United States Patent

Asada et al.

[15] **3,650,414**

[45] **Mar. 21, 1972**

[54] AUTOMATIC CONTROL SYSTEM FOR A TEMPERATURE MEASURING DEVICE UTILIZING AN EXPENDABLE IMMERSION THERMOCOUPLE UNIT

[72] Inventors: **Yutaka Asada; Tatsuichi Obinata; Kamematsu Matsuda,** all of Kitakyushu, Japan

[73] Assignee: **Osaka Sanso Kogyo Kabushiki Kaisha,** Osaka, Japan

[22] Filed: **Mar. 26, 1970**

[21] Appl. No.: **22,843**

[30] **Foreign Application Priority Data**

Apr. 5, 1969 Japan.....44/26000

[52] **U.S. Cl.**.....**214/8.5 F,** 73/359, 214/1.5, 221/253

[51] **Int. Cl.**.....**B65g 59/06**

[58] **Field of Search** .....214/8.5 A, 8.5 F, 8.5 R, 1.3, 214/1.4, 1.5; 73/359; 221/82, 253

[56] **References Cited**

UNITED STATES PATENTS

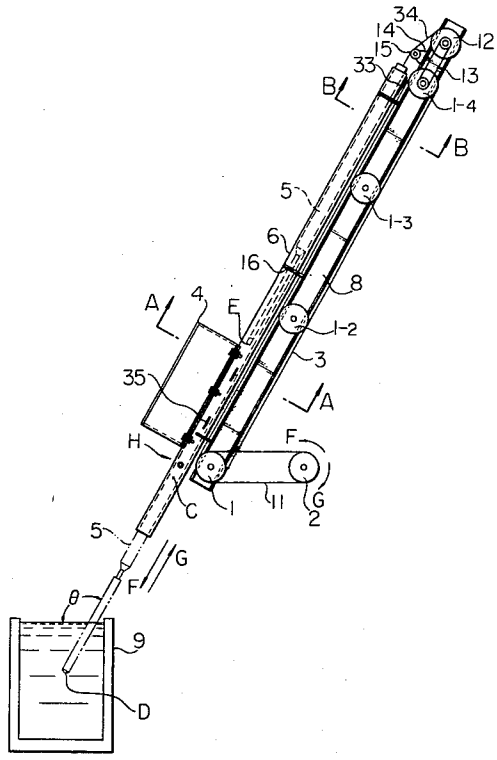
3,390,578	7/1968	Moore	73/359
2,560,255	7/1951	Shirley	221/253 X

Primary Examiner—Gerald M. Forlenza
Assistant Examiner—George F. Abraham
Attorney—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

A holder for removably holding a member to be immersed into a molten metal bath in a furnace or a vessel, such as a ladle, is mounted on a fixed frame so as to be moved reciprocally toward and away from the furnace. Along the path of the holder are provided means for supplying said members one by one in the path of the holder, and means which is adapted to automatically mount the member thus supplied onto the holder during the movement of the holder toward the furnace and to automatically dismount the same from the holder during the return stroke of the holder to its original position.

4 Claims, 17 Drawing Figures



PATENTED MAR 21 1972 3,650,414

SHEET 1 OF 6

Fig. 1

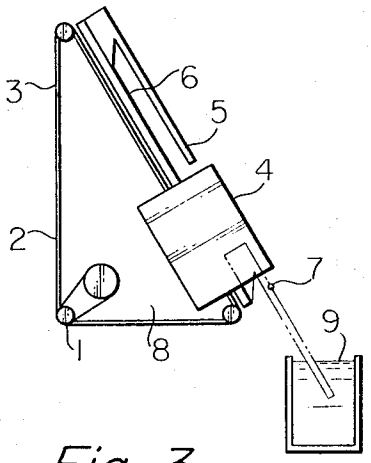


Fig. 2

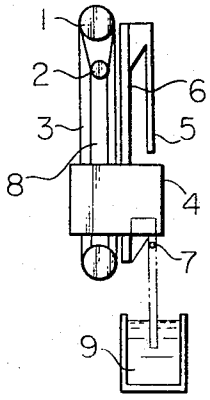


Fig. 3

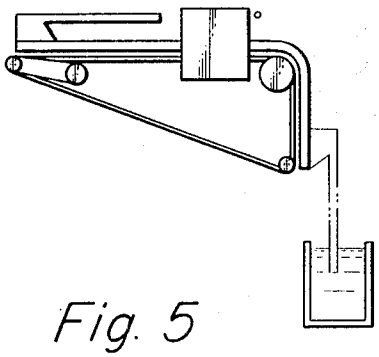


Fig. 4

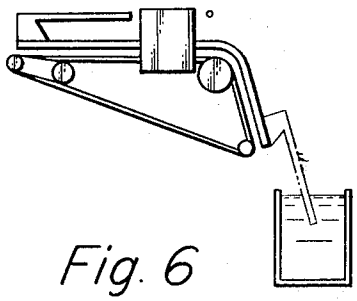


Fig. 5

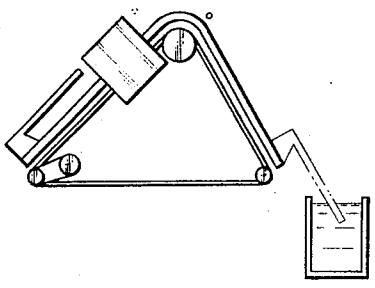
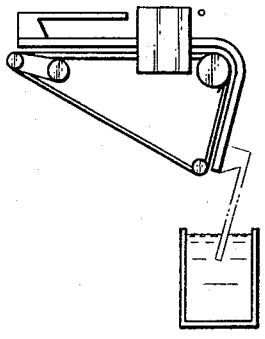


Fig. 6



YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack ATTORNEYS

Fig. 7

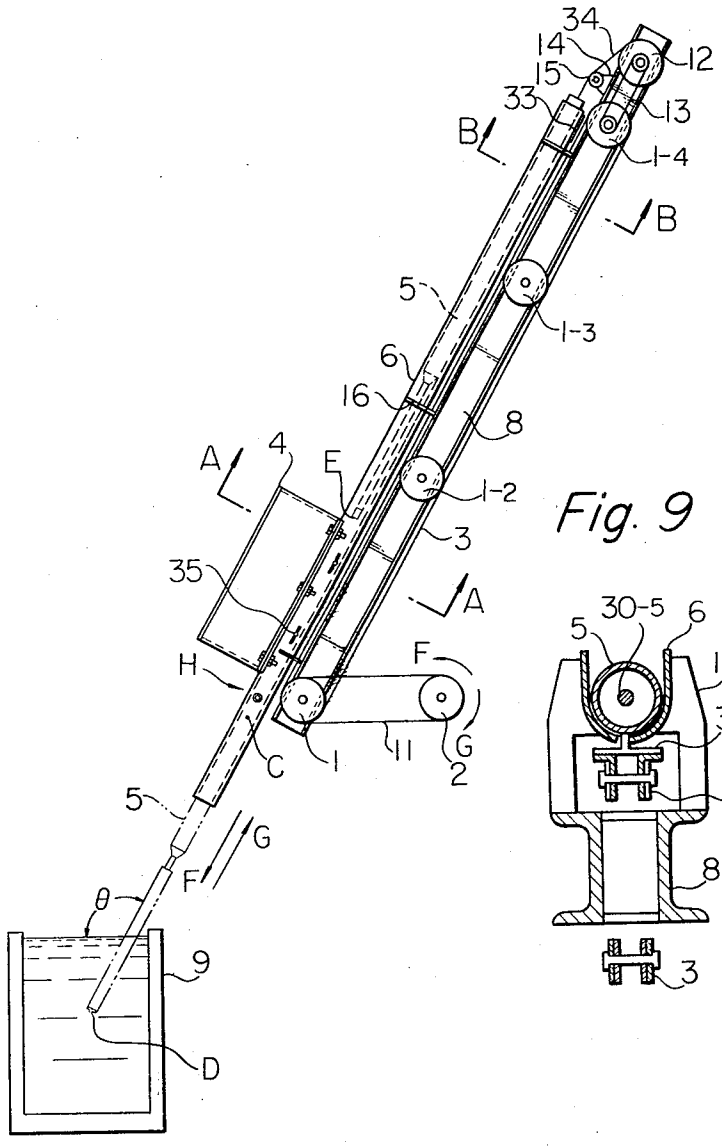


Fig. 9

YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack ATTORNEYS

Fig. 8C

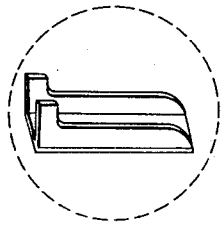


Fig. 8A

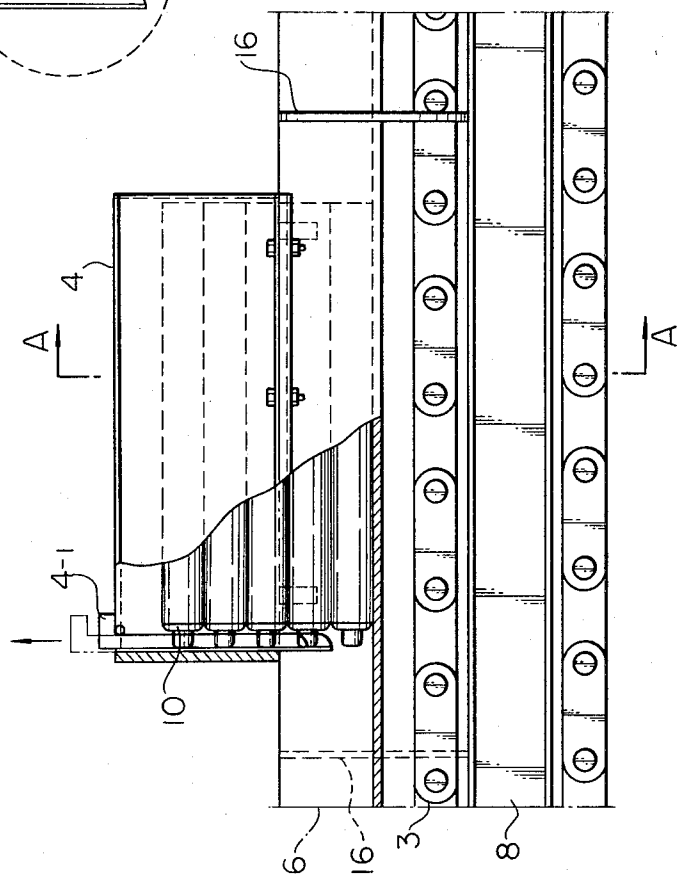
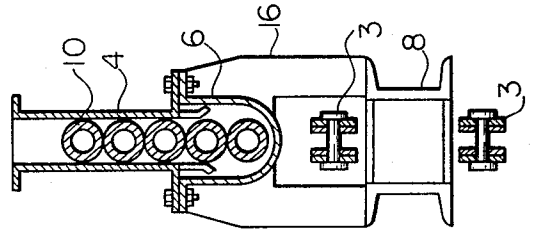


Fig. 8B



YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack ATTORNEYS

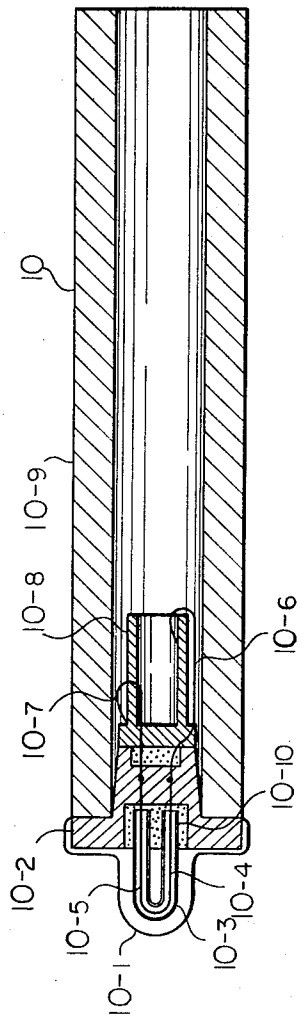


Fig. 10

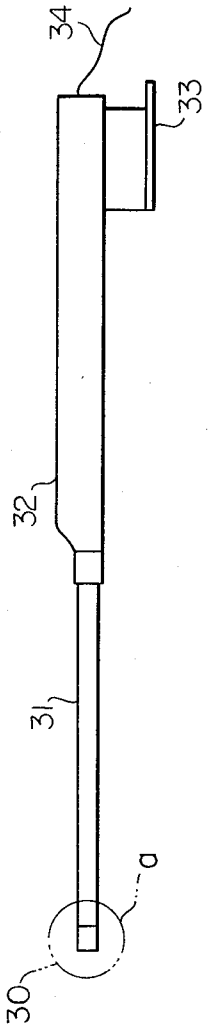


Fig. 11

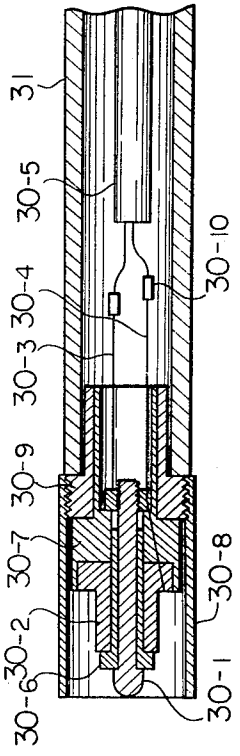


Fig. 12

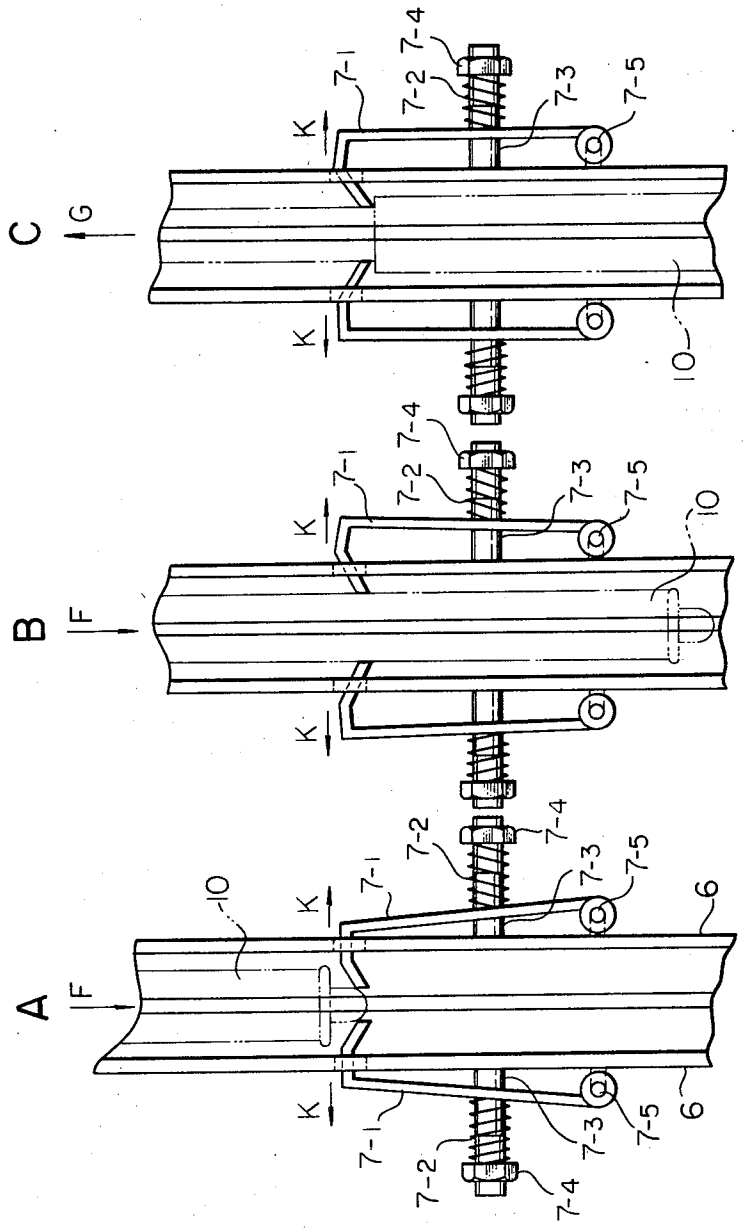
YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack

ATTORNEYS

Fig. 13



YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack ATTORNEYS

Fig. 14

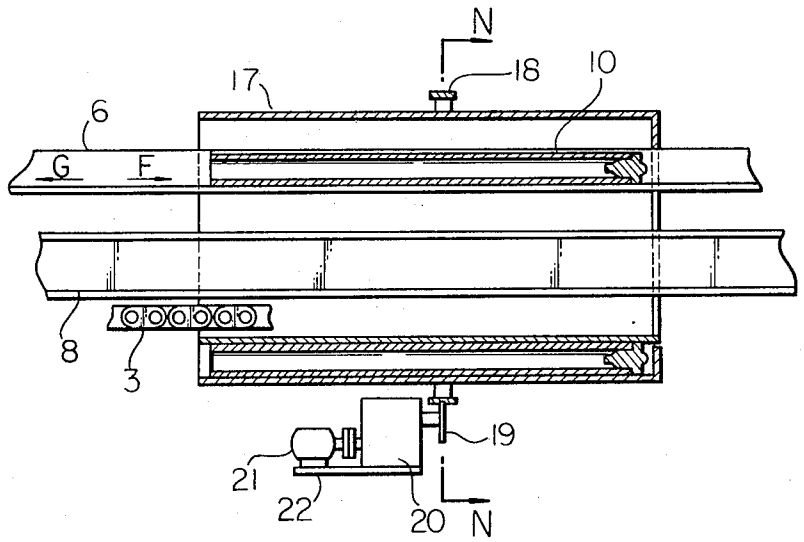
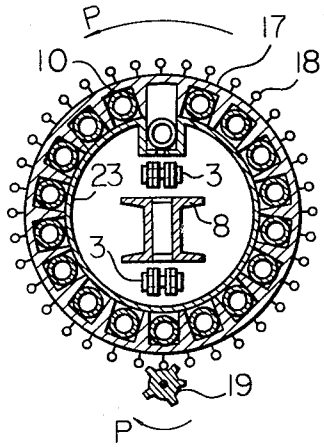


Fig. 15



YUTAKA ASADA,
TATSUICHI OBINATA and
KAMEMATSU MATSUDA,

INVENTORS

BY Wenderoth, Lind & Ponack ATTORNEYS

AUTOMATIC CONTROL SYSTEM FOR A TEMPERATURE MEASURING DEVICE UTILIZING AN EXPENDABLE IMMERSION THERMOCOUPLE UNIT

BACKGROUND OF THE INVENTION:

Field of the Invention:

This invention relates to a device for automatically mounting and dismounting a member to be immersed into a molten metal bath, such as a thermocouple unit, onto a movable supporting rod (referred to as "holder" hereinafter).

Description of the Prior Art:

As is well known, temperature control is a very important procedure in steel making, and particularly the accuracy of measurement of the temperature of the molten steel has a large influence on the quality of the final product, such as steel. Thus, in order to improve the quality of steel products it is an important that precise temperatures necessary for controlling the steel works may be promptly determined. Further, it is well known that, in operation of the vacuum degasing system or the converter system, molten steel is sampled to be analyzed during the operations, and in accordance with the results of such analysis the amounts of alloy to be added are adjusted to give a fine regulation of ingredients.

Practically employed as means for measurement of the temperature of the molten steel or the like are the expendable immersion thermocouple which may directly be immersed into the molten steel for measuring the temperature thereof, the optical pyrometer which may read the temperature according to the varying intensity of light, and the radiation pyrometer which will sense radiation energy to give an indication of the temperature. It is well known that the expendable immersion thermocouple can make a quicker and more accurate measurement than the other devices mentioned above.

In conventional manual temperature measurement by means of the expendable immersion thermocouple, it is performed by aid of a vehicle containing the temperature measuring element, for example, by manipulating a holder which is equipped with the measuring element at the end thereof, from the working floor adjoining the furnace. But this procedure has drawbacks such as: (a) a correct temperature cannot be obtained due to the variability of depth and/or position of the spot of immersion thereof at each measurement according to the personal difference of the operators, and (b) a serious danger is feared from splash during measurement.

Another example of a device for automatic temperature measurement, which has heretofore been contrived for the purpose of relieving such drawbacks, is comprised of: a motor installed on the uppermost floor above the furnace, a measuring rod being suspended from said floor directly above the furnace by a wire and a pulley to be driven by said motor, said rod being adapted to make up and down motion through a rod guide provided between the uppermost and middle floors, a plurality of thermocouple holders with the immersion type of expendable thermocouple unit manually attachable thereto, said holders being adapted to be fed one by one by means of the feeding device, the thermocouple unit being adapted to be mechanically attached at the lowermost floor above the furnace to the measuring rod which has been lifted thereabove and is to be lowered and immersed into the molten steel bath. The measuring rod is provided with a rod guide as well as limit switches so that it may be adapted to make measurements at a predetermined position at a predetermined depth. However, the aforesaid device is also deficient in that (a) the attachment of the thermocouple unit to the holder must be manually performed one by one, (b) the compensating lead wire for conducting the thermal-electro-motive force to the temperature indicator is placed directly above the thermocouple, so that burning damage thereof is feared due to the splash and the radiated heat during immersion, (c) since the feeding device for the thermocouple holder is to be installed directly above the object to be measured, the feeding device tends to be readily injured by radiated heat, and (d) capability of application to existing sites of temperature measurement is restricted.

SUMMARY OF THE INVENTION

This invention is proposed for overcoming the above described defects, and the device thereof comprises a stationary frame for supporting a holder slidably in reciprocation towards the molten metal bath in a furnace. The frame being provided with means supported thereby for keeping the holder at a retreated and a standing-by position thereof and making the holder reciprocate towards and away from the furnace. Means are provided to supply to the front of said holder on the passage thereof, when the holder is at the retreated position, with a member to be immersed into the molten metal bath each time the holder is to be operated, and means to keep said member on the passage of the holder, to cause it to be automatically attached to the holder by the advancement thereof at the arrival of the holder and to cause it to be automatically removed from the holder when it retreats.

In the followings will now be described the invention further in detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1 through FIG. 6 schemically show side views of the basic form of the device according to this invention;

FIG. 7 shows a side view of an example corresponding to FIG. 1 of the device according to this invention;

FIG. 8A is an enlarged sectional view of a portion of FIG. 7;

FIG. 8B is a sectional view taken along a line A — A in FIG. 8A;

FIG. 8C is an enlarged perspective view of a portion 4 – 1 of FIG. 8A;

FIG. 9 is a sectional view taken along a line B — B in FIG. 7;

FIG. 10 shows a longitudinal sectional view of an expendable immersion thermocouple unit;

FIG. 11 is an outline of a thermocouple holder assembly;

FIG. 12 is an enlarged sectional view of the part "a" of FIG. 11;

FIGS. 13A, 13B and 13C show portions of FIG. 7 as viewed in the direction of H, wherein FIG. 13A shows the thermocouple unit kept at a state prior to the same being mounted onto the holder, FIG. 13B shows the state of the thermocouple unit when being mounted onto the holder, and FIG. 13C shows the thermocouple unit in relation to the holder just before being removed therefrom;

FIG. 14 shows a longitudinal sectional view of another embodiment of an automatic feeding device for the expendable immersion thermocouple units; and

FIG. 15 shows a cross sectional view taken along a line N — N in FIG. 14.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

FIG. 1 through FIG. 6 show the various postures of the device according to this invention with respect to a blast furnace of the open ceiling type. FIG. 7 shows the same as in FIG. 1 but enlarged to show details thereof, and the device will now be described in particular with reference to FIG. 7. The device in FIG. 7 is shown as it is provided obliquely above the furnace body 9, and the frame 8, which is installed obliquely in a fixed state, is equipped with a plurality of sprocket wheels 1, 1 – 2, 1 – 3, 1 – 4 with predetermined spaces therebetween. An endless roller chain 3 is put on the sprocket wheels, of which the lowermost sprocket is connected through the driving roller chain 11 with the driving motor 2 reversible in rotation, whereby the rotation of the motor 2 is transmitted to the roller chain 3. The roller chain 3 is adapted to be provided with an attachment 33 (FIG. 9), by means of which is mounted the thermocouple unit holder assembly 5, to be described hereinafter assembly 5 is capable of shifting in the direction of F or G, as shown by the arrows, along the guide 6, which is held at a predetermined position by means of the rib 16 fixed to the frame. The uppermost sprocket is connected by the roller chain 13 in driving relation with the conductor wire winding device 12 rotatably mounted to the frame above the uppermost sprocket. A compensating lead wire 34 extending

from the rear end of said assembly is adapted to be wound up through a pulley **15** rotatably mounted on the rib **14** projected from one side of the frame **8** by winding device **12**, the compensating lead wire **34** being connectable with the thermocouple unit within said holder assembly **5**.

Element wires **10 – 4**, **10 – 5** of the thermocouple unit are connected within a quartz tube **10 – 3**, which is encased within a steel cap **10 – 1** as shown in FIG. **10**, these components being built into a suitable insulator integral therewith, and the element wires making terminal portions **10 – 6** and **10 – 7** having been wired along the wall of a rear cylinder **10 – 8**. This unified body as held in one end of a protecting card-board tube **10 – 9** through the side edge flange **10 – 2** and the cylindrical portion succeeding thereto. As may seen from FIG. **11**, the holder assembly **5** consists of a first thicker tube portion **32** fixed to the attachment **33**, a second tube portion **31**, which is thinner than the first portion and protruding therefrom, and a connector assembly **30** positioned at the distal end of the second portion **31**. As may be seen in FIG. **12**, the connector assembly **30** comprises an insulating sleeve **30 – 6** disposed between a conductive stem **30 – 1** and a conductive sleeve **30 – 2** externally enclosing the outer periphery of said stem **30 – 1**. An insulator piece **30 – 7** is provided rearward of sleeve **30 – 2**. Conductive stems **30 – 1**, **30 – 2** are connected respectively to the corresponding ends of lead wires **30– 5** through lead wires **30 – 3**, **30 – 4**. The connector assembly **30** is covered by casings **30 – 8**, **30 – 9**, and then connected with the end of the tube portion **31** in sliding fit. By inserting the connector assembly **30** into the card-board tube **10–9**, the thermocouple unit will surely be electrically connected with the holder with the stem **30 – 1** and sleeve **30 – 2** contacted the terminals **10 – 7** and **10 – 6**, respectively.

Now, referring to FIGS. **7**, **8** and **9**, the feeding of the thermocouple unit will be described. The device **4** for automatically feeding the thermocouple unit, which is shown in FIG. **7** as mounted at the middle portion of the frame **8**, is illustrated in further detail in FIG. **8**. As may be seen in FIG. **8**, the thermocouple units **10** are contained in a stacked state within the device **4** with open bottom thereof open in continuity with the holder guide **6**. If the holder assembly **5** mounted on the attachment **33** be shifted in the direction of F in accordance with the roller chain **3** travelling, said second tube portion **31** will be inserted into the thermocouple unit **10**, which is the lowermost one held by the guide **6** in the passage of the holder assembly **5**, whereby the connector **30** may be fitted into the thermocouple unit **10** to make electrical connections. The guide **6** of the holder assembly **5** is provided with a device to removably mount the thermocouple unit onto the holder, the detail of which is shown in FIG. **13**. A pair of clutches **7 – 1** are provided on the guide **6** in such a manner that they may pivot around the pivotal axis **7 – 5**. Helical springs **7 – 2**, which are mounted on bolts **7 – 3** protruding from both sides of the guide, are compressed between the clutches **7 – 1** and nuts **7 – 4**, and urge the hooked heads of the clutches inwardly through the holes provided in the guide member. A thermocouple unit **10** is normally held within the guide by the clutches as shown in FIG. **13A**. But if the holder assembly **5** arrives, the second tube portion **31** will enter the thermocouple **10**, so that the clutches are pushed by the holder assembly **5**, to be opened in the direction of K as shown in FIG. **13B**, whereby the thermocouple unit will be pass through the clutches. On the contrary, when the holder assembly **5** is returned in the direction of G after the thermocouple unit **10** has been used, the thermocouple unit will be prevented from such movement as the rear end thereof is abutted by the ends of the clutches, which have returned to the inward position, so that the thermocouple unit may be removed from the second tube portion.

In operation, the distal end portion *a* (FIG. **11**) of the thermocouple unit holder assembly having electrical connection with the end portion of the expendable immersion thermocouple unit or with the thermocouple circuit closed, starts at point C in FIG. **7**, and advances in the direction of F to arrive at point D, where the temperature of the molten steel bath will be detected. After having finished the measurement of the molten steel temperature, the motor is made to rotate so that the thermocouple unit holder assembly **5** will be returned in the direction of G (See FIG. **7**). In the return stroke of the holder assembly **5**, the thermocouple unit **10** will be detatched and expelled from the furnace zone, whereupon the assembly **5** will return with the distal end to the point E. Thereafter it is moved again in the direction of F to make the next thermocouple unit to be attached to the end of the holder assembly and then come to the point C, where it stands ready for the succeeding measurement. The compensating lead wire **34** goes out of the holder assembly **5** at the end thereof remote from the furnace and is wound on the winding device **12** as may be seen in FIG. **7**.

The arrangement illustrated in FIGS. **14** and **15** is another example of a possible thermocouple unit feeding device. In FIG. **15** the thermocouple units **10** are disposed in the cells provided at equal angles around the circular periphery of a box **17**. At the point where the thermocouple unit holder assembly has completed its transference in the direction G, the feeding motor **21** on the common stand **22** will be started, whereby a predetermined angle of rotation is given by the angle setter machine **20** on the common stand **22**, thus permitting the driving gear **19** to mesh with the gear teeth **18** on the box side, so that the box **17** will be rotated by an angular segment corresponding to one thermocouple unit in the direction of arrow P, and one thermocouple unit will fall down into the holder guide **6** located at the upper portion of an inner fixed cylindrical member **23**. If the above series of operation be set to be performed once for each reciprocation of the thermocouple unit holder assembly on the holder guide, it is apparent that automatic temperature measurement may be performed optionally and at predetermined time intervals up to the time all of the thermocouple units distributed on the periphery of the box have been consumed.

As may be evident from the description above, the temperature measuring device according to this invention enables automatic temperature measurement to be done successively optionally and at predetermined time intervals. Correct temperature measurement is done promptly without necessitating the manual change of thermocouple unit by the operator. The problem of destruction of the compensating lead wire or of the observation error due to the rise of temperature is eliminated, and the temperature is detected accurately enough to meet the demand by temperature control required in steel manufacturing. And the device according to this invention has a further advantage in that it may readily be adapted to match to the existing conditions of the various measuring sites. And, accordingly, for any of the basic styles of automatic temperature measurement as shown in FIG. **2** through FIG. **6**, such a device suitable thereto may be attained by providing the frame **8** configurated correspondingly.

Though this invention has been described in connection with the device for measuring the temperature of the molten steel which is taken by way of an example, it is to be understood that it is not limited to that application. For example, it can be applied to an automatic sampling device by attaching removably to the end portion of the holder assembly **5** a crucible for taking up a sample to be examined.

We claim:

1. A system for automatically positioning generally cylindrical expendable immersion members into a bath, said system comprising:

a cylindrical holder having a forward end engageable with one of said immersion members;

a stationary frame mounted generally above said bath and having a guide supporting said holder, said frame having means mounted thereon for selectively reciprocating said forward end of said holder along said frame toward said bath into an operative position and away from said bath into a retracted position;

means positioned on said frame forward of said forward end of said holder when said holder is in said retracted posi-

tion for storing a plurality of said immersion members and supplying said immersion members one by one into the path of said holder when said holder is in said retracted position; and

clutch means mounted on said guide forward of said storing and supplying means for causing said holder to be engaged with said one immersion member when said holder reciprocates from said retracted position to said operative position and for causing said holder to be disengaged with said one immersion member when said holder reciprocates from said operative position to said retracted position, said clutch means comprising a pair of clutch arms having forward and rearward ends, said clutch arms being pivoted at their forward ends to said guide and extending longitudinally of said guide in opposing manner on opposite sides thereof, spring means biasing said rearward ends of said clutch arms toward said guide and said guide having openings therein, said rearward ends of said clutch arms having bent portion means extending through said openings in said guide for providing a seat for said one immersion member, said bent portion means preventing movement of said one immersion member during engagement of said holder therewith, said bent portion means allowing said one immersion member to pass therethrough and rotate said clutch arms against the bias of said springs during movement of said holder to said operative position, and said bent portion means causing removal of said one immersion member from said holder when said holder reciprocates back to said retracted position.

2. A system as claimed in claim 1, wherein said bath is a molten bath in a furnace, and said immersion members are expendable immersion thermocouple units.

3. A system as claimed in claim 2, wherein said means for storing and supplying comprises an outer rotatable tubular member having a plurality of cells equally spaced around the inner periphery thereof, each of said cells housing one of said thermocouple units, an inner stationary cylindrical member disposed within said outer rotatable member, said inner member having at its top portion a depression of a size to receive one of said thermocouple units, said depression being longitudinally aligned with the path of reciprocation of said holder, and means for rotating said outer rotatable member by an angle equal to the spacing between said cells upon each reciprocation cycle of said holder, whereby upon reaching said depression said one thermocouple unit falls into said depression.

4. A system as claimed in claim 2, wherein said means for storing and supplying comprises an elongated box extending perpendicularly upwardly from said frame immediately above and along the path of said holder, the width of said box being such that said thermocouple units are stacked therein one above the other and fall one by one into said path of said holder upon each reciprocation thereof into said retracted position.

* * * * *