Dec. 24, 1957 W. A. PENNINGTON ET AL 2,817,494

ELECTRODE SUPPORT

Filed May 17, 1955

3 Sheets-Sheet 1

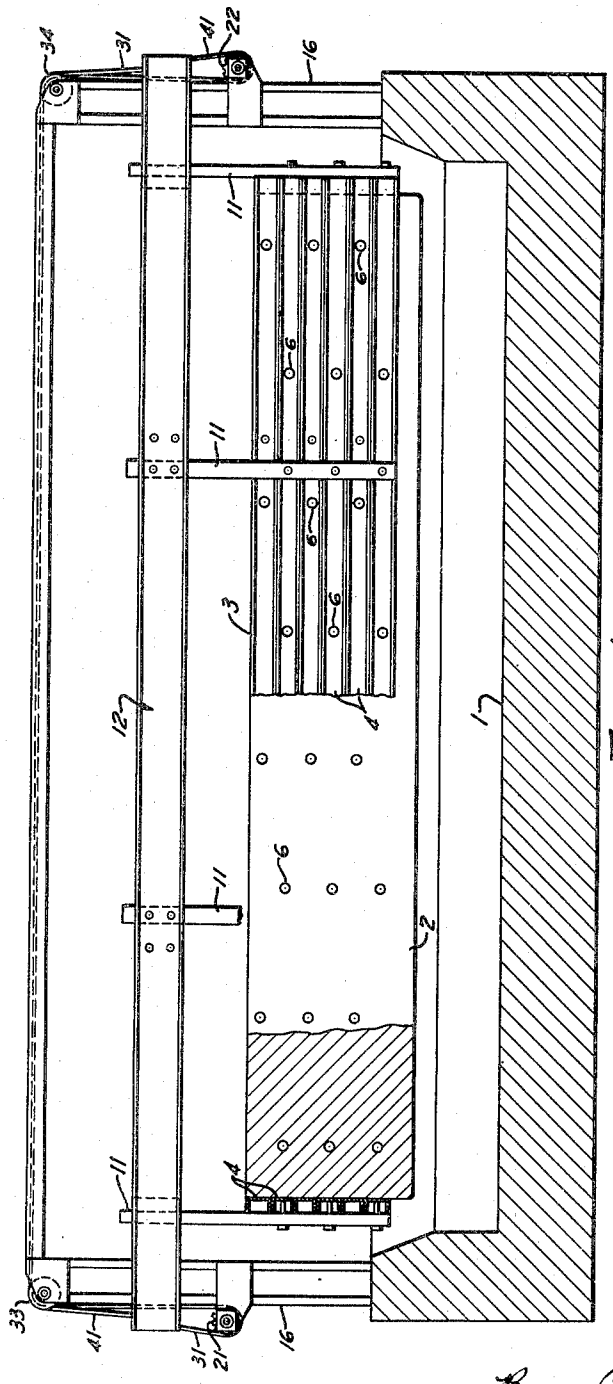


Fig. 1

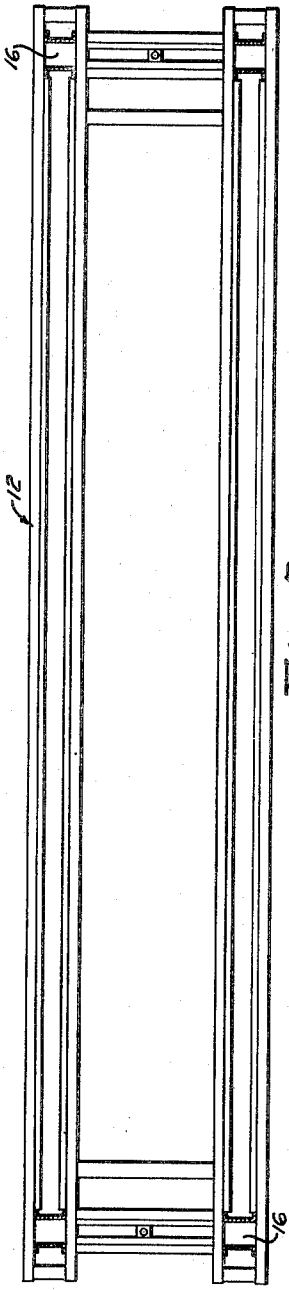


Fig. 2

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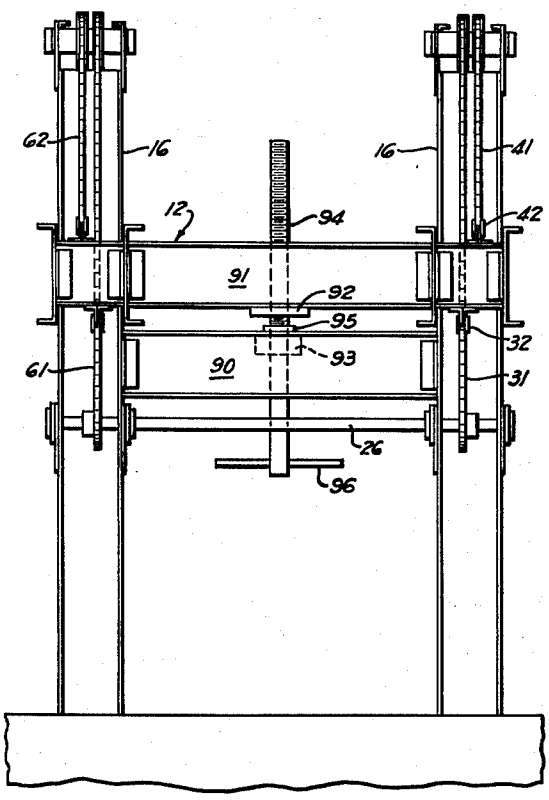


Fig. 3

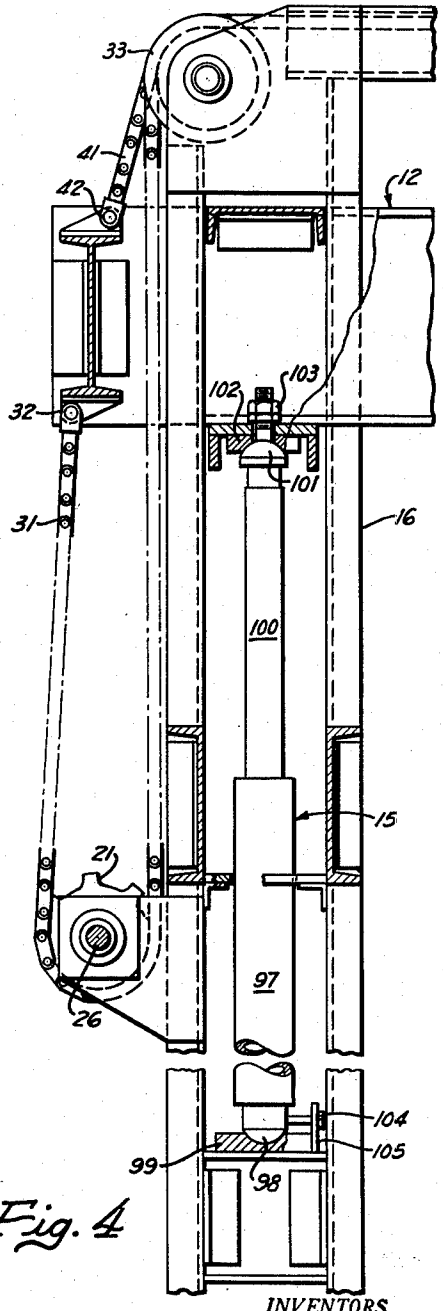


Fig. 4

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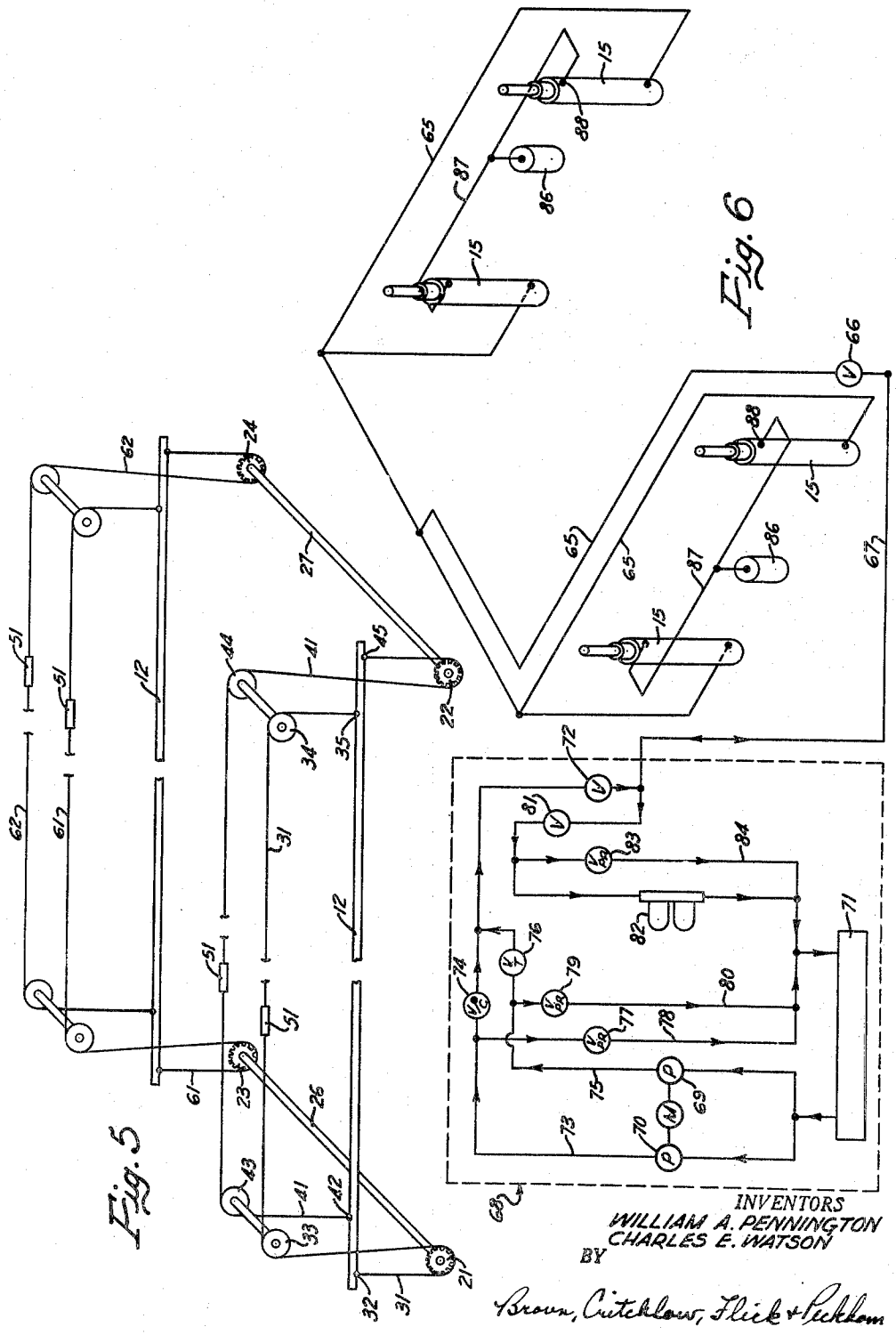


Fig. 5

Fig. 6

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ELECTRODE SUPPORT

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Application May 17, 1955, Serial No. 508,995

11 Claims. (Cl. 254—144)

This invention relates to an electrode support, particularly for supporting electrodes of the self-baking type used in the production of aluminum. Those electrodes, or anodes, are generally of rectangular shape and are suspended in a metal casing or frame over the furnace or melting pot. The heat from the pot bakes and hardens the electrode material, which is added from time to time in the form of a paste at the top of the frame to replace the electrode material that is consumed at the bottom. Anode support straps are attached to certain of the frame members at various points and extend above the frame where they are secured to a beam assembly supported by a plurality of mechanical jacks. The operation of those jacks permits the entire electrode and its supporting frame to be raised and lowered in accordance with operating requirements.

The jacks used to raise and lower the electrodes are of the screw or rack type, interconnected by shafting and gearing to operate in unison. Due to the increased size of electrodes that are presently being used, some of which are over 60 tons in weight and as much as 30 feet long, the number and size of the lifting jacks has also increased, and jack failures have become more common. One cause of such failure is the deflection in the shafting, as well as the play in the gearing by which all of the jacks are operated, causing the jack or jacks nearest the power source to pick up most of the load before the other jacks take their proportionate share. When such a failure occurs, there may be a tilting of the electrode that is highly objectionable. In addition, as the load per jack has increased the mechanical efficiency of the jack, especially when operated at high speed, has decreased, and at the same time there has been greater wear on the working surfaces of the jack which are not adaptable to high speed service.

While it has been proposed that hydraulic rams be used in place of mechanical jacks, it is well known that two hydraulic rams under unequal loads will not move evenly under the same hydraulic pressure, the ram with the least load always moving first and continuing to move until the loads are equalized. Accordingly, although the use of rams would eliminate many of the disadvantages inherent in the use of mechanical jacks, the lack of adequate means for keeping the electrode level during the operation of the rams has prevented their adoption.

It is accordingly among the objects of this invention to provide an electrode support that will permit the electrode to be raised and lowered at varying speeds and yet maintain the electrode level at all times, that will permit the elevation of the electrode to be controlled within narrow limits and to be locked in any given position, and that will raise and lower the electrode quickly or slowly with equal efficiency.

Other objects of the invention will be apparent from the following specification.

A preferred embodiment of this invention is shown in the accompanying drawings, in which

Fig. 1 is a front elevation, partly in section, of an aluminum melting pot using a self-baking electrode supported by the apparatus of this invention;

Fig. 2 is a plan view of the beam assembly shown in Fig. 1;

Fig. 3 is an end elevation of the apparatus shown in Fig. 1;

Fig. 4 is a detail elevation, partly in section, of one of the supporting columns of Fig. 1, showing one of the hydraulic rams used to raise and lower the electrode;

Fig. 5 is a schematic diagram of the leveling means for maintaining the beam assembly and electrode in a horizontal position; and

Fig. 6 is a schematic diagram of the hydraulic system and controls for operating the hydraulic rams.

In accordance with this invention, the electrode is supported by a rectangular beam assembly, which is preferably raised and lowered by hydraulic rams, the beam assembly being kept level at all times by flexible lines attached to each end of the assembly and passing over and under a plurality of sheaves mounted on fixed supports. The sheaves and lines are so arranged that vertical movement of one corner of the beam assembly is transmitted through tension on the lines to the other corners of the assembly to cause the latter to move a corresponding distance in the same direction.

Referring to Figs. 1 to 3, a pot or furnace 1 is adapted to hold the aluminum ore that is to be electrolytically refined. Suspended above the pot is a self-baking electrode 2, which has a generally rectangular shape and is surrounded on its four sides by a supporting casing 3. This casing is of a conventional type made of a plurality of channel sections 4, which are detachably secured at their ends to other channel sections on adjacent sides of the casing. Accordingly, when the electrode is lowered, the bottom channel sections can be removed to avoid the heat of the molten bath and can be replaced on top of the other sections to extend the casing upward for receiving new electrode material. A number of electrical contact studs (not shown) are adapted to be inserted through holes 6 in the casing and in the electrode to secure the latter to the casing and to supply electrical current.

The casing and its contained electrode are suspended above the pot by support straps 11, the lower ends of which are secured to the channel sections and the upper ends to a rectangular beam assembly 12, supporting the four sides of the electrode. The beam assembly is made sufficiently strong to carry the weight of the electrode when the assembly is supported at its corners alone by hydraulic rams 15 positioned in each of the four hollow columns 16. These rams permit the electrode to be raised and lowered in response to hydraulic controls to be described later. Since it is essential that the electrode, and therefore the beam assembly, be maintained level at all times to obtain uniform contact between the electrode and the molten bath, leveling means are provided to maintain the beam assembly in a horizontal position even when the entire load of the electrode is borne by one or more but less than all of the rams.

The leveling means, shown schematically in Fig. 5, includes three sheaves attached to each column and chain cables passing around those sheaves and attached to the beam assembly. Preferably, the sheaves and cables lie in planes parallel to the long side of the beam assembly, as shown in Figs. 1 and 5. One of the three sheaves on each column is mounted below the lowest point of travel of the beam assembly, and the two remaining sheaves are mounted above its highest point of travel. The four lower sheaves 21–24 are preferably of the sprocket type adapted to engage the links of the chain cables, while the upper sheaves may be plain. In addition, the two

lower sheaves 21 and 23 at one end of the beam assembly are keyed to a common shaft 26; and the corresponding sheaves 22 and 24 at the other end are keyed to a shaft 27, so that, when one of the lower sheaves rotates, the other lower sheave at that end of the beam assembly will rotate the same amount. One of the chain cables 31 for the front set of sheaves has one end attached to a corner of the beam assembly at 32 and passes down under the lower sheave 21, then up and over one of the upper sheaves 33 on the same column, then extends horizontally above the front of the beam assembly over upper sheave 34 on the other front column, and then down to the beam assembly, to which it is attached at 35. A second chain cable 41 is attached at the left front corner of the beam assembly at 42, from where it passes up and over the second upper sheave 43 on the front left column, then extends across and over the upper sheave 44 on the other front column, then down and under the lower sheave 22, and up to the right front corner of the beam assembly, to which it is attached at 45. Obviously, the function of the two cables just described can be performed by one continuous cable secured to each of the front corners of the beam assembly at some intermediate point between the upper and lower sheaves. Each of the chain cables is provided with a turnbuckle 51 to eliminate slack. An identical arrangement of sheaves and chain cables is provided for the rear of the beam assembly, as shown diagrammatically in Fig. 5. All of the upper sheaves are free to rotate independently on their respective shafts.

It will be apparent that if the beam assembly were to be lifted by only one of the hydraulic rams, for example, the one at the left front corner, it would cause point 32 on the beam assembly to move upward and exert tension on cable 31, which would in turn raise the point 35 on the opposite end of the beam assembly by the same amount. At the same time, sheave 21 would be rotated through a certain angle by the movement of the chain 31 in engagement with it; and sheave 23, keyed to the same shaft, would rotate through the same angle, and in so doing would cause its engaging cable 61 to lift the right rear corner of the beam assembly by the same amount as the other two corners. Moreover, the raising of the right rear corner (as well as the raising of the right front corner) would cause shaft 27 to rotate, thereby exerting tension on cable 62 to raise the left rear corner. The same result will follow from a lifting movement at any one of the other three corners of the beam.

In other words, by the leveling means here described, it is possible to overcome the difficulties formerly inherent in the use of separate hydraulic rams for lifting a beam assembly and its suspended electrode. If one of those rams should fail by reason of some leak in its hydraulic system, or if one ram should be overloaded as compared with the others due to unequal distribution of weight in the electrode, the beam assembly would still be maintained in a level position by the cables and sheaves of the leveling means.

The hydraulic system controlling the hydraulic rams is shown diagrammatically in Fig. 6. Each of the hydraulic rams 15 is connected to a common hydraulic line 65. A coupling valve 66 connects that line with a conduit 67, which is connected to a pumping unit, generally designated by the numeral 68. That unit includes a high pressure, low volume pump 69 and a low pressure, high volume pump 70, each pump being driven by the same electric motor M. When that motor is started by closing an electrical switch (not shown), both pumps are operated and hydraulic fluid is forced through both pumps from a fluid reservoir or tank 71. The low pressure pump 70 is designed to supply a large volume of fluid to the hydraulic rams for raising the beam assembly rapidly when that assembly is disconnected from the electrode. The high pressure pump 69, on the other hand, is designed to deliver high pressure fluid at a lower, but controllable, rate for raising the beam assembly under full load.

Assuming that the beam assembly is disconnected from the electrode and that the motor M is operating and that main valve 72 is open, fluid is delivered from the tank 71, through pump 70, conduit 73, check valve 74, and main valve 72, to conduit 67, and then to the individual rams through conduit 65. At the same time, fluid is also delivered from the tank 71 by pump 69, through conduit 75, and throttle valve 76, thereafter joining the fluid from the low pressure pump. In other words, under conditions of minimum load, both pumps supply fluid at a maximum rate (when throttle valve 76 is wide open) to the lifting rams 15. Under conditions of full load, however, the fluid discharged by low pressure pump 70 into conduit 73 cannot overcome the pressure in the line on the other side of check valve 74, and the fluid is consequently discharged back into the tank 71 through low pressure relief valve 77 and conduit 78. The high pressure pump 69 alone delivers fluid to conduit 67 and the rams beyond at a rate controlled by throttle valve 76. If, for any reason, there should be a blockage in the high pressure line (or if valve 72 were closed before motor M was stopped), the high pressure fluid flows through high pressure relief valve 79 and conduit 80 back to the tank. Check valve 74 prevents any of the high pressure fluid from flowing into the low pressure line 73.

From the foregoing description, it will be clear that, when operating conditions change from no load on the beam assembly to full load, the high pressure pump automatically supplies all of the fluid to the rams at a controllable rate, while the low pressure pump merely circulates fluid in a closed low pressure circuit. Under conditions of minimum load, when maximum lifting speed is desirable, both pumps automatically supply fluid to the rams.

When it is desired to lower, rather than lift the beam assembly, main valve 72 is closed, the pumps are idle, and release valve 81 is opened. Fluid from the rams then flows backwards through conduit 67, through release valve 81 (which may also act as a throttle valve to control the rate of lowering), and then flows through oil filter 82 back to tank 71. In the event of any obstruction in the oil filter, this backward flow is through a low pressure relief valve 83 and conduit 84 to the tank.

Since there is almost always a certain amount of leakage in a hydraulic ram and since uncontrolled leakage would be a hazard adjacent the melting pot, the rams are provided with a sump or reservoir 86 connected by conduits 87 to a drain opening 88 at the top of each ram cylinder. The sumps themselves may be provided with an air outlet and a drain (not shown).

Pumping unit 68 may be a self-contained portable unit, as shown, for controlling the elevation of as many as ten to fifteen electrodes suspended over as many different pots. In such case, the unit would be mounted on wheels; and wherever needed would be wheeled to the pot, the electrical circuit plugged in, and the hydraulic connection made to the coupling valve 66, that valve, of course, being closed when the pumping unit is disconnected. Since the usual adjustment of the electrode during the refining operation involves lowering it a fraction of an inch at more or less regular intervals, there is obvious economy in having one pumping unit serving a number of pots. When the electrode has been consumed at the bottom to the point where it becomes necessary to remove the lower channels of the casing 3, and when it is necessary to reattach the supporting straps 11 at a higher point on that casing, both operations being done at more or less regular, but relatively infrequent, intervals, the portable unit will again perform its lifting function for more than one pot. If each pot is provided with its own pumping system, it would be desirable, and possibly even necessary, that a separate standby pumping unit be provided as well, in

case of trouble with the first unit. Two pumping systems for each pot would of course be quite expensive as compared with two portable units (one acting as a standby unit) capable of handling from ten to fifteen pots.

As the hydraulic rams become worn, they may tend to develop leaks, resulting in a certain amount of settlement of the beam assembly. However, because of the leveling means previously described, that settlement will not tip the beam assembly and will even be an advantage in providing for lowering of the electrode without the use of the pumping unit if the settlement can be controlled. To control the amount of settlement, and also to act as a safety lock, a cross member **90** (see Fig. 3) extends between the two columns at each end of the pot below the corresponding cross member **91** of the beam assembly. The latter is provided with a threaded nut **92** on its bottom surface, while the cross member **90** is provided with a thrust bearing **93**. The two cross members are then locked apart by means of a threaded rod **94**, provided with a thrust collar **95** adapted to engage the thrust bearing. The beam assembly can be locked in any given position by rotating the rod **94** by its handle **96** until the thrust collar **95** bears against the thrust bearing **93**. The locking device will then hold all or part of the load at that end of the beam assembly; and a similar locking device is provided at the other end of that assembly. In the event the load is taken by the locking device due to settlement of the rams from leakage of hydraulic fluid, the rams will be carrying less load than normally and this reduced pressure is likely to eliminate further leakage. In the event there is some further leakage, the beam assembly can be lowered without use of the pumping unit by turning screw rods **94** at each end of the pot to decrease the distance between cross members **90** and **91**.

Referring to Fig. 4, it will be noted that the ram **15** is mounted within the column **16** so as to have some slight movement to accommodate any slight shifting of the beam assembly that would otherwise cause an off center load on the ram. To permit this movement, the ram cylinder **97** is provided with a hemispherical bottom **98** resting on a support **99** having a conforming curvature. Likewise, the plunger **100** of the ram is provided with a hemispherical end portion **101** that engages a similarly curved seat **102** on the beam assembly to which the plunger is loosely secured by the threaded nut **103**. Ram cylinder **97** is prevented from turning or lifting by the bolt **104** secured to plate **105**. The column itself acts as a heat shield around the ram, as well as a guide to center the beam assembly (see Fig. 2).

It is among the advantages of this invention that it provides a simple and economical means for controlling the movement of the electrode and for maintaining the electrode level at all times. In addition, it provides means for locking the anode beam assembly and its supported electrode in a given fixed position to guard against any damage from a possible breakdown of the lifting elements.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A support for a horizontally disposed and vertically movable rectangular member, comprising four sets of sheaves rotatably mounted in fixed supports, each set being adjacent to a different corner of the member and the sets being grouped into two pairs on opposite sides of the member and each set having a first sheave spaced vertically from the member in one direction and second and third sheaves spaced vertically therefrom in the opposite direction, and separate flexible lines connecting the sheaves of each pair of sets with the adjacent side of the member supported thereby, a first such line being secured to a side of the member at one end and passing successively about the first and second sheaves of the adjacent set and then about the third sheave of the second set of the same pair and then secured to the same side of the member at its other end, and a second such line secured to this other end of the member and passing successively about the first and second sheaves of the second set of the pair and then about the third sheave of the first set of the pair and then secured to the same side of the member at its first end.

2. A support in accordance with claim 1, in which one of the sheaves in each of the two sets adjacent one end of the member is provided with means for positively engaging the flexible line passing about it, and in which said sheaves so provided are rotatably fixed relative to each other.

3. A support in accordance with claim 1, in which one sheave in each of the four sets is provided with means for positively engaging the flexible line passing about it, and in which said sheave in each of two of said sets adjacent an end of the member are rotatably fixed relative to each other.

4. A support in accordance with claim 3, in which the flexible lines are chain-link cables and the said engaging sheaves are provided with sprocket teeth to engage the links of the cables.

5. A support in accordance with claim 3, in which the said sheaves adjacent each of the two ends of the member are mounted on a common shaft.

6. A support in accordance with claim 1, in which means are provided for raising and lowering the rectangular member.

7. A support in accordance with claim 1, in which means are provided for raising and lowering the rectangular member, said means being connected directly to that member.

8. A support in accordance with claim 7, in which said raising and lowering means include four hydraulic rams, each positioned adjacent to and acting directly on a corner of the member.

9. A support in accordance with claim 1, in which a plurality of hydraulic rams are connected directly to the rectangular member for raising and lowering it, the rams being operated by a hydraulic system that includes a low pressure high volume pump and a high pressure low volume pump, means for operating both pumps at the same time, a conduit for delivering the output of each pump to the rams, a check valve in the conduit from the low pressure pump and a pressure relief valve in the conduit between the pump and the check valve.

10. A support in accordance with claim 1, in which means are provided for positively locking the rectangular member at a given elevation.

11. A support in accordance with claim 10, in which said locking means include a fixed member spaced from the rectangular member and adjustable threaded means between those two members for supporting the rectangular member on the fixed member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,733,018 Nitchie ---------- Jan. 31, 1956