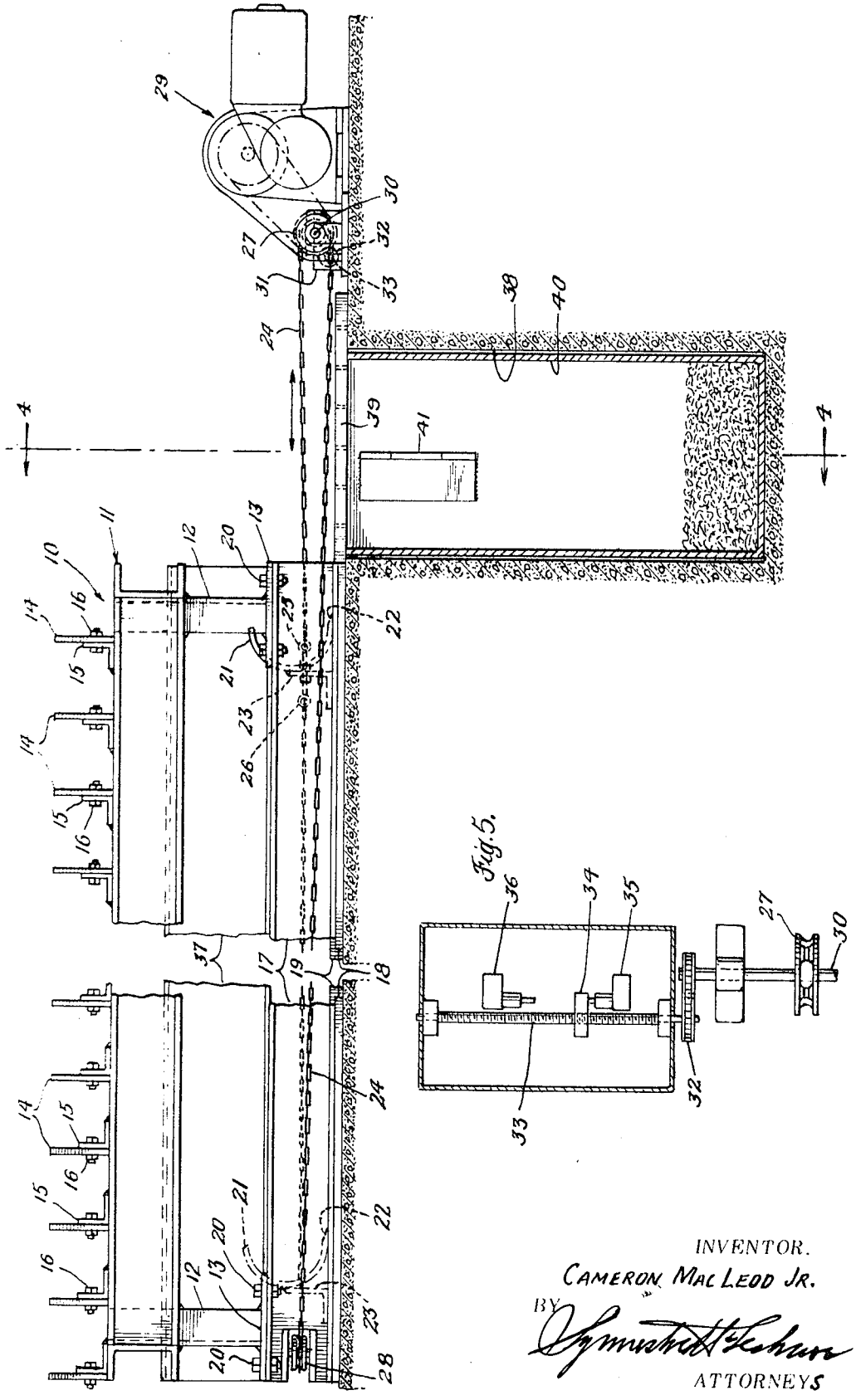



Fig. 3.

Fig. 5.




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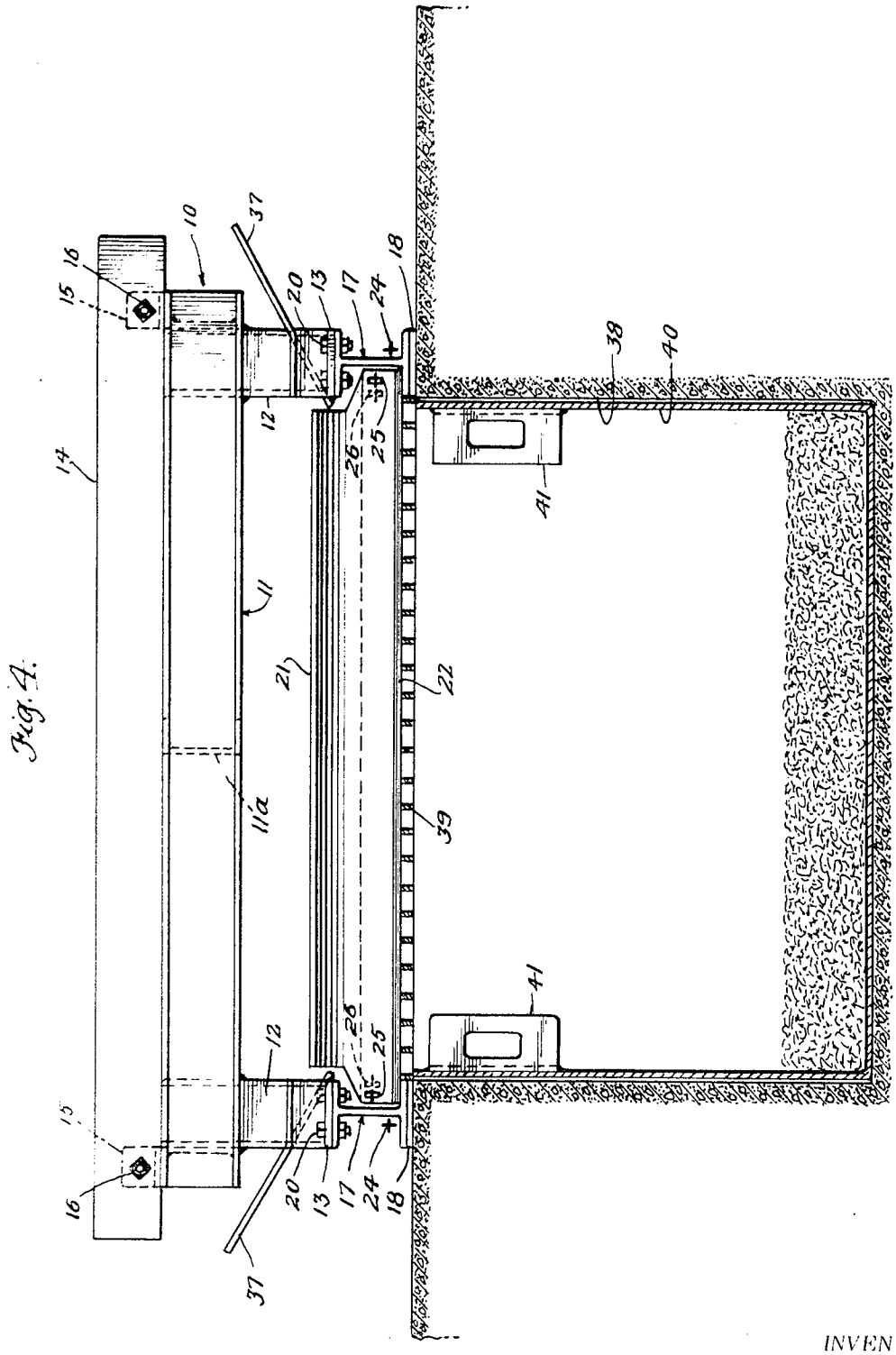



Fig. 4.

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# SLAG SCAVENGER FOR FLAME BURNING TABLE

This invention relates to the removal of slag which drops through the supporting tables on which steel slabs are placed for flame-cutting operations. It is particularly concerned with the provision of mechanism which is extremely rugged and positive in its operation, relatively inexpensive to produce, and readily replaced or repaired.

The primary object is to facilitate the removal of slag as frequently as may be necessary without interrupting the operation of the flame cutting torches as they burn through the work piece on the cutting table. It is important to the successful operation of the more or less conventional cutting table, that the slag which drops through the supporting plates should not be allowed to build up to a substantial height, because the intensity hot flame projecting from the burning torches downward and impinging on the slag is likely to melt it, and cause it to coalesce or fuse. At the same time, as the distance between the upper level of the mound of slag and the lower level of the supporting plate diminishes, heat and flame projected downward from the burning torches is reflected to the under edges of the plates, causing them to burn or warp and thus shortening their useful life. Furthermore, if the crest of the mound of slag gets too close to the work piece, that also may be cut or damaged.

The mechanism which is illustrated herein includes an electrical drive motor and a limit switch connected therewith, so that the scraper structure which is used to remove the slag automatically reverses its direction as soon as it has reached the margin of the slag pit, and returns to its starting position at the opposite end of the table. At that point it comes to rest until the operator again activates the motor control switch, causing it to repeat the cycle.

How these and other objectives and advantages which may be incident to the invention are attained is explained in the following pages, and is illustrated in the accompanying drawings, in which

FIG. 1 is a diagrammatic plan view illustrating slag scavenging equipment of the present invention and an associated flame cutting machine;

FIG. 2 is an enlarged broken out plan view of the equipment;

FIG. 3 is a broken out side elevational view of FIG. 2 with the slag pit and removable slag container shown in section and with the near slag shield omitted so as not to hide other parts;

FIG. 4 is a cross section taken on the line 4—4 of FIG. 3;

FIG. 5 is a plan view of a control device of the equipment;

FIG. 6 is an isometric view of one of the structural table units or sections of the equipment;

FIG. 7 is an isometric view of laterally spaced longitudinally extending wide-flange beams for supporting the equipment, and the associated slag scooping or scraping mechanism;

FIG. 8 illustrates an alternate way of supporting the transverse work piece supporting plates; and

FIG. 9 is an end view of a modified form of slag scoop.

Turning now to FIG. 1, it will be seen that letters have been applied to parts of the flame cutting machine (indicated as a whole by the letter F) since these elements form no part of the present invention, and are purely conventional. In the unit shown, the templet table T moves along the rails TR, for operation lengthwise of the machine. Between the track TR and the burning table, a monorail M guides a carriage C on which rests the burner support BS, which is movable in either direction. At one end the support carries the scanner S. Below its other end a work piece WP is shown, above which the burners B are mounted on the burner support. Other types are known, including one in which the burner support is moved by program tapes.

As workers in this art will fully appreciate, the scanner S follows the pattern of the templet, and directs movement of the templet table and burner support so as to enable the burners to produce on the work piece the precise pattern provided by the templet which is carried on table T.

Turning now to the construction of the burning table itself, this is indicated as a whole by the reference numeral **10**. In



order to facilitate production and installation of this equipment, it is desirable to produce it in a series of separate units, which can be more readily handled than the assembled apparatus. For this purpose, the units **10***a*, **10***b*, **10***c* and **10***d*, have been illustrated, as sub-assemblies, each handleable as a single unit, but readily bolted or welded in place in line with other units, to produce a burning table of the desired length.

As will be more clearly seen in FIG. **6**, each unit has a rectangular frame **11** of channel section steel elements, the elements being welded together. A supporting beam **11***a* is desirably positioned about midway of each unit, this being welded at its ends to opposite elements of the frame **11**. The frame itself is supported on four legs, each of these being numbered **12** and each terminating in a pad **13**, which is welded to the bottom of the leg **12**.

Throughout the length of each unit, a plurality of parallel vertical plates **14** are positioned at spaced intervals, as will be more clearly seen in FIG. **3**, by angle members **15**. The horizontal portion of each angle is welded to the upper surface of a longitudinal element of the frame **11**. Bolts **16** connect the vertical portion of each angle to the plates **14**, and firmly maintain those plates in a vertical position. It is necessary to connect the plates **14** physically to the frame in installations where the heavy work piece is handled by overhead cranes using electromagnets. In plants where the work piece is moved by mechanical rather than magnetic means, it is possible, as shown in FIG. **8**, to slip each vertical plate **14***a* between a pair of vertical angles **15***a*, **15***a* which are spaced apart and face in opposite directions, so that the plate **14***a* can be readily removed if replacement becomes necessary.

It will be observed that the elements which constitute the structure just described are of standard structural shapes. The walls of the frame and the legs which support it are of channel section. The vertical plates **14** are likewise of common commercial stock.

The structure of each of the units **10***a*, **10***b*, **10***c*, and **10***d* is supported as is shown in FIG. **7**. The pads **13** are bolted to the longitudinal wide-flange beams **17**. These beams extend throughout the length of the device, and each of them has, welded to its underside, a spacer plate **18**. Between the bottom flanges of the two wide-flange beams **17**, **17** there is a heavy steel plate **19**, which is preferably about 1 inch thick. The spacer plates **18** are welded to the lower flanges of the wide-flange beams **17** in order to bring the plane of the upper surface of the bottom flange on each beam to the same level as the upper surface of the bed plate **19**. This is seen at the lower part of the broken-out portion of FIG. **3**. In order to secure the wide-flange beams permanently to the edges of the base plate **19**, it may be desirable to tack-weld the flanges to the plate edges at intervals. An alternative is to mount the wide-flange beams directly upon the bed plate **19**.

At the right hand end of FIG. **7**, there is shown the scraper structure **21**, this being more clearly illustrated in FIG. **3**. The showing in FIG. **3** is on an enlarged scale, and the deflector plate **37** (seen in FIG. **4**) has been omitted in order to show the structure behind it more clearly. The mounting of the legs **12** by bolts **20** passing through the pads **13** is shown, left and right of this view. This is a convenient method for positioning the units **10***a*, **10***b*, **10***c*, and **10***d* in accurate and permanent alignment, by reason of the common support—the wide-flange beams **17**, **17**.

The scoop element **21** is shown in full lines at the end of its movement towards the slag pit, in FIG. **3**, and in dotted lines at the end of its movement in the opposite direction.

The scoop **21** is cut from a section of pipe having substantial wall thickness, and this is bent out of round, in the area **22**, in order to provide the desired contour for picking up particles of slag. Its leading edge is ground, or otherwise beveled, to the desired pitch. The scoop is held at the proper angle by means of the transverse angle iron **23**, the upper edge of which is welded to the back of the scoop, throughout its length, along a line which is substantially midway of its exterior arcuate surface. This affords a very firm and sturdy back-up support for

the scoop. At either end of the scoop a pair of eye bolts **25** and **26** are mounted, these being adjustably secured to the scoop by means of lock nuts on the threaded shanks of the bolts.

An alternative form of scoop is shown in FIG. **9**. Instead of using a scoop which is arcuate in section, the scooper blade in this embodiment is planar—that is, a flat sheet, **21***a*, welded to a back-up angle **23***a*. It will be noted, however, that the horizontal portion of the back-up angle member extends forwardly, to underlie the leading edge **22***a* of the scoop, instead of extending rearwardly, as in FIG. **3**. This view shows, more clearly than FIG. **3**, that the eye bolts are mounted far enough from each other to permit easy adjustment of the tension on each bolt, by varying the setting of the lock nuts.

In either embodiment, one of the eye bolts engages an end link of the chain **24**, while the other eye bolt engages the other end. The chain **24**, which is the drive chain for the scoop, is, in other words, functionally endless.

The run of the chain which extends forwardly—that is, towards the slag pit—in FIG. **2**, passes over a socket wheel **27** on the drive shaft **30**, which is journaled on the far side of the slag pit. At the opposite end of the device, the chain passes over a socket pulley **28**, which is mounted upon a vertical axis. With this arrangement, one run of the chain is on the outer side of the web of the wide-flange beam **17**, as is indicated, at **24** in FIG. **4**, while the other run of the chain lies to the opposite side of the web of the beam **17**, and is below the upper flange of that beam.

The chain mounting just described with reference to one side of the apparatus, is precisely duplicated, on the opposite side of the unit. Both of the drive pulleys **27**, **27** are powered by the motor **29** through appropriate reduction gearing which is connected to the drive shaft **30**, to which shaft both of the drive pulleys **27**, **27** are keyed. Near the motor **29** is the control unit **31** which is operated from the drive shaft **30** by a chain take-off **32**.

FIG. **5** illustrates, diagrammatically, the control unit **31**. A threaded rod **33**, journaled in the end walls of the unit, is rotated by the chain drive connection **32**. The switch actuator **34** travels on the threaded rod **33**. Presently the switch actuator **34** is illustrated as in contact with the reversing switch **35**, because the scoop is presently at the forward limit of its travel, as is seen in FIG. **3**. When it reaches that point, it operates to reverse the direction of movement, thus causing the scoop to return to its starting position, and causing the actuator **34** to return to the stop switch **36**.

Upon reaching the stop switch **36**, the mechanism comes to rest until the starting button is again manually operated. The pitch of the thread on rod **33** is such that it moves the actuator **34** from switch **35** to switch **36** in the same time interval as is required for the scoop to complete its run in one direction.

Reversal of movement may be effected entirely electrically (using a reversible motor) or partly mechanically, using a double-acting clutch, for example, between the prime mover and the shafts which are driven thereby.

The upper flanges of the wide-flange beams **17** shield the chains below them from excessive heat and also protect them from flying sparks and falling slag. In addition, a deflector plate **37** is mounted along each side of the unit, extending lengthwise of the same, and positioned so that bits of slag falling upon it will slide inwardly and downwardly, and drop upon the base plate **19**, in a location within the reach of the scoop **21**.

FIG. **4** illustrates the manner in which the top of the scoop is configured so as to accommodate the lower edges of the deflector plates **37**, **37**.

An alternative structure for making the scavenging scoop is, as previously mentioned, shown in FIG. **9**. This has been found to be quite as effective as the arcuate scoop shown in FIG. **3**. It is easier to manufacture and less expensive. The arrangement of lock nuts on the eye bolts **25***a* and **26***a* is more clearly seen in FIG. **9** than in FIG. **3**.

It is an important feature of the present device, to provide for such an adjustment of the orientation of the scoop in relation to the beams **17**, **17**. If the scoop is not precisely at right angles to its path of travel, there will be a tendency for the slag to shift towards the lagging end of the scoop, and thus, to push the slag into contact with the drive chain on that end of the scoop. This is quite undesirable, for sometimes the slag is still molten and if it fouls the chain, trouble ensues. In order to be certain that the scoop is always in its optimum position, the threaded eye bolts and their double lock nuts provide means for increasing or reducing the effective length of each of the chains on either side of the cutting table. Although one tension member on each chain would probably be sufficient it is more convenient and more effective to provide adjustability for each of the eye bolts **25**, **26**, on each side of the apparatus. With this provision, it is easy to make certain that the scoop is always at right angles to the broad-flange beams, this being otherwise a rather troublesome problem, because the driving chains cannot be kept taut, like a bow-string; they inherently follow their own catenary pattern, and this makes it a little difficult to keep them precisely together.

Incidentally, it will be noted in FIG. **4** that the lower portion of the scoop **26** extends beyond the edges of the plate **19**, and overlies the upper surface of the inner flange of each of the wide-flange beams **17**, **17**.

FIG. **4** shows in transverse elevation the slag pit **38**. Over the upper end of this pit the slag screen **39** is positioned, and below this screen the slag pot **40** rests. The slag pot is provided with a couple of inwardly projecting ears **41**, **41**, which are welded to its sides. These ears are apertured to be engaged by crane hooks to hoist the pot in order to empty it.

Although the apparatus shown can readily be built as a single, unitary structure, it has been so devised as to facilitate shipment in unassembled form, for erection at the plant in which it is to be used. The most significant aspect of this concept is the construction of the table units pictured in FIG. **6**. It is a great deal easier to handle and ship units of the size there shown than it would be to handle a table structure of the size indicated, as a single piece.

It is obvious that equipment of this sort may be custom built to fit the point of installation. None the less, it is believed that economy and efficiency might both be served by fabricating units of this device to modular standards. The apparatus here shown, for instance, provide a flame cutting table which is 8 feet wide and 24 feet long. It is composed of four units of the type shown in FIG. **6**, each unit matching the 8 foot width of the bed, and extending 6 feet along its length. The most common width for steel plate is 8 feet, since this will fit most truck bodies, the length usually being multiples of 8 feet or 10 feet. The other standard sizes vary from these dimensions by 2-foot intervals, both in length and width. The slag bucket corresponds in width with the table, and the grating which covers it is only slightly larger. The vertical plates **14**, which extend beyond the edges of the frame a few inches on each side, may be unbolted and stacked for ready shipment. They will fit easily into the slag bucket.

The largest single unit will be the base plate **19**, which may be divided into two 12-foot lengths. This plate is of inordinate thickness, because otherwise it would be very prone to warp or buckle, in view of the extremely uneven application of heat as the burning torches move from one position to another. If the base plate warps, the scraper may bind, or stick, or remove the slag in an uneven or unsatisfactory manner. For this reason, it is not regarded as wise or practical to form the base plate in multiple short lengths, to match the units **10***a*, etc. Similarly, it is the longitudinal rails, or wide-flange beans **17**, **17** which establish alignment and rigidity for the entire device. These rails are therefore cut to 8-foot lengths, and these lengths may be secured together, like railroad rails, by the use of fish plates, or by applying simple weldments. That is to say, the provision of sections **10***a*, etc. in lengths of 6 feet, rails **17** in lengths of 8 feet, and bed plate **19** in 12 feet, minimizes the concurrence of joints at final assembly.

In view of the nature of the work done by flame cutting tables of the type herein described, it is important to consider

the replacement of the vertical plates **14** which support the work piece. As the cutting torches move across the tops of these work pieces, the flame inevitably burns away parts of the metal near the upper edge of each vertical plate. One of the advantages of the arrangement here shown for mounting the plates **14** is the fact that plates of differing thickness may be used. From an engineering point of view, the strength of the plate is conditioned substantially more by its vertical dimension than by its thickness. As a matter of practice it has been found that scrap metal cut from plates five-sixteenths inch in thickness can be used along with metal from plates three-eighths inch thick. Indeed, slightly thinner or slightly thicker plate may be used, but when the thickness of the plate becomes significantly greater than three-eighths inch it resists the impingement of the flame from the torch and causes the flame to spread or bend back upon itself, in ways which are likely to damage the underside of the work piece.

The opportunity to use supporting plates of differing thickness made from scrap metal is an advantage which is lost when the plates are supported by double angles, as shown in the embodiment of FIG. **8**.

Although the apparatus has been illustrated and described as having a slag grate which is substantially flush with the upper surface of the bed plate **19**, it may be preferable to dump the slag directly into the slag pot, particularly in situations where the amount of slag produced is inordinately large, as where the work piece is of unusual thickness. Under such conditions, enough residual heat may remain in the slag, even after it has been conveyed to the discharge end of the apparatus, to form relatively large and awkward lumps, which will not pass through the slag grating. This difficulty may be obviated quite easily simply by mounting the grating **39** at a level far enough above that of the bed plate **19** to allow big chunks to pass beneath it. It may be extended, if desired, to overlie the chains **24**, **24**, on either side of the apparatus. The grating itself will then serve purely as a safety feature, to prevent persons and things from falling into the slag pot by accident.

It is preferable to use the apparatus with the grating in the position shown in FIGS. **3** and **4**, where it helps to break up lumps of slag passing over it. There is a modest industrial market for slag in particulate form, but the price is even lower if the slag contains chunks which are large enough to require crushing.

It may be noted that flame cutting apparatus is usually supported on a heavy concrete base, to ensure that the cutting elements remain in alignment with the work-supporting portion. For this reason, the bed plate will lie flat, even when made up of two lengths, or possibly three, so that the leading edge of the scoop can pass without obstruction from one length of plate to the other. If the wide-flange beams are mounted on top of the bed plate **19**, the ends of the scoop should, of course, be cut away sufficiently to pass the bottom flanges of these beams.

I claim:

**1**. Apparatus for removing fallen slag from beneath a flame-cutting operation, comprising: a rigid bed of substantial size and thickness upon which the slag falls, two parallel wide-flange beams, bordering the bed, and extending lengthwise of it; a scavenging scoop member positioned perpendicularly to said beams and extending substantially from one to the other of them; and a chain drive assembly associated with each beam, comprising a pair of pulleys, mounted adjacent opposite ends of the associated beam, a chain having one end connected to the leading edge of the scoop, extending thence around both of said pulleys and having its other end engaging the trailing edge of said scoop; and drive mechanism engaging one of the pulleys of each pair and driving the engaged pulleys in synchronism to cause movement of the scoop in one direction or the other while still maintaining it perpendicular to the beams.

**2**. Apparatus according to claim **1**, wherein the web of each beam extends between runs of its associated chain, and the upper flange of each beam overlies the run of chain which is adjacent the scoop member, to protect it from falling slag and heat.

**3**. Apparatus according to claim **1**, wherein a slag deflecting plate is positioned above the upper flanges of each of said wide-flange beams, said plates sloping inwardly and downwardly, so as to deflect falling slag into the path of said scoop.

**4**. Apparatus according to claim **1**, wherein spacer plates are employed in association with the bed and wide-flange beams, for the purpose of ensuring that the upper surface of the bed is coplanar with the upper surface of the lower flanges of the wide-flange beams.

**5**. The apparatus of claim **1**, in which the connection between the chain and the scoop on each side of the apparatus is independently capable of being lengthened and shortened, to facilitate positioning and maintaining the scoop at right angles to the wide-flange beams during its movement.

**6**. The apparatus of claim **5** in which the connections between the ends of each chain and the scoop are capable of adjustment at the leading edge of the scoop independently of the adjustment at the trailing edge.

**7**. Apparatus according to claim **1**, wherein a slag pit is provided having an opening at substantially the level of the upper surface of the bed, and positioned to receive slag advanced to it by the leading edge of the scoop, a removable grating is mounted above the pit, and a slag pot is positioned within the pit and provided with hoist-engaging means welded to either side.

**8**. Apparatus according to claim **7**, wherein the grating is provided with bars configured to aid disintegrating of slag lumps and is positioned at or below the level of the rigid bed.

**9**. Apparatus according to claim **1**, wherein the wide-flange beams rest upon the rigid bed, and the leading edge of the scoop member extends substantially from web to web of said beams and is cut away at either side for a distance and to an extent appropriate to clear the lower flanges of said beams.

**10**. In apparatus for removing slag from beneath a flame-cutting table, said apparatus having a rigid bed to receive fallen slag and a scoop member with means to move it lengthwise of the bed and remove the slag, the combination of a power drive for said scoop-moving means comprising a threaded element which rotates when the power drive is actuated, a contact member engaging the threads of said threaded element and adapted to be moved thereby, a reversing switch and a stop switch in the path of said contact member, a mechanical connection between the scoop-moving means and the power drive means, and electrical connections between the switches named and the drive means so correlated as to effect actuation of a selected switch by said contact member when the mechanical connection has traversed a predetermined range of movement in either direction.

**11**. Apparatus for removing fallen slag from beneath a flame-cutting operation, comprising: a rigid bed member extending lengthwise of the apparatus, a pair of wide-flange beams bordering the bed member along two parallel sides, drive chains mounted for movement beneath the upper flanges of the respective beams, a transversely extending scoop connected to the said drive chains and substantially spanning the distance between the webs of said beams; power means for simultaneously actuating the drive chains and connected to a threaded element to cause rotation thereof; a stop switch and a reversing switch and a switch actuator mounted on the threaded element and movable thereby between said switches; the threaded element being adapted to operate the switch actuator through one cycle of its movement in the same time interval as is occupied by movement of the scoop through one cycle of its movement.

* * * * *