Oct. 4, 1949. E. A. HANFF 2,483,828

EMERGENCY STOP MECHANISM

Filed June 6, 1946

3 Sheets-Sheet 1

Fig. 1.

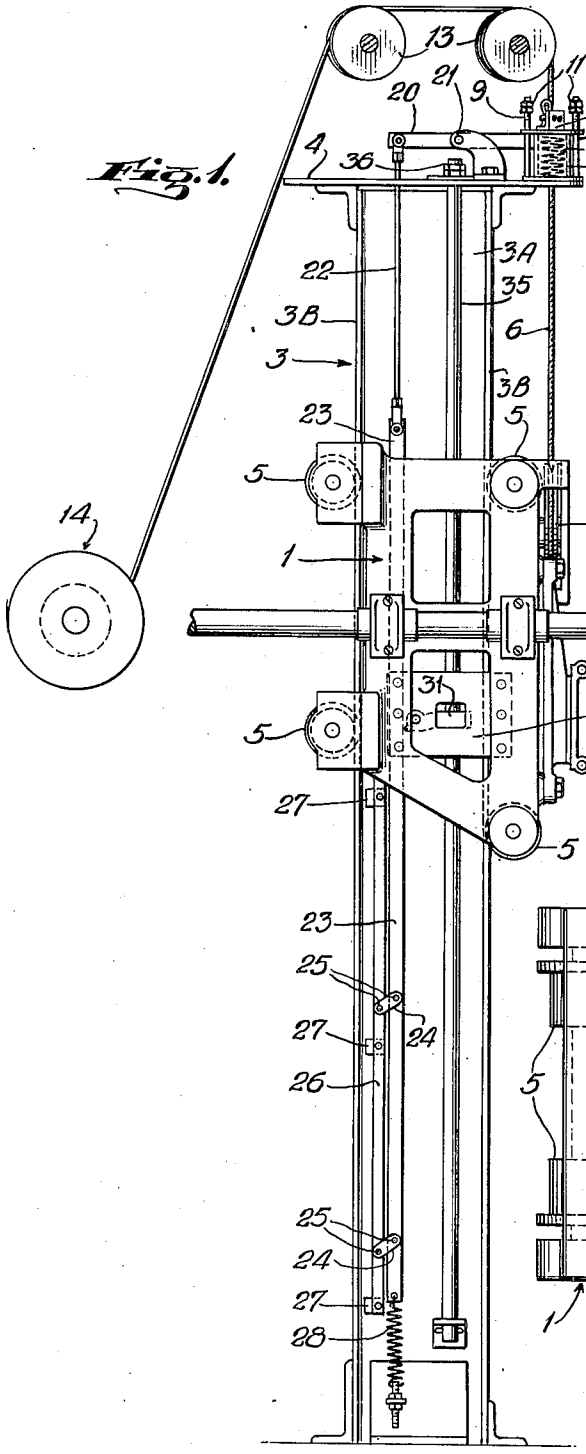


Fig. 6.

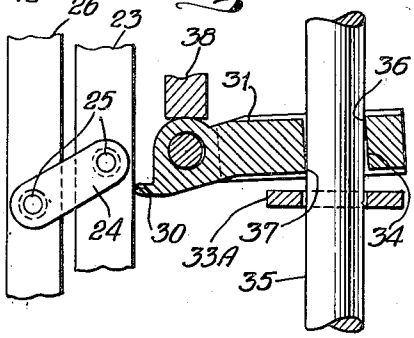
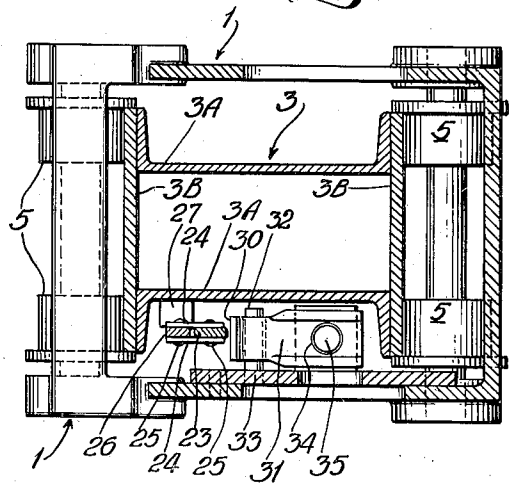


Fig. 5.



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3 Sheets-Sheet 2

Fig. 1.

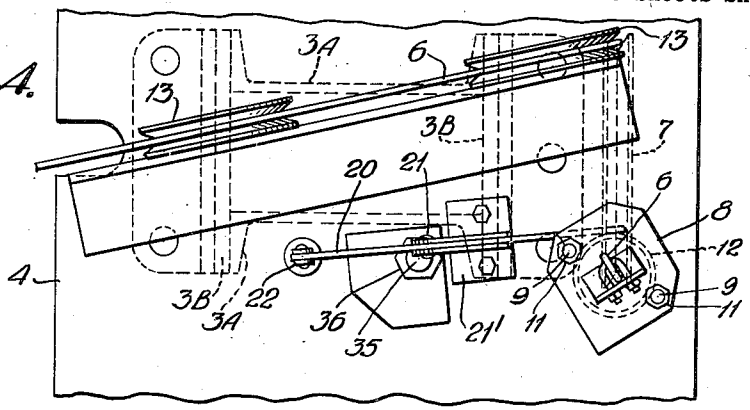


Fig. 2.

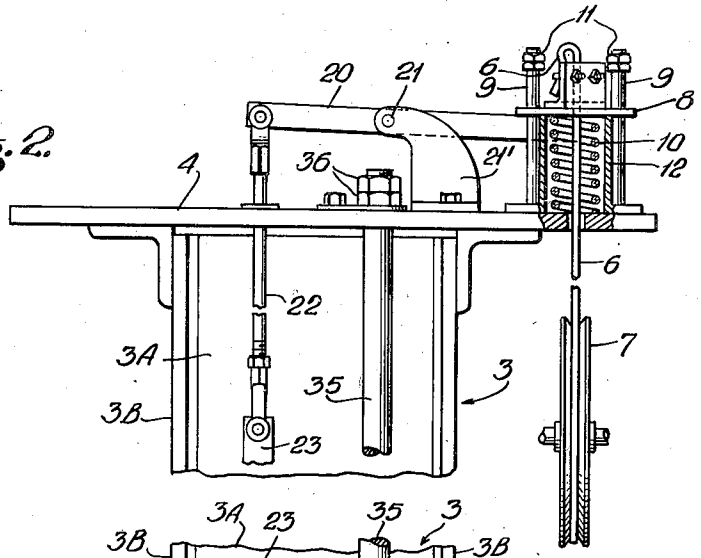
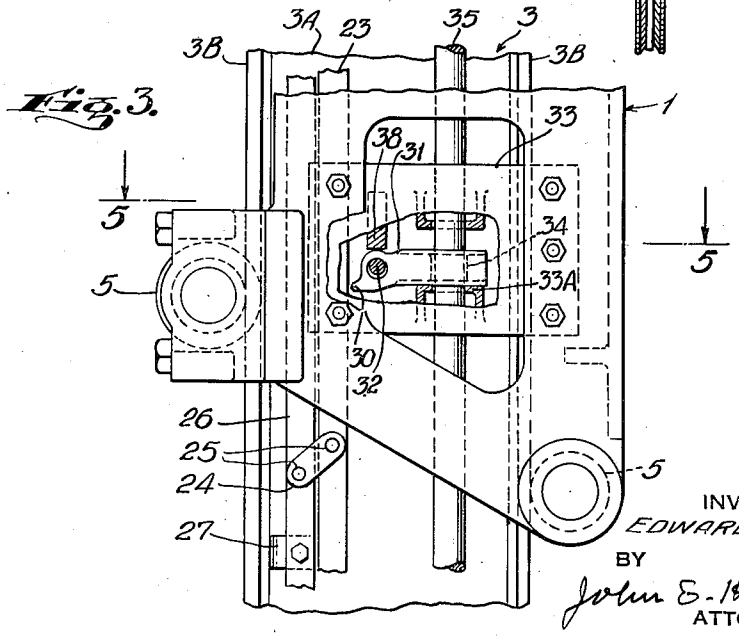


Fig. 3.



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EMERGENCY STOP MECHANISM

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3 Sheets-Sheet 3

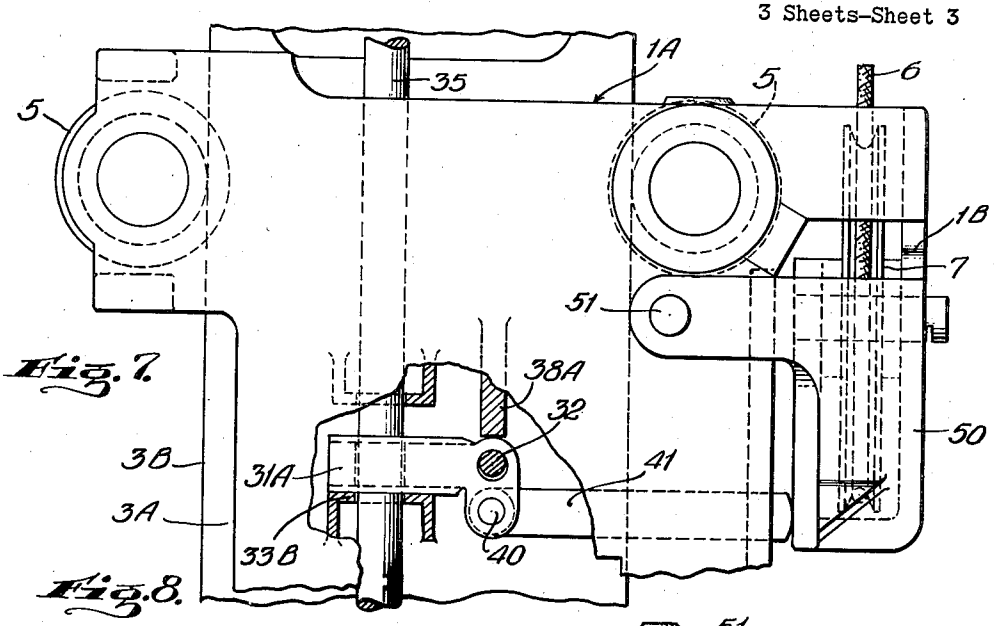

Fig. 7.

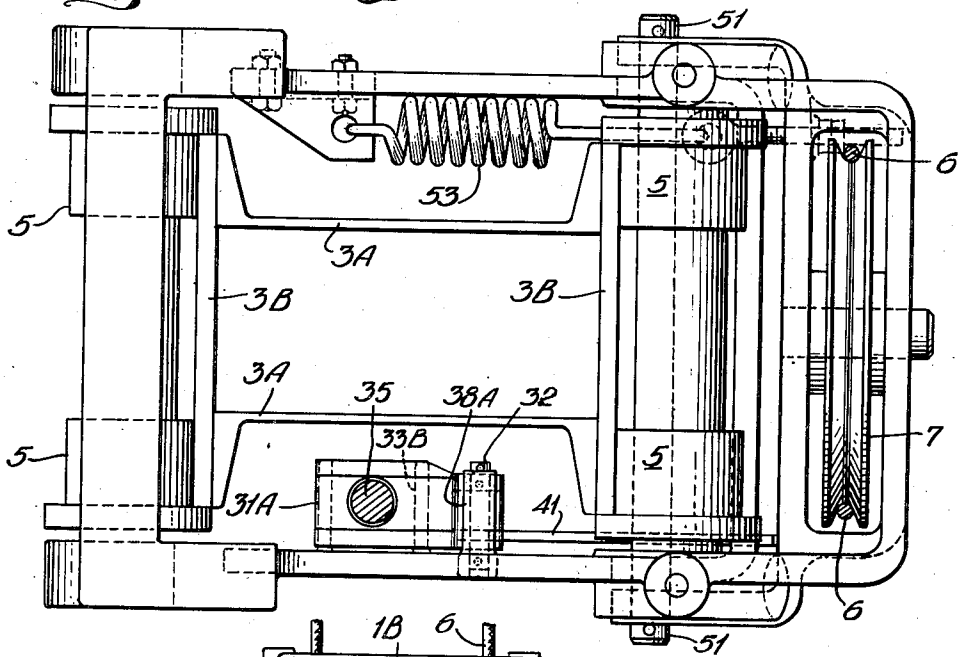

Fig. 8.

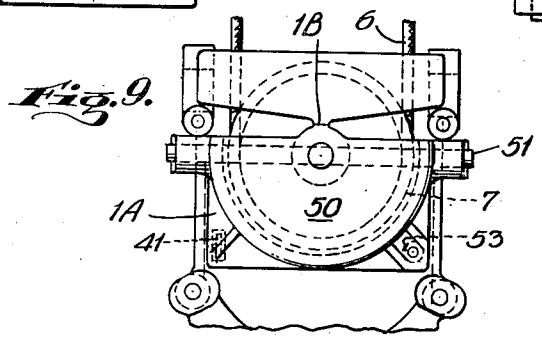

Fig. 9.

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EMERGENCY STOP MECHANISM

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Application June 6, 1946, Serial No. 674,753

8 Claims. (Cl. 187—81)

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The present invention comprises an improved emergency stop mechanism for arresting the downward movement of a heavy body which occurs on a breakage of the suspension element by which said body is normally suspended. The general object of the invention is to provide simple, effective and reliable mechanical means operating automatically when the suspension element breaks to establish a frictional connection between the body and a stationary element to thereby arrest the falling movement of the body.

By the use of the present invention the falling movement of the normally suspended body may be quickly arrested without subjecting the apparatus to such shock as is experienced when the movement of the falling body is arrested, as heretofore proposed, by the direct interengagement of positive locking parts, such as a pawl and rack bar.

My present invention was primarily devised and is especially adapted for use in electric arc furnaces of the well known type in which heavy, vertically disposed electrodes extend into a furnace chamber through the furnace roof and are each supported by a corresponding crosshead vertically adjustable along a vertical mast. In such furnace each of said crossheads is customarily suspended by means of a cable loop depending from the top of the mast and shortened and elongated by the action of a winch or other hoist apparatus. Each such electrode and its supporting crosshead and connections may weigh several thousand pounds, and much damage may result from an electrode suspension cable break, unless the falling movement of the electrode is arrested quickly enough to prevent violent impingement against the roof or furnace hearth. The damage caused when an electrode suspension cable breaks is not confined to the electrode and the furnace structure, but may include serious damage due to absorption by molten material in the furnace of excess carbon from broken electrode pieces.

In the preferred forms of embodiment of my invention in an electric arc furnace, the falling movement of an electrode supporting crosshead is arrested by a frictional connection established between the crosshead and a vertical friction rod or bar-like portion of the mast structure, by means of a clutch member which is mounted on the crosshead. Said clutch member is formed with a guideway through which the friction rod extends and which is automatically canted, or tilted, when the suspension cable breaks from a normal position in which there is clearance

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between the walls of said guideway and friction rod, into an emergency position in which the clutch member frictionally engages and quickly grips the friction rod.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

Of the drawings:

Fig. 1 is a side elevation of an electrode supporting portion of an electric arc furnace;

Figs. 2 and 3 are elevations on a larger scale than Fig. 1, of upper and intermediate portions, respectively, of the structure shown in Fig. 1;

Fig. 4 is a plan view of the apparatus shown in Figs. 1 and 2;

Fig. 5 is a section on the line 5—5 of Fig. 3;

Fig. 6 is a sectional elevation showing emergency stop parts in their emergency operation positions;

Fig. 7 is a partial elevation taken similarly to Fig. 1, illustrating a modification;

Fig. 8 is a plan view of the apparatus shown in Fig. 7; and

Fig. 9 is an elevation taken at right angles to Fig. 7.

In the drawings, and referring first to the form of construction shown in Figs. 1–6, a carriage or crosshead 1 carries an electrode supporting arm 2 and is mounted for vertical movement on a vertical mast 3. As shown in Fig. 5 (and in Fig. 8 also) the mast 3 comprises a pair of channel bars 3A spaced apart and with their flanges facing in opposite directions, and plates 3B at the opposite sides of said bars and to each of which the corresponding side flanges of the two channel bars are connected. At its upper end the mast carries a horizontal top plate 4. The crosshead 1 has an upper and a lower flanged roller 5 at each side of the mast, each bearing snugly against the smooth outer face of the adjacent mast side plate 3B. The crosshead is suspended from the upper end of the mast structure by a suspension cable 6 which has a depending bight or loop extending about a sheave or pulley 7 journalled in the crosshead.

The suspension cable 6 has its dead end anchored in a housing or dead end support 8 which is mounted, with freedom for a small up

and down movement, on vertical guide posts 9 extending upward from, and supported by, the mast top plate 4. A compression spring 10 beneath the housing dead end support 8 tends to hold the latter in an elevated position in which it engages top nuts 11 at the upper ends of the guide posts 9. In normal operation the tension of the suspension cable 6 holds the dead support in the position shown best in Fig. 2, in which the spring 10 is compressed and the bottom of the support 8 rests on the upper end of an open ended cylindrical casing 12 which surrounds the spring 10 and has its lower end in engagement with and supported by the mast top plate 4. The live end portion of the cable 6 passes from the sheave 7 to and over guide pulleys or sheaves 13 supported on the mast top plate 4. From the sheaves 13 the live end portion of the cable 6 passes to mechanism used to give longitudinal movement to the cable as needed to raise and lower the crosshead 1. Such mechanism may comprise a hydraulic cylinder, or any other suitable power actuated mechanism and commonly and as shown, is a motor operated winch drum 14 mounted on a stationary support which may be a portion of the furnace structure. Insofar as already described, the mechanism shown in Figs. 1–6 is of known type and includes nothing claimed as novel herein.

The novel emergency stop apparatus shown in Figs. 1–6, comprises a lever 20 mounted intermediate its ends on a fulcrum pivot 21 which has its ends supported by a bracket 21' secured on the mast top plate 4. The lever 20 has one end in engagement with the underside of the dead end support 8, and is normally held by the latter against counter-clockwise motion as seen in Figs. 1 and 2, notwithstanding the down-pull on the other end of the lever 20 due to the weight of a suspended link 22 and of a relatively heavy, vertically disposed tripper bar 23 pivotally connected to and suspended from the lower end of the link 22. The bar 23 is connected by parallel motion links 24 and pivots 25 to the mast structure. As shown, the links 24 are distributed along the length of the bar 23 and are connected to the mast structure through a stationary vertically disposed anchor bar 26 alongside the tripper bar 23 and to which one end of each link is directly pivoted. The bar 26 is rigidly secured to the mast at intervals along its length by brackets 27. A tension spring 28 connects the lower end of the tripper bar 23 to the base of the mast 3, and accelerates the down movement of said bar 23 occurring when the rupture of the cable 6 permits the lever 20 to turn counter-clockwise and thereby permits such down movements of the bar 23.

The down movement of the tripper bar 23 is necessarily attended by a lateral movement of the latter away from the anchor bar 26, as a result of the disposition and action of the parallel links 24. As shown in its normal position, each link 24 is inclined at a slight angle to the horizontal with its end connected to the bar 23 at a higher level than its end connected to the bar 26. When the bar 23 moves downward the links 24 become more nearly horizontal and thus move the bar 23 farther away from the bar 26. The lateral movement of the tripper bar 23 causes the latter to engage the end 30 of a clutch member 31 and tilt the latter into its position shown in Fig. 6. The clutch member 31 is loosely journalled on a horizontal pivot pin or stud 32

anchored in the side frame plate 33 of the crosshead, and is normally held by gravity in a normal horizontal position in which it rests upon a horizontal bracket 33A carried by a side plate 33 as is clearly shown in Fig. 3. The end 30 of the clutch member 31 is so shaped and disposed that when it is engaged by the laterally moving bar 23, the clutch member 31 is turned counter-clockwise about the shaft 32.

The clutch member 31 is formed with a guideway 34, shown as a round aperture which receives, and is normally coaxial with, a stationary vertical friction rod or bar 35 extending through the mast top plate 4, and suspended from the latter through lock nuts 36 on the upper end of said rod. The aperture or guideway 34 is slightly larger in cross-section than the rod 35, so that there is clearance between the wall of the guideway 34 and the rod 35, when the clutch member 31 is in its normal horizontal position shown in Fig. 3. When the cable breaks and thereby causes the clutch member 31 to be tilted into the position shown in Fig. 6, the upper right hand corner edge 36 of the cylindrical wall of the aperture 34 and the lower left hand corner 37 of that wall are brought into gripping, frictional engagement with the friction rod 35, as is clearly shown in Fig. 6. As shown, the rod 35 is circular in cross section as is the aperture 34. However, the cross section of the rod may take other forms and the shape of the aperture 34 will then be varied as required to permit it to frictionally grip the rod 35, generally as described.

In the condition of the apparatus illustrated in Fig. 6, the weight of the crosshead and its load is directly transmitted to the clutch member 31, and is transmitted by the latter to the stationary friction rod 35. It will be noted that the lost motion between the clutch member and pivot 32 permits the weight of the crosshead and its load to be transmitted to the clutch member 31 through a strong bearing part 38 rigidly attached to the crosshead, instead of through the pivot 32. Due to the action of the springs 10 and 28 and the general form and disposition of the parts, only a fraction of a second, following the rupture of the cable, is required for the movement of the parts into their relative positions shown in Fig. 6, so that only a small down movement of the crosshead carrier occurs as a result of the cable rupture. It is to be noted, however, that while the tilting or canting of the clutch member 31 is expedited by the action of the springs 10 and 28, the actual crosshead and friction bar interlocking system of the clutch member 31 is not dependent on spring action. Since the arresting engagement of the clutch member 31 with the friction rod 35 is frictional, some slippage between the engaging surfaces of the clutch and friction rod can occur. Such slippage while relatively small in extent, reduces the shock developed as the down movement of the crosshead is arrested by the rod 35 and clutch member 31.

It should be noted that an important feature of this invention is what may be called the "self-energization" action of the clutch member. The tripper bar 23 and associated mechanical linkage constitutes a tripper mechanism, the sole function of which is to initiate stoppage of the falling movement of the carriage by tilting the clutch member 31 into frictional engagement

with the vertical rod or element 35. The tripping mechanism, therefore, may be of relatively light construction, since no part of it is subject to heavy forces required to bring the falling crosshead or carriage to rest. Another notable feature of the invention is that upon repair of a broken cable, the hoisting mechanism can immediately release or eliminate the frictional carriage holding action and thus permit resumption of normal operation of the furnace.

As will be apparent, changes may be made in the form of the apparatus shown in Figs. 1–6 without departing from the principle of the invention, and in Figs. 7, 8 and 9 I have illustrated a form of the invention which is simpler, and which I now consider practically preferable, to the form of the invention shown in Figs. 1–6. The essential differences between the two forms of construction are confined to the means for bringing the clutch member into engagement with the friction rod 35. The clutch member 31A included in the construction shown in Figs. 7, 8 and 9 is essentially like the clutch member 31 previously described insofar as its operative relationship with the crosshead and friction rod 35 are concerned. However, the clutch member 31A is tilted into its emergency position by mechanism mounted on the crosshead 1A, and not on the mast 3.

The crosshead 1A of Figs. 7, 8 and 9 differs essentially from the crosshead 1 of the construction first described only in respect to the mounting of its sheave element 7. In Figs. 7, 8 and 9, the sheave 7 is mounted in a housing or support 50 which is connected to the crosshead 1A by a horizontal pivot pin or shaft 51 laterally displaced from the sheave 7, as is clearly shown in Figs. 7 and 8. In consequence, the sheave 7 is gravitationally biased for clockwise movement, as seen in Fig. 7, about the pin 51 when a break in the cable 6 permits such movement. The gravitational bias of the sheave support 50 for clockwise movement, is supplemented by the action of a bias spring 53 at one side of the crosshead and connecting a lower portion of the sheave support 50 to the portion of the crosshead laterally displaced from the sheave or pulley 7, as is clearly shown in Fig. 8. On a rupture of the cable and consequent clockwise movement of the sheave support 50, the latter engages the adjacent end of a horizontal thrust bar 41 mounted in the crosshead 1A and having its other end connected to the clutch member 31A by a pivot pin 40. The latter is mounted in a depending portion of clutch member 31A directly beneath the pivot 32 by which the member 31A is loosely pivoted to the crosshead structure.

On a rupture of the cable 6, the sheave support 50 turns clockwise as seen in Fig. 7, under the action of gravity and the tension of spring 53. Such movement of the support moves the link 41 to the left and thereby tilts the clutch member 31A about the pivot pin 32 into a position corresponding to the position of the clutch member 31 shown in Fig. 6. The clutch member 31A and friction rod 35 then cooperate to arrest the down movement of the crosshead 1A, just as the parts 31 and 35 cooperate to arrest the down movement of the crosshead 1 of the construction first described. In the normal condition of the apparatus, the clutch member 31A is held by gravity in a horizontal position on a supporting bracket or platform portion 33B of the crosshead 1A. In the tilted, emergency, crosshead arresting, position of the clutch member 31A, the weight of the crosshead and its load is transmitted to the clutch member 31A, not through the pivot pin 32, but through the rigid thrust or bracket portion 38A of the crosshead structure. In the normal condition of the apparatus in which the crosshead is supported by the cable 6 through the pulley 7, the tendency of the pulley holder 50 to turn counter-clockwise about the pivot pin 51, results in the engagement of the front end of the part 50 with the abutment shoulder 1B of the crosshead frame.

With the arrangement shown in Figs. 7 and 9, as with that shown in Figs. 1–6, when, following the failure and subsequent repair of the hoisting mechanism, the cable 6 is again put under tension sufficient to support the carriage or crosshead 1, the furnace is thereby restored to its operative condition. As the respective cables are put under tension, the tripper bar 23 of Figs. 1–6 is raised to its normal position shown in Figs. 2 and 3, and the sheave support 50 is turned counter-clockwise into the position shown in Figs. 7 and 8. As soon as the carriage 1 begins to move upward, the gripping engagement of the clutch member, 31 or 31A, with the rod or bar 35, is interrupted, and the clutch member then moves back into its normal position relative to the carriage.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the forms of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The combination with a vertical framework, a carriage mounted in said framework for vertical movement and having a downwardly facing rigid abutment portion, a cable connection between an upper portion of said framework and said carriage through which the latter is suspended, said cable connection comprising a dead end connection device and a guide pulley each mounted on the upper portion of said framework, a hoisting mechanism and a cable extending over said pulley and connected at one end to said mechanism and having its other end connected to said device and having a portion between said pulley and device forming a depending loop engaging and supporting said carriage, of a vertical element supported by said framework and having spaced apart, oppositely facing, vertically extending surfaces laterally displaced from said abutment portion in the direction toward which one of said surfaces faces, a clutch member mounted in said carriage for adjustment between first and second positions and normally in said first position and having a shoulder adjacent and facing said one surface and having a second shoulder at a level above the level of the first mentioned shoulder and adjacent and facing the second of said surfaces, and having an upwardly facing surface beneath said abutment portion and spaced away from the latter when said member is in its first position but adapted to engage said abutment portion and thereby support the

carriage when said member is in its second position, and having said shoulders so spaced that each shoulder is respectively in or out of frictional gripping engagement with the adjacent surface accordingly as said clutch member is in its second position or in its first position, and means responsive to the reduction in cable tension occurring when the cable breaks and thereby actuated to move said clutch member relative to said carriage into said second position in which the clutch member grips said vertical element and its said upwardly facing surface is in position to be engaged by said abutment portion of the falling carriage and interrupt the falling movement of the latter.

2. A combination as specified in claim 1, which includes a loose pivotal connection between said clutch member and carriage for turning movement of said clutch member between its first and second positions and in which the abutment portion of said carriage is engaged and supported by said clutch member independently of said loose pivotal connection when the latter is turned into its second position and is in gripping engagement with said element.

3. A combination as specified in claim 1, in which the means responsive to the tension of said cable comprises a spring included in said dead end connection and distorted by the cable when the latter is subjected to normal tension.

4. A combination as specified in claim 1, in which the means responsive to the reduction in cable tension occurring when the cable breaks comprises a sheave which is mounted in said carriage for movement between first and second positions and which is normally engaged by said cable loop and thereby held in its first position when said cable is under normal tension, and which is biased for movement into its second position on said reduction in cable tension.

5. In an electric arc furnace, the combination of a vertical mast, an electrode supporting crosshead mounted on said mast for movement longitudinally thereof and having a downwardly facing rigid abutment portion, a cable connection between the upper end of said mast and said crosshead through which the latter is suspended, said cable connection comprising a dead end connection device and a guide pulley each mounted on said mast at its upper end, a hoisting mechanism, a cable extending over said pulley and connected at one end to said mechanism and having its other end connected to said device and having a portion between said pulley and device forming a depending loop engaging and supporting said crosshead, a vertical bar like member having its upper end connected to and suspended from the upper end of said mast and laterally displaced from said abutment portion, a clutch member formed with a passageway through which said bar like member extends and normally supported by said crosshead in a position in which there is clearance between the said members permitting them free relative movement and having an upwardly facing surface laterally displaced from said bar-like member and directly beneath said abutment portion and means responsive to the reduction in cable tension occurring when the cable breaks and thereby actuated to tilt said clutch member into a position in which it grips said bar like member and arrests down movement of the crosshead following the engagement of said upwardly facing surface by said abutment portion.

6. The combination with a vertical framework, a carriage mounted in said framework for vertical movement, a cable connection between an upper portion of said framework and carriage through which the latter is suspended, said cable connection comprising a dead end connection device and a guide pulley each mounted on the upper portion of said framework, a hoisting mechanism and a cable extending over said pulley and connected at one end to said mechanism and having its other end connected to said device and having a portion between said pulley and device forming a depending loop engaging and supporting said carriage, of a vertical element supported by said framework and having spaced apart, vertically extending, surfaces, a clutch member mounted in said carriage for adjustment between first and second positions and normally in and biased for movement into said first position and comprising shoulders each alongside and adjacent a corresponding one of said surfaces and spaced apart so that each shoulder is respectively in or out of frictional gripping engagement with the adjacent surface accordingly as said clutch member is in its second position or in its first position, tripper mechanism including a part arranged for horizontal movement out of a normal position in which it is out of operative engagement with the clutch member into a second position and in such movement to engage said clutch member and move the latter from its first position into its second position, and means responsive to cable tension for moving said tripper mechanism into its second position on an abnormal reduction in said cable tension and for causing the return of the tripper mechanism to its normal position when normal cable tension is restored.

7. The combination with a vertical framework, of a carriage mounted in said framework for vertical movement, a cable connection between an upper portion of said framework and said carriage through which the latter is suspended, said cable connection comprising a dead end connection device and a guide pulley each mounted on the upper portion of said framework, a hoisting mechanism, a cable extending over said pulley and connected at one end to said mechanism and having its other end connected to said device and having a portion between said device and guide forming a depending loop engaging and supporting said carriage, a vertical element supported by said framework and having spaced apart, oppositely facing, vertically extending surfaces laterally displaced from said engaging part in a direction toward which one of said surfaces faces, a clutch lever having an arm normally in a generally horizontal position pivotally mounted on said carriage to turn about a horizontal axis and having a projection adjacent but vertically displaced from said axis and having a shoulder adjacent and facing said one surface and having a second shoulder at a higher level and adjacent and facing the other of said surfaces, said shoulders being spaced apart so that each shoulder is respectively in or out of frictional gripping engagement with said adjacent surface accordingly as said clutch lever is in its normal position or is tilted into a second position to raise said shoulders relative to said axis and means responsive to the reduction in cable tension occurring when the cable breaks and including a part movable horizontally into engagement with said projection to thereby tilt said arm about said axis into said position in

which the clutch lever grips said vertical element and arrests down movement of the carriage.

8. A combination as specified in claim 1, in which the means responsive to the reduction in cable tension occurs when the cable breaks, comprises a vertical bar alongside the mast, a suspension connection to said bar normally operative to prevent down movement of the bar but made inoperative to prevent such movement when the cable breaks, parallel links connecting the bar to the mast and slightly inclined to the horizontal so that the bar moves horizontally as well as downward when said suspension connection becomes inoperative, and means actuated by such horizontal movement of said bar to move said clutch into said second position.

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