United States Patent

Stawarski et al.

[15] **3,673,869**

[45] **July 4, 1972**

[54] RELEASABLE SUPPORTING APPARATUS

[72] Inventors: **Chester C. Stawarski,** 388 Pinehaven Drive, Bethel Park, Pa. 15102; **Charles C. Gerding,** 728 Gaywood Drive; **Richard T. Adams,** 149 Rose Avenue, both of Penn Hills, Pa. 15235

[22] Filed: **Sept. 1, 1970**

[21] Appl. No.: **68,778**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 836,687, June 2, 1969, abandoned.

[52] **U.S. Cl.** .....**73/343 R,** 73/359

[51] **Int. Cl.**.....**G01k 1/14,** G01k 13/00

[58] **Field of Search** 73/359; 248/320, 322, 5; 52/232, 1; 169/42; 126/287.5; 73/343, 170

[56] **References Cited**

UNITED STATES PATENTS

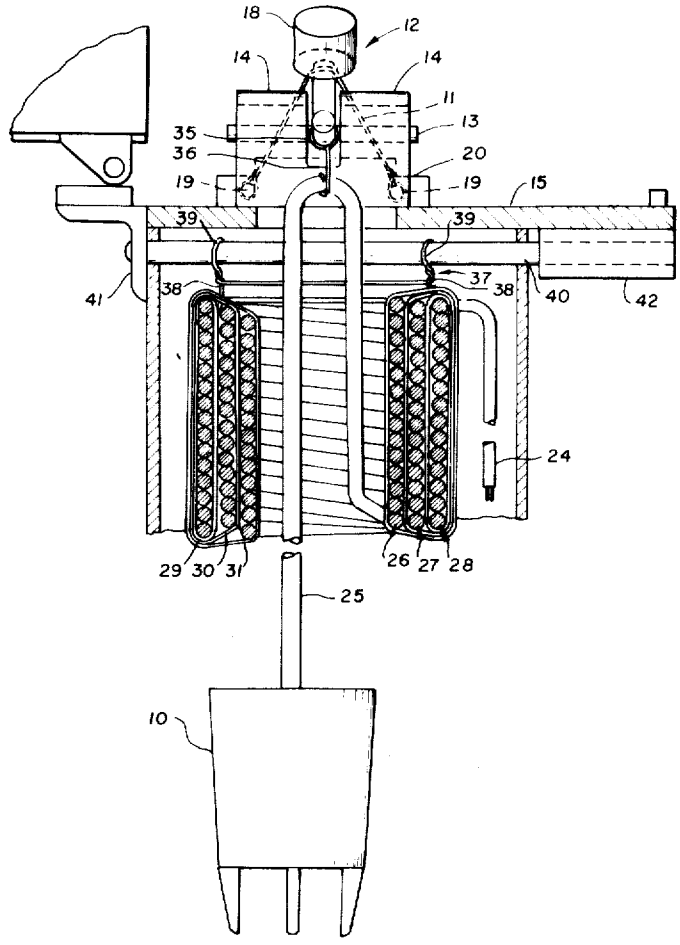
3,396,580	8/1968	Cole	73/359
1,029,277	6/1912	Copeland et al	169/39
1,167,481	1/1916	Copeland	169/42
2,270,073	1/1942	Merry	126/287.5
3,520,188	7/1970	Bixby	73/344
2,646,243	7/1953	Rycroft	248/314

Primary Examiner—Louis R. Prince
Assistant Examiner—Denis E. Corr
Attorney—T. A. Zalenski and G. R. Harris

[57] **ABSTRACT**

Apparatus is disclosed for releasably suspending a condition measuring device, such as a weighted or sinker thermocouple, above a steel-refining vessel. The apparatus includes a fusible link, the fusing of which acts to release the device whereby it drops into the vessel. The electrical lead wire of the measuring device is arranged in a controlled bundle for ease of handling and for insuring the smooth pay-off of the wire as the device drops.

9 Claims, 4 Drawing Figures



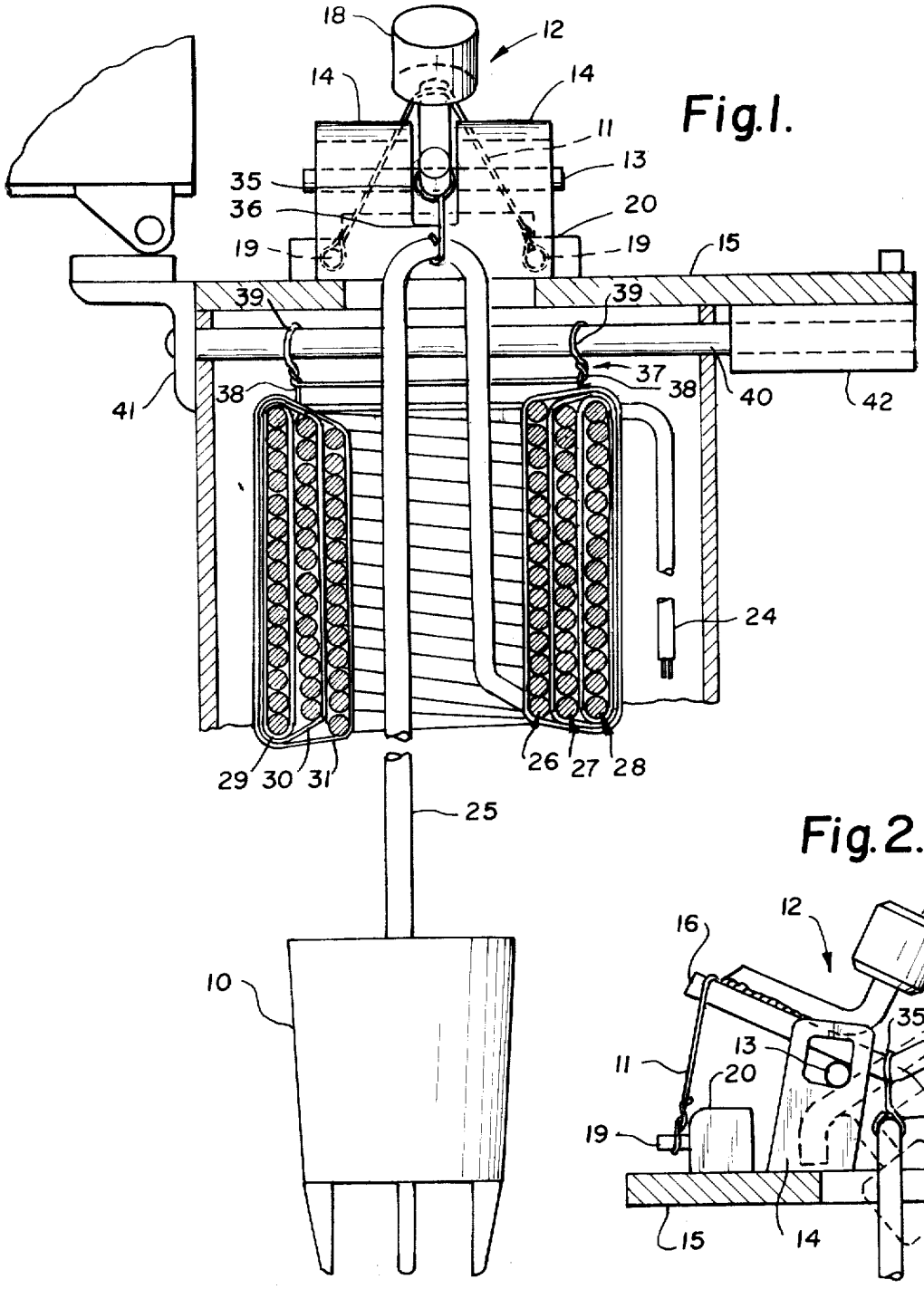


Fig. 1.

Fig. 2.

INVENTORS.
CHESTER C. STAWARSKI
CHARLES C. GERDING
BY RICHARD T. ADAMS
ATTORNEY

Fig. 3.

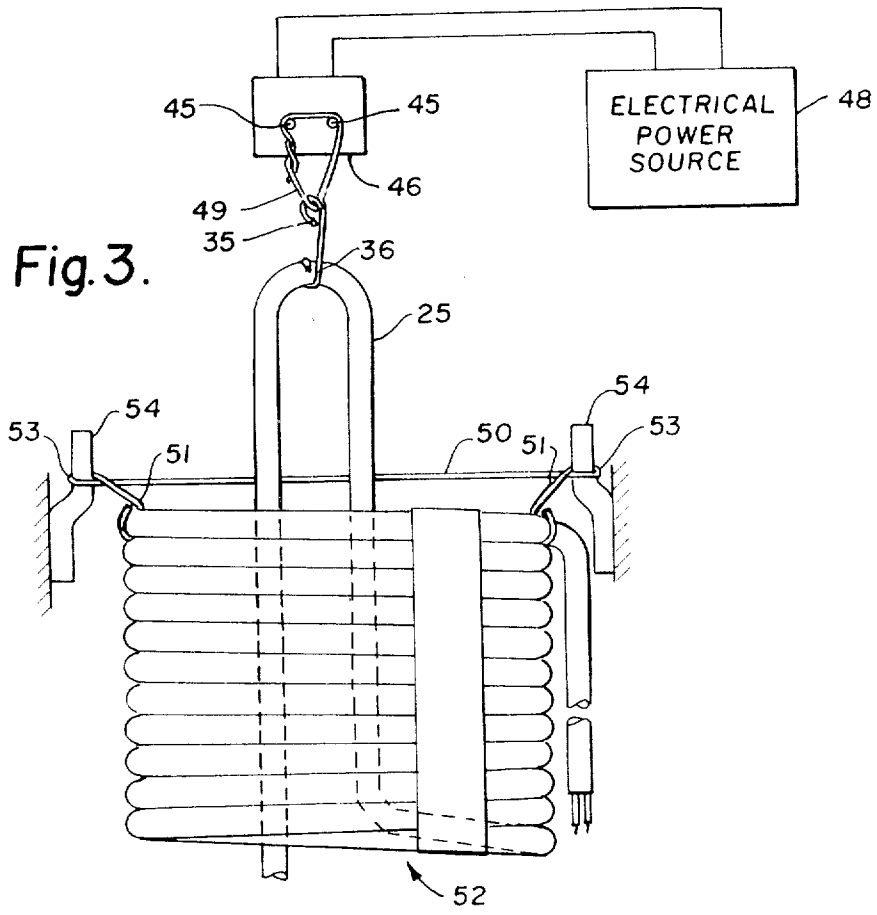
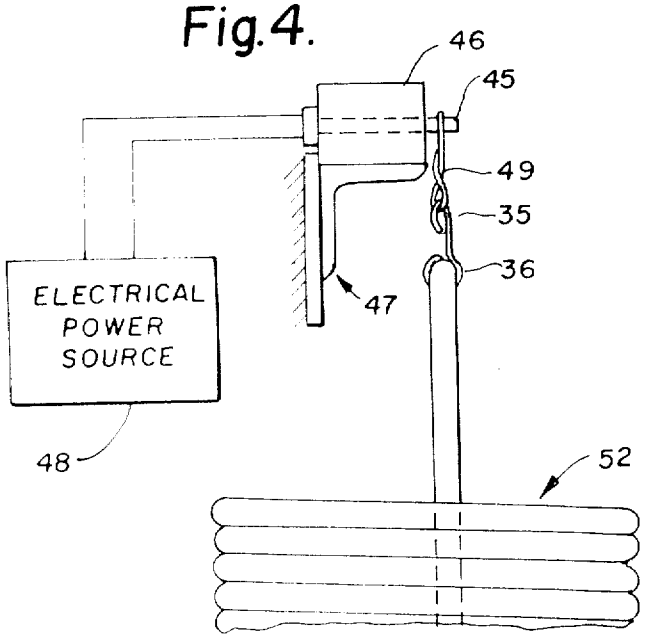


Fig. 4.



INVENTORS.
CHESTER C. STAWARSKI
CHARLES C. GERDING
RICHARD T. ADAMS
BY
ATTORNEY

RELEASABLE SUPPORTING APPARATUS

This application is a continuation-in-part of our application Ser. No. 836,687, filed June 2, 1969, now abandoned.

This invention relates to apparatus, including a link, breakable upon the application of electrical power thereto, comprising a releasable support. The invention relates particularly to apparatus for supporting and selectively releasing a sinker thermocouple, having its lead wire arranged in a controlled bundle, into a basic oxygen furnace to measure the temperature of the molten steel contained therein.

For controlling the course of refining of a basic oxygen steelmaking process, as well as for other reasons, it is important to know the temperature of the molten bath at various times during the refining cycle. Weighted or sinker thermocouples of the type disclosed in U.S. Pat. No. 3,347,099 are particularly useful for this purpose since their use does not require the vessel to be turned down in order that its mouth be accessible from the operating platform.

Sinker thermocouples can be injected into a basic oxygen steelmaking vessel by, for example, pitching the thermocouples up over the lip of the vessel or having a workman drop them from above the vessel through an opening in the waste-gas hood covering the mouth of the vessel. The first method is not reliable and it is not, in either method, convenient or desirable to station a workman near the mouth of the vessel during the refining cycle to inject the thermocouples therein. In addition, because these and other methods require manual assistance at or near the mouth of the vessel, some signalling means from the furnace control room is also required.

Thus, a need exists for apparatus for automatically introducing sinker thermocouples into a basic oxygen steelmaking furnace, apparatus which is reliable in the demanding environment of a basic oxygen shop. Accordingly, it is an object of our invention to provide such apparatus, including a fusible link and associated means for fusing the link to release the sinker thermocouple into the furnace. Another object of our invention is to provide such apparatus wherein the thermocouple is suspended from the fusible link which in turn is suspended from a pair of electrodes connected to a source of electrical power. Yet another object of our invention is to provide such apparatus wherein the thermocouple is supported by means adapted for movement from a first position supporting said device to a second position releasing it, the fusible link maintaining said means in the first position and fusing of the link allowing said means to move to the second position. Still another object of our invention is to provide the electrical lead wire of the thermocouple in a compact bundle for ease of handling the thermocouple and for ease of loading it onto the apparatus and for insuring the smooth pay-off of the wire as the thermocouple drops.

These and other objects and advantages of our invention will be more apparent from the following detailed description thereof with reference to the accompanying drawings in which:

FIG. 1 is a front-elevational view of a first embodiment of the invention, in which the circular coil of wire is shown in section;

FIG. 2 is a fragmentary, reduced, side-elevational view of the first embodiment of the invention;

FIG. 3 is a fragmentary, front-elevational view of a second embodiment of the invention; and

FIG. 4 is a fragmentary, side-elevational view of the second embodiment of the invention.

Typically, a plurality of the releasable supporting mechanisms shown in the drawings are arranged in a row at the top of a funnel-shaped chute, about 15 to 30 feet above a molten metal bath. The bottom of the chute extends through the waste-gas hood covering the mouth of a basic oxygen steelmaking vessel containing the molten metal, whereby the thermocouples associated with the mechanisms, upon their release into the chute, pass into the vessel.

According to a first embodiment of the invention, the means for releasably supporting a sinker thermocouple **10** and the electrical lead wire associated with it includes fusible link **11**, comprising, for example, 0.0181 inch diameter steel wire, and a rotating means, indicated generally at **12**. The rotating means comprises a first rod member **13** mounted in openings in brackets **14—14** for rotation therein about its longitudinal axis. The brackets are mounted on a stationary support plate **15**. A second rod member **16** integral with rod member **13** and extending transversely thereof has at one end a crook **17** from which sinker thermocouple **10** is suspended. A weight **18** integral with the first and second rod members is located along the longitudinal axis of rod member **13** in a position such that when the rotating means is in its suspending position, as shown in FIG. **1**, the center of gravity of the rotating means is on the same side of the longitudinal axis of rod member **13** as crook **14** and sinker thermocouple **10**. The rotating means is counterbalanced and maintained in this position by fusible link **11** which is looped over rod member **16** on the side of the longitudinal axis of rod member **13** opposite that of crook **14** and sinker thermocouple **10**. Each end of the fusible link is firmly attached to electrically conductive pins **19—19** mounted in block **20** made of electrical insulating material and mounted on support plate **15**.

The electrically conductive pins are connected by suitable electrical lead wires, not shown, to a source of electrical power which is preferably located at some remote spot, such as the operating floor. When it is desired to measure the temperature of the molten metal within the vessel, electrical energy from the source is applied to the fusible link causing the link to fuse, freeing rotating means **12** for rotation to the position shown in phantom lines in FIG. **2**, thereby dropping the thermocouple into the vessel.

In the apparatus of the invention, the electrically fusible link **11** comprises any wire element whose ability to bear tension is destroyed by the passage therethrough of an electrical current of suitable magnitude. We have observed that such an electrical current has several destructive effects on the wire. These are, the heating of the wire to its fusion point, the heating of the wire to a temperature where it softens, and, to some extent, surface oxidation of the wire. The relative magnitudes of these effects in the destruction of a particular wire depend, among other variables, on the electrical current, the tension in the wire, the rate of temperature rise of the wire, and the wire cross-section. From a practical standpoint, the exact mode of failure of the wires is not significant. What is important is that for a particular wire employed, a reasonable current and voltage drop results in the failure of the wire within 5 seconds under the tension imparted by the weight of the thermocouple. For example, a No. 26 gage annealed, carbon-steel wire fails in substantially less than 5 seconds when a voltage drop of 30 volts per inch is applied across the wire.

To prevent the electrical lead wire associated with the thermocouple **10** from tangling as the thermocouple drops into the vessel and to provide a compact bundle which can be conveniently handled, the wire is arranged in three concentric spirally-wound cylindrical layers **26**, **27** and **28**. The innermost layer of wire **26** terminates in a first free end-length **25** of lead wire which is electrically connected to thermocouple **10**. The outermost layer of lead wire **28** terminates in a second free end-length **24** of lead wire and is adapted to be connected to a temperature recorder for recording the temperature of the molten metal within the vessel. Preferably, the recorder is located adjacent the electrical power source for fusible link **11**; and end-length **24** of the lead wire is connected to an intermediate station adjacent rotating means **12**, which station is in turn permanently connected to the recorder through compensating circuitry as described, for example, in U.S. Pat. No. 3,347,099.

The layers of the lead wire bundle are held in place and the integrity of the bundle maintained while the thermocouple is in its supported position by a number of tear-tape strips breakable upon application of a sudden jerking force. Each lead wire layer is joined by the tape strips to all layers lying inside of it. First tape strips **29—29** longitudinally encircle outer layer **28**; second tape strips **30—30** longitudinally encircle

outer layer 28 and middle layer 27; and third tape strips 31—31 longitudinally encircle outer layer 28, middle layer 27 and inner layer 26.

A wire ring 35 is clamped to end-length 25 of lead wire at a point adjacent thermocouple 10 by a means of a depending portion 36 and the thermocouple unit suspended on crook 17 by the ring. The weight of the thermocouple is thus transferred to the supporting mechanism through ring 35 and no strain is placed on the wire bundle as would be the case if the sinker were suspended merely by looping the wire over the crook 17.

A wire mounting bracket 37 is clamped by means of depending portions 38—38 to the last convolution of the outermost layer 28 of the spirally wound wire bundle, that is, substantially at the location where the layer terminates into free end-length of wire 24. The bracket includes a pair of mounting rings 39—39 through which positioning rod 40 is inserted when thermocouple 10 is loaded onto rotating means 12. Rod 40 is supported by stationary support member 41 and 42.

When a temperature measurement of the molten metal within the vessel is to be made, the electrical power source is activated and resulting electrical energy flowing through fusible link 11, fuses the link whereupon rotating means 12 rotates to its releasing position as shown in phantom lines in FIG. 2. As this occurs, ring 35 becomes free of crook 17 and sinker thermocouple 10 begins to fall, extending the free end-length 25 of lead wire. Thereafter, the force of the falling sinker thermocouple snaps tapes 31—31. The innermost layer of wire 26 then pays off until it is expended whereupon tapes 30—30 snap and the middle layer of wire 27 pays off until it is expended; then tape strips 29—29 are snapped and the outermost layer of wire 28 pays off; by this time the sinker thermocouple has entered the molten metal in the vessel. The tape strips are arranged so that except for the last layer to play out each layer is attached to one of the layers which plays out after it. The tear-tape strips thus act as means for causing the layers of lead wire to successively play out upon release of the sinker thermocouple.

As the thermocouple falls, bracket 37 maintains the bundle of lead wire in an anchored position allowing each successive layer of the bundle to pay off in an orderly fashion. In addition, if it is desired to stop the thermocouple at a particular level above the bottom of the vessel, a lesser length of lead wire is used between the sinker and the bracket and the thermocouple is arrested as it settles in the molten bath when the lead wire has been extended to the point where it is attached to the bracket. We find that a certain amount of plastic bending of the bracket occurs when the thermocouple is dropped and regard this as desirable in that the falling wire is thus decelerated without undue stress.

To reload the releasing apparatus, rod 40 is withdrawn from its supports 41 and 42, bracket 37 and associated expended lead wire from the previously released thermocouple mechanism are removed from the rod and disposed of by being dropped into the furnace and a fresh thermocouple mechanism mounted onto rod 40 by means of its mounting bracket 37.

In the embodiment of the invention illustrated in FIGS. 3 and 4, means for supporting the thermocouple mechanism in a suspended position includes a pair of electrodes 45—45 mounted in a block of electrical insulating material 46 which is supported by fixed support 47. The thermocouple is suspended from electrodes 45—45 by means of a loop of fusible wire 49 which is in electrical contact with the electrodes and is attached to the thermocouple through ring 35. As described above, the ring is clamped to the electrical lead wire 25 by means of its depending portion 36. Alternates, the loop of wire 49 is made longer and twisted directly about lead wire 25, eliminating ring 35 and depending element 36.

A wire bracket is clamped to wire bundle 52 at its last convolution by means of depending portions 51—51. The wire bundle is formed in the manner as described above. Wire bracket 50 includes a pair of mounting rings 53—53 which are placed over vertical mounting pins 54—54 secured to suitable fixed supports.

By activating electrical power source 48 associated with fusible link 49, electrical energy flows through the link fusing it and allowing the sinker thermocouple to fall. As the thermocouple falls, wire bundle 52 pays off in the manner described above. A fresh thermocouple is loaded simply by looping a fusible link associated with a thermocouple mechanism over electrodes 45—45 and mounting the thermocouple mechanism's support bracket 50 over pins 54—54.

We claim:

1. Apparatus for releasably supporting a device in a suspended position comprising rotating means mounted for movement about an axis of rotation from a first position carrying said device to a second position releasing said device, a link breakable upon the application of electrical power thereto being attached to said rotating means to maintain the rotating means in said first position, means associated with said link for causing failure of the link as desired, such failure of said link allowing said rotating means to move to said second position.

2. The apparatus of claim 1 wherein said rotating means when in said first position has a center of gravity spaced to one side of said axis of rotation, said link being attached to the rotating means at a location spaced to the other side of said axis of rotation.

3. The apparatus of claim 1 wherein said rotating means includes a first rod member having a crook at one end thereof, a second rod member integral with said first rod member and extending transversely thereof, said second rod member being mounted within brackets for rotative movement about its longitudinal axis, and a weight integral with said first rod member and positioned thereon so as to be on the same side of the first rod member as said crook with relation to the longitudinal axis of the second rod member when the supporting means is in said first position, and said link comprising a wire fastened at both ends to electrically conductive pins and looped over the first rod member on the side thereof with relation to the longitudinal axis of the second rod member opposite from the weight when the supporting means is in said first position.

4. Means including a link breakable upon the application of electrical power thereto supporting a device in a suspended position for selective release, and means associated with said link for causing failure of the link as desired releasing said device from its suspended position, said supporting means including a pair of spaced electrodes and said link comprising a loop of fusible wire suspended from said electrodes, said device being suspended from said link.

5. The apparatus of claim 4 wherein said device includes an extended length of electrical lead wire arranged in a compact bundle and bracket means clamped to said lead wire and attached to a stationary support, thereby anchoring said lead wire thereat.

6. The apparatus of claim 5 wherein the compact bundle of lead wire comprises a plurality of spirally wound concentric layers of lead wire, each layer being joined to all layers lying inside of it by means breakable upon application of a sudden jerking force.

7. Apparatus for developing and transmitting an electrical signal in response to a condition in a molten metal bath comprising a condition measuring device and a length of electrical lead wire arranged in a compact bundle comprising a plurality of spirally wound concentric layers of lead wire, there being innermost and outermost layers of lead wire, the innermost layer of lead wire terminating in a first free end-length of lead wire, the outermost layer of lead wire terminating in a second free end-length of lead wire, said condition measuring device being electrically connected to one of said free end-lengths of lead wire, means attached to said bundle of lead wire causing said plurality of layers to successively play out upon release of said condition measuring device from a suspended position, and bracket means for positioning the apparatus on a fixed support clamped to one of the innermost and outermost layers of lead wire substantially at the location where it terminates into a free end-length of lead wire.

8. The apparatus of claim 7 wherein said means attached to said bundle of lead wire comprises means releasable upon application of a sudden jerking force, said releasable means joining each layer of lead wire to all layers of lead wire which play out after it upon release of the condition measuring device from a suspended position.

9. The apparatus of claim 8 wherein the condition measuring device comprises a sinker thermocouple for measuring the temperature of the molten metal bath, said bundle of lead wire consisting of three spirally wound concentric layers of lead wire, said thermocouple being electrically connected to said first free end-length of lead wire, and said means releasable upon the application of a sudden jerking force comprises first tape strips longitudinally encircling the outermost layer, second tape strips longitudinally encircling only the middle and outermost layers and third tape strips longitudinally encircling all three layers.

* * * * *