United States Patent [19]

Franklin

[11] **3,861,571**

[45] **Jan. 21, 1975**

[54] **LADLE FLOW CONTROL SAFETY DEVICE FOR CONTINUOUS CASTING MACHINE**

[76] Inventor: **Arch V. Franklin,** 2427 Dickenson, Trenton, Mich. 48183

[22] Filed: **June 19, 1972**

[21] Appl. No.: **264,228**

[52] **U.S. Cl.** **222/533,** 164/152, 164/337, 222/547

[51] **Int. Cl.** **B22d 37/00**

[58] **Field of Search** ..... 164/136, 152, 153, 281, 164/337; 222/1, DIG. 26, DIG. 4, DIG. 21, 533, 545, 567, 160, 166; 193/17

[56] **References Cited**

UNITED STATES PATENTS

419,145	1/1890	Ely et al	193/17 X
612,610	10/1898	Levy	164/136
2,328,267	8/1943	Freeman	222/DIG. 21
2,834,075	5/1958	Hausen	164/152
3,354,939	11/1967	Calderon	222/DIG. 4
3,435,882	4/1969	Falk	164/337 X

FOREIGN PATENTS OR APPLICATIONS

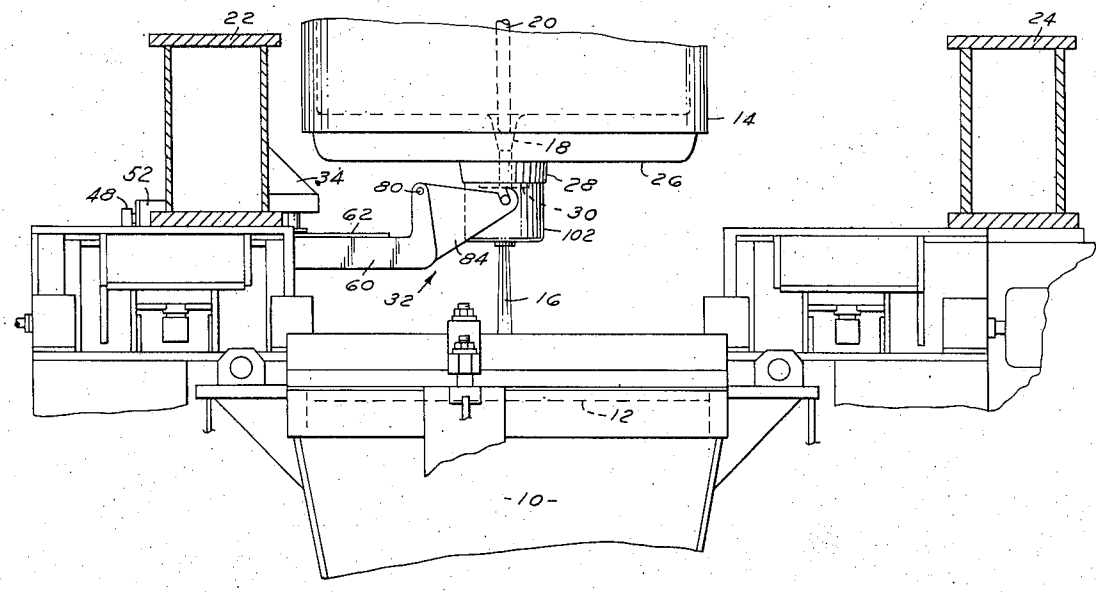
22,746	11/1914	Great Britain	222/DIG. 1
549,212	11/1942	Great Britain	222/DIG. 1
743,000	5/1933	France	222/166

Primary Examiner—Robert B. Reeves
Assistant Examiner—David A. Scherbel
Attorney, Agent, or Firm—Farley, Forster & Farley

[57] **ABSTRACT**

A continuous casting machine for molten steel requires a carefully controlled hydraulic head of molten steel for proper operation. The hydraulic head is provided by a tundish atop the continuous casting machine. The tundish in turn is supplied by a bottom pour ladle placed directly above the tundish and having an internal adjustable stopper rod for controlling the flow through the bottom tap or nozzle of the ladle. The invention comprises an auxiliary powered device which can move a separate external funnel or nozzle tightly up against the bottom of the ladle about the bottom tap to reduce the flow of metal from the ladle and thereby prevent overflow of the tundish with concurrent loss of molten metal when the stopper rod and nozzle of the ladle fail to operate and the flow from the ladle would otherwise exceed the requirements of the continuous casting machine.

12 Claims, 4 Drawing Figures



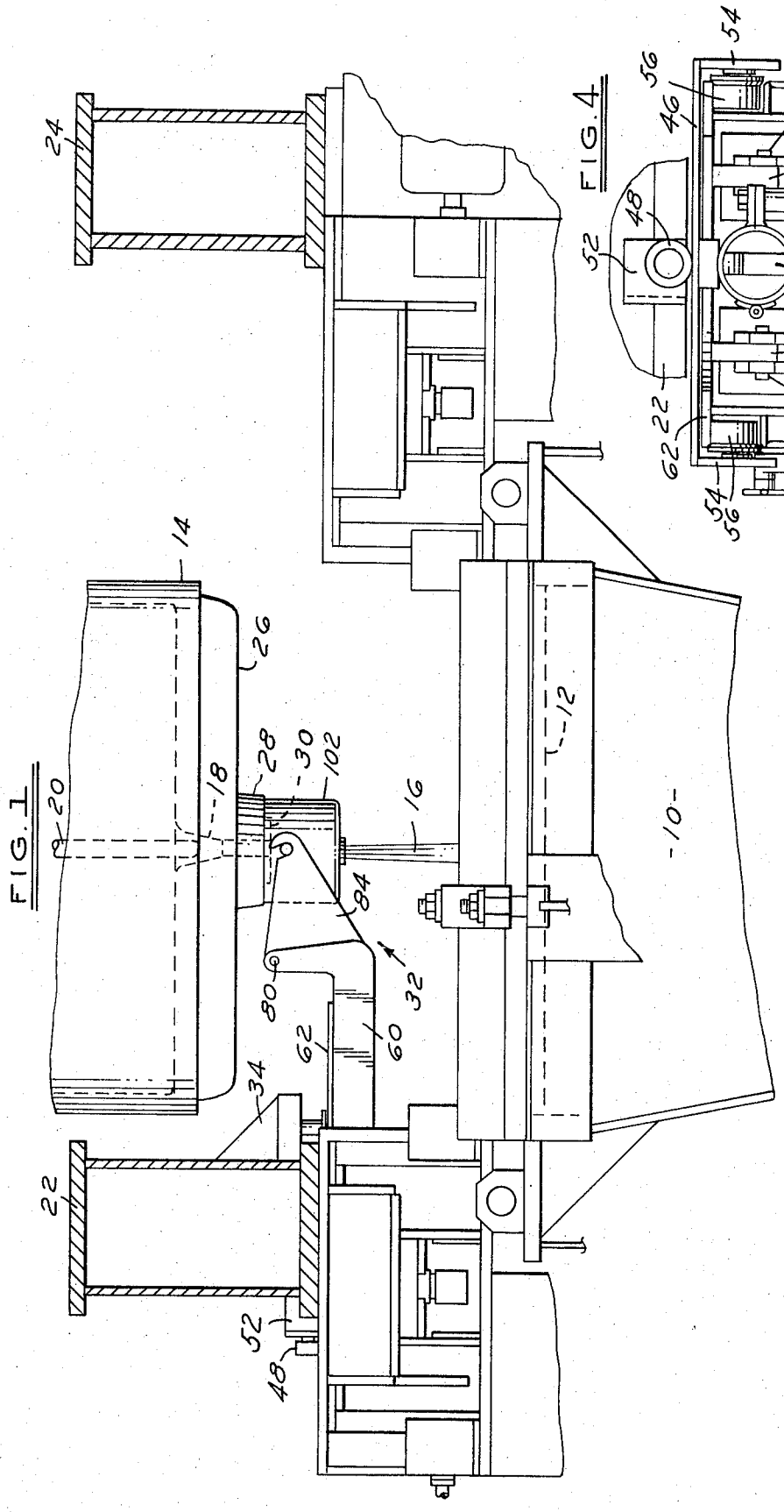

24
14
26
18
20
28
30
102
16
12
10
84
80
32
60
62
34
22
52
48

FIG. 1

54
112
56
46
94
88
96
66
48
64
52
96
88
22
62
94
60
114
54
56
112

FIG. 4

FIG. 3

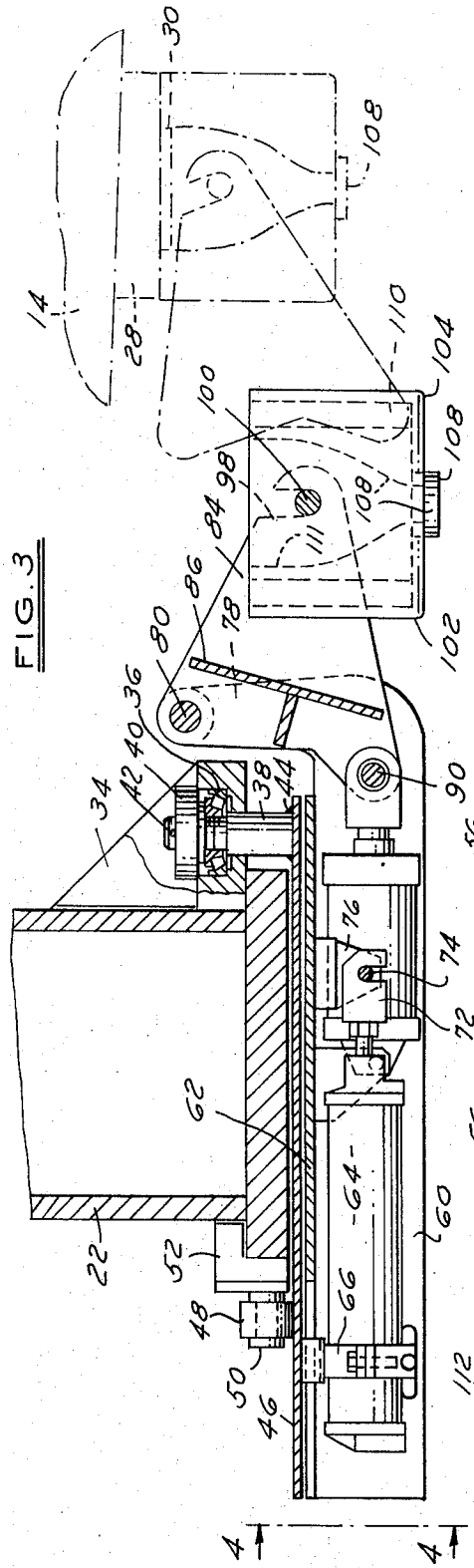
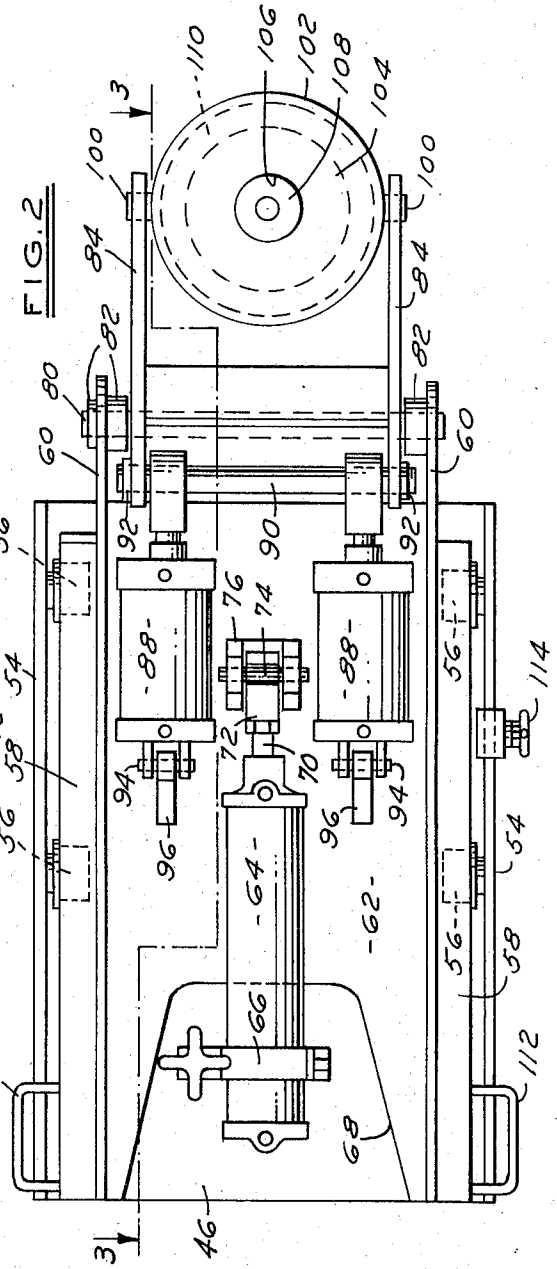

30
108
14
28
110
104
100
108
98
84
86
78
102
80
36
40
42
34
38
44
90
76
74
72
54
62
64
60
22
52
48
50
46
66
4
4

FIG. 2


3
110
106
102
108
104
100
84
82
80
60
92
90
88
76
74
72
94
96
70
56
54
58
62
64
66
68
112
114
46
3

LADLE FLOW CONTROL SAFETY DEVICE FOR CONTINUOUS CASTING MACHINE

BACKGROUND OF THE INVENTION

Continuous casting machines have been long known in the art for relatively low melting point metals. However, it has only been in recent years that practical large scale continuous casting machines have been built and operated for steel because of the relatively high pouring temperature and the great tonnage capacity that is required for economic production. For proper operation of the continuous casting machine, a controlled hydraulic head of molten steel is required at the vertical inlet of the continuous casting machine. This substantially constant hydraulic head is provided by a tundish having a nozzle in the bottom leading into the continuous casting machine. The tundish has a controllable stopper rod in the nozzle. In normal operation, the tundish stopper rod is pulled and the molten steel in the tundish continuously pours into the continuous casting machine. In order to retain the proper hydraulic head in the tundish, a relatively larger supply of molten steel is positioned in a bottom pour ladle directly above the tundish. This ladle has a nozzle in the bottom tap and a ladle stopper rod insertable in the nozzle to control the flow of molten steel from the ladle according to requirements as determined by the operator of the machine. As molten steel pours from the ladle into the tundish, the operator can observe the level of molten steel in the tundish and accordingly increase or decrease the flow of steel from the ladle. The nozzle in the bottom tap of the ladle is subjected to severe temperatures and flow rates. Although typically made of the best refractory materials available, it is normally replaced prior to each use of the ladle. Despite this precaution, a ladle nozzle will fail through erosion typically as often as once a day for each continuous casting machine. Such failure prevents the ladle stopper rod from adequately reducing the flow of molten steel into the tundish thereby causing overflow of the tundish through an overflow spout provided thereon. Molten steel that overflows from the tundish is lost from the casting process and must be scrapped and remelted. In addition, the ladle must be quickly moved from above the tundish and the molten steel remaining in the ladle dumped into a holding pit or other salvage device. Since a typical ladle for supplying a continuous casting machine contains upwards of **100** tons of molten steel, the failure of the ladle nozzle can result in a substantial loss of steel production and constitutes a substantial hazard to operating personnel adjacent the continuous casting machine.

SUMMARY OF THE INVENTION

The invention comprises a safety device located above the tundish and adjacent the bottom tap of the ladle during operation of the continuous casting machine. The device is normally in a retracted position wherein it does not interfere with the flow of molten steel from the bottom tap of the ladle. In the event the operator observes that the flow of molten metal from the ladle is exceeding demand and the ladle stopper rod no longer can control the flow, the operator then actuates the device which extends underneath the ladle and upwardly into tight contact about the nozzle opening of the bottom tap. The device includes a separate refractory lined nozzle which tightly contacts the ladle substantially reducing splash and restricting the flow of molten steel from the ladle. Alternately, the device may be fitted with a plugged nozzle or refractory stopper to completely stop the flow of molten steel from the ladle and thereby effectively prevent molten steel from pouring into the tundish.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary view of a portion of the continuous casting apparatus showing the location of the invention;

FIG. **2** is an enlarged bottom view of the invention;

FIG. **3** is a sectional side view of the invention taken along the line **3—3** of FIG. **2**; and,

FIG. **4** is an end view of the invention taken in the direction **4** of FIG. **3.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. **1,** a tundish **10** is located above a continuous casting machine (not shown) for casting molten steel. For proper operation, the level of molten steel in the tundish should be kept at a level indicated by the dotted line **12** to provide the proper hydraulic head and sufficient reservoir capacity for operation of the continuous casting machine. A ladle **14** is positioned above the tundish **10** to supply a continuous stream of molten steel indicated by **16** to the tundish. The ladle **14** is a bottom tap ladle having a refractory lined nozzle **18** and a vertically movable internal stopper rod **20** to control the flow of molten steel through the nozzle **18.** On either side of the ladle **14** are bridge girders **22** and **24** forming a part of the movable structure adapted to support a plurality of ladles and position them in turn above the continuous casting machine. The ladle **14** is supported in a ladle car which in turn is movable upon rails located on top of the bridge girders **22** and **24.** The ladle car rails, and movable structure, not shown, are well known in the art of continuous casting machinery. The interior of the ladle **14** is lined with refractory brick and the nozzle **18** is usually cast of a refractory material. Supporting the refractory brick bottom of the ladle interior is a steel bottom **26** which includes an annular steel plate **28** surrounding and supporting the refractory nozzle **18** which in turn extends through the annular plate **28** as indicated at **30.** During normal operation of the continuous casting machine, the operator will move the ladle stopper rod **20** up or down to control the rate of flow of molten steel **16** into the tundish **10** and thereby retain the level of molten steel in the tundish at the line indicated by **12.** The nozzle **18** is subjected to severe temperature and flow and is therefore subjected to severe erosion by the molten steel. In the event that the operator can no longer control the flow with the stopper rod **20,** applicant's device, a portion of which is shown in FIG. **1** and generally denoted by **32,** will be extended under the ladle **14** as shown and upwardly against the annular plate **28** about the bottom **30** of the ladle nozzle **18.**

The preferred embodiment of the applicant's device, as shown in FIGS. **2, 3** and **4,** is hung below and attached to the bridge girder **22.** A bracket **34,** welded or otherwise suitably attached to the bridge girder **22,** in turn supports a bearing **36** as shown in FIG. **3.** The bearing **36** in turn supports a vertical pivot **38** by means of a head **40** threaded thereon, and locked in place by

means of a pin **42** or other suitable device to prevent the head **40** from disengaging the pivot **38.** The lower end of the pivot **38** is welded at **44** to a large supporting plate **46.** The supporting plate **46** is in contact with a roller **48** mounted upon a pivot **50** in turn attached to a bracket **52** welded or otherwise suitably fastened to the bridge girder **22.** The supporting plate **46** is thereby free to rotate through a limited angle about the pivot **38.**

Extending downwardly along opposite sides of the supporting plate **46** are side plates **54,** best shown in FIGS. **2** and **4.** The side plates **54** in turn support trunnion mounted rollers **56** engaging rail members **58,** welded to side plates **60** of the extendable portion of the device. The side plates **60** are joined together by a horizontal flat plate **62.** Thus, the horizontal plate **62,** side plates **60** and rail members **58** can roll as a unit horizontally back and forth underneath the supporting plate **46.** An air cylinder **64** is clamped by the hand operated clamping means **66** to the supporting plate **46.** The clamping means **66** extends through the gap **68** formed in the plate **62.** The piston rod **70** of the air cylinder **64** is connected to a U-shaped jaw **72** which rests upon a pin **74.** The pin **74** in turn is supported by a bracket **76** in turn welded or otherwise suitably fastened to the plate **62.** Actuation of the air cylinder **64** therefore can extend and retract the plate **62** and side plates **60** from under the supporting plate **46.**

The side plates **60** extend upwardly at **78** to support a pivot pin **80** extending therebetween. The pivot pin **80** includes collar means **82** to retain the pin **80** in position joining the side plates **60.** The pin **80** supports twin hooks **84.** Extending between the twin hooks **84** is a T-shaped welded shield plate assembly **86** which preferably is welded to both hooks **84** and retains them in proper position. The shield plate assembly **86** also deflects splashing molten steel away from the moving parts of the device located beneath the support plate **46.** The head **40** on the pivot **38** is also preferably large enough to completely cover the bore hole thereunder and bearing **36** thereby preventing molten steel, slag, or other debri from interfering with the bearing **36.**

The hooks **84** are actuated to rotate about the pivot pin **80** by twin air cylinders **88,** the piston rods of which are pivotally attached by a single pin **90** extending through and between the hooks **84.** Collar means **92** are attached at either end of the pin **90** to retain it in proper position, joining the twin hooks **84.** The body of each air cylinder **88** is pivotally attached by a pin **94** to a bracket **96** welded or otherwise suitably fastened to the plate **62.** Thus, actuation of the air cylinders **88** will cause the twin hooks **84** to rotate and elevate upwardly. The hooks **84** include hook openings **98** extending upwardly and adapted to support trunnion pins **100** welded or otherwise suitably attached to a cup **102,** preferably formed of **8''** diameter steel pipe and having a bottom **104** welded thereto. Thus, upon actuation of the twin air cylinders **88** the cups **102** will be elevated. The bottom **104** has a hole **106** through which a funnel or nozzle **108** cast of refractory material extends. The refractory nozzle **108** is set in fire clay **110** inside the cup **102.** A plurality of cups may be prepared with nozzles ahead of time and easily positioned or removed from the twin hooks **84.** When the device is used, the refractory nozzle **108** will suffer from the errosive effects of the molten steel and therefore is intended for only one use.

The device normally remains in the retracted position shown in FIGS. **2** and **3** and is actuated to the operating position shown in FIG. **1** and in phantom in FIG. **3** when the ladle nozzle **18** fails during a pour from the ladle **14.** Thus, the cups **102** need be exchanged only after pours where there has been a failure of the ladle nozzle **18.** The upper opening end **111** of the cup nozzle **108** is large enough as shown in FIG. **2** to fit over the lower portion **30** of the ladle nozzle **18.** This allows the cup **102** to tightly fit up against the annular plate **28** and thereby reduce to a minimum any splashing of molten steel when the device is used. In order to accommodate differences in position of the ladle which is movable as explained above with respect to the bridge girder **22** to which the device is fastened, handles **112** are fastened to each of the rail members **58.** Thus, the operator can swivel the device about the pin **38** an amount sufficient to accommodate the position of the ladle **14.** In addition the operator can position a hand operated clamp **114** at any suitable location on the side plate **54.** The clamp **114** will engage the handle **112** and thereby provide an adjustable stop to determine the maximum extension of the device outwardly underneath the ladle **14.**

As an alternative, the cup **102** may have a solid bottom **104** and refractory cup inside to stop the flow of molten steel entirely or a refractory plug or ball may be inserted into the refractory nozzle **108** prior to use. Since the cups **102** are relatively small in size and weight, both the nozzle version and the refractory cup version may be kept at a conveniently close location for insertion into place just prior to use. As a second alternative the cup **102** may be replaced by a refractory plate which is thrust upwardly into tight engagement with the ladle nozzle bottom **30** to stop the flow of molten steel. With the flow from the ladle completely halted the movable structure can be actuated to move the ladle **14** and ladle car out of position without spillage of molten steel through the inoperative ladle nozzle **18.**

The weight of the device is slightly biased horizontally about the pivot **38** to the right when retracted in order to retain engagement of the support plate **46** against the roller **48.** Additional weight may be added to either end of the device to adjust the balance and thereby provide ease of rotational movement with the cup extended but not elevated into tight engagement with the ladle.

I claim:

1. A molten metal flow control safety device for use with a continuous casting machine supplied from a bottom tap ladle; comprising support means positioned adjacent the ladle bottom, linear extension means mounted on and movable on the support means to extend under the ladle upon actuation, means accommodating lateral positioning of said extension means, flow control means mounted on said extension means, and means providing vertical positioning of said flow control means adapted upon actuation to engage said flow control means with the ladle bottom about the bottom tap.

2. The device of claim **1** wherein said flow control means comprises a cup circumferentially engageable about the bottom tap and containing a nozzle adapted to resist the temperature and erosive effects of flowing molten metal.

3. The device of claim 2 wherein said flow control means include a refractory stopper adapted for insertion into the nozzle prior to actuation.

4. The device of claim 1 wherein said vertical positioning means includes fluid powered rotatable hook means adapted to support the flow control means.

5. The device of claim 4 wherein said flow control means includes trunnions adapted to rest in said hook means.

6. The device of claim 4 wherein said hook means includes shield means adapted to protect the fluid powered actuation means.

7. The device of claim 1 wherein said extension means is actuated by fluid powered means.

8. The device of claim 1 wherein said lateral positioning means includes a vertical pivot on said support means to allow horizontal rotational positioning relative to a bottom tap ladle.

9. The device of claim 8 wherein said device is slightly horizontally unbalanced toward said flow control means at said vertical pivot when retracted.

10. The device of claim 8 wherein said device is slightly horizontally unblanced toward said flow control means at said vertical pivot when extended.

11. The device of claim 1 wherein said flow control means comprises a refractory lined cup adapted to provide a complete stoppage of flow from a bottom tap ladle.

12. A molten metal flow control safety device comprising support means mounted upon a vertical pivot, linear extension means movable horizontally on the support means, elevating means rotatably mounted on the extension means, flow control means mounted on the elevating means and adapted for engagement with the bottom tap of a ladle, and fluid powered means adapted to actuate the extension means and elevating means.

* * * * *