United States Patent

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[33] **Germany**
[31] **P 17 58 027.7**

[54] **CONTINUOUS CASTING APPARATUS WITH PRESSURE EQUALIZATION CHAMBER**
5 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **164/154,** 164/259
[51] **Int. Cl.** **B22d 11/02**
[50] **Field of Search** 164/259, 66, 83, 260, 154; 138/31; 73/219, 243

[56] **References Cited**
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ABSTRACT: Continuous casting apparatus in which the mold oscillates and the space above the melt in the mold is enclosed and connected to an equalization chamber. Oscillation of the mold varies the volume and thereby the pressure in the space above the melt and the equalization chamber has variable volume means for substantially compensating the volume change in the space above the melt and thereby maintaining a substantially constant pressure in the space above the melt as the mold oscillates.

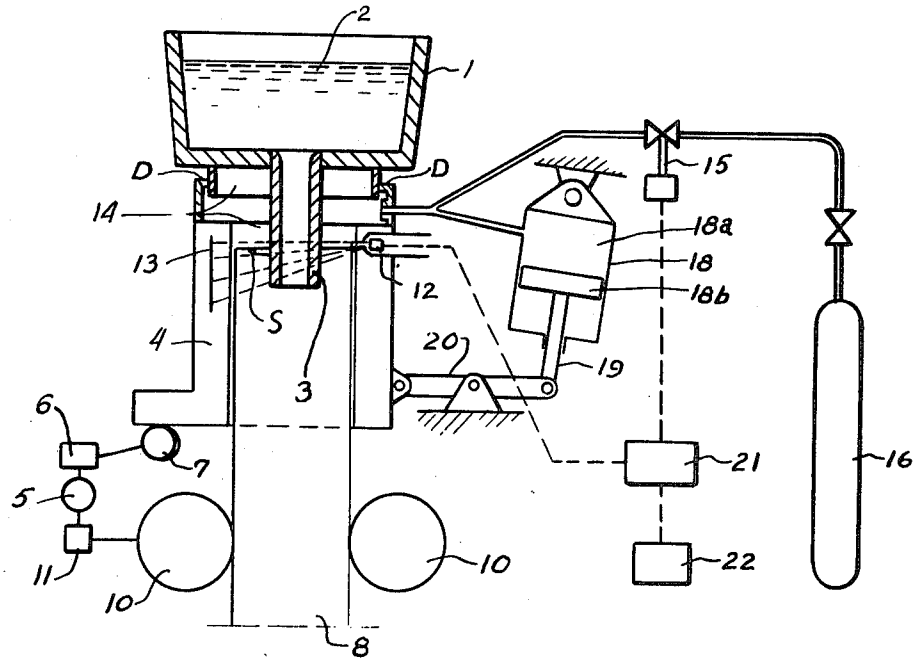


FIG.1

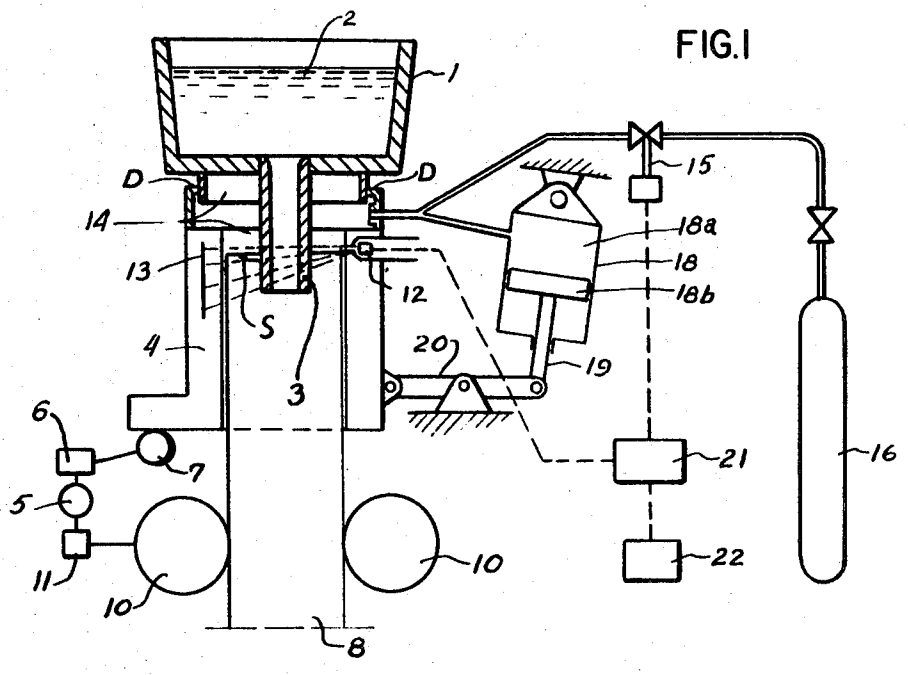


FIG.2

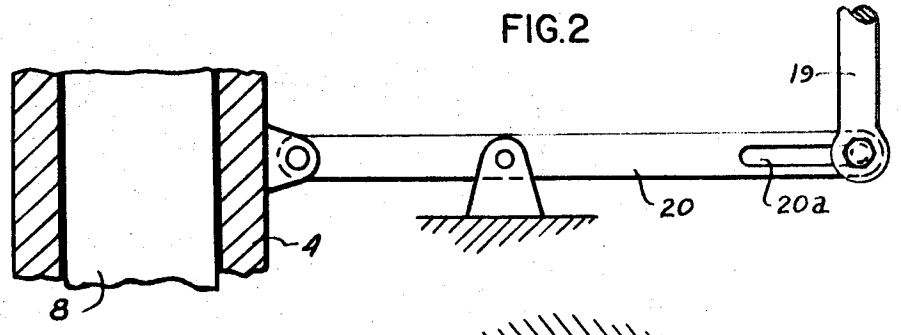
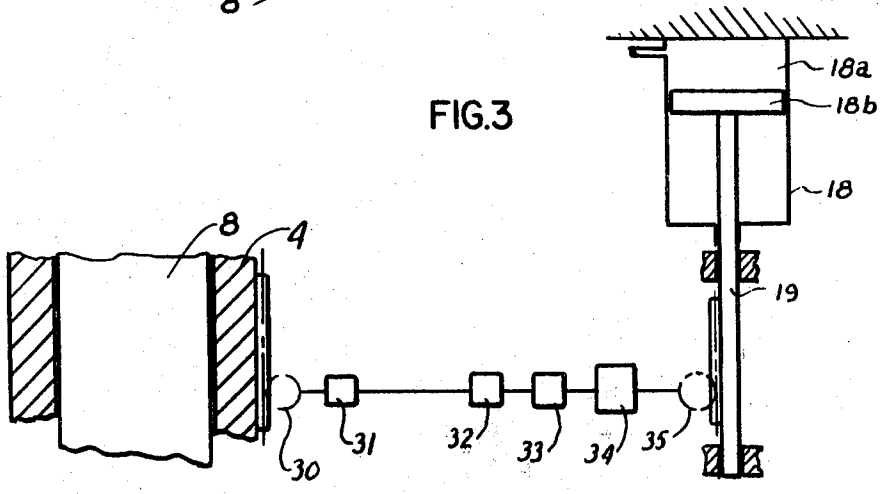


FIG.3



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CONTINUOUS CASTING APPARATUS WITH PRESSURE EQUALIZATION CHAMBER

This invention relates to the casting of metals into continuously cast strands in which the melt passes to the mold from a tundish through a pouring tube whose discharge opening is immersed in the melt in the oscillating mold. During the mold motion, the melt is cooled and, while solidifying, continuously withdrawn downwardly.

BACKGROUND

To prevent oxidation of the melt and also to maintain the melt level constant, it has been proposed that the space between mold and pouring tube be sealed gastight and that the seal be made elastic so as to allow for oscillation of the mold. The space is filled with a protective gas or solid substance to maintain a definite ferrostatic head, and consequently a definite melt level, during the casting process. (French Pat. No. 1,160,289, German Pat. No. 1,213,963 31*c*/21.)

During the oscillatory mold movement, however, the medium confined in the enclosed space is compressed or expanded, depending on whether the mold moves upward or downward, as a result of the volume variation in that space due to the moving mold components, and this has an effect on the pressure prevailing in that space, and hence, indirectly, on the melt level in the mold.

OBJECT

It is the object of this invention to maintain melt level and inflow constant even though the mold is oscillating and even when a gaseous or solid medium is used to fill the gastight space.

SUMMARY

To attain this object, it is proposed that the sealed space be connected with an equalization chamber. This offers the advantage that an effective pressure variation of the gaseous medium in the sealed space is avoided and that pressure equalization takes place in the combined volume of the sealed space and the equalization chamber, thereby preventing a significant rise or fall in pressure. Such a design is relatively simple and inexpensive.

More specifically, it is proposed that the equalization chamber is designed as a cylinder of variable volume and the piston which moves in the cylinder is driven as a function of the mold motion so that the combined volume of sealed space and equalization chamber remains the same at any instant during the mold motion.

A further characteristic is that the piston is connected to the mold by a two-armed lever. One lever arm is variable by having an elongated hole or similar means to permit the lever ratio to be adjusted to obtain the desired piston stroke when different mold sizes are used which cause a corresponding variation of the volume displaced in the sealed space. The piston might also be driven as a function of mold motion by means of an electric stroke-control system.

DRAWINGS

An embodiment of the invention is shown in the drawings in which:

FIG. **1** is a schematic general view of the apparatus with a mechanical drive for the equalization cylinder;

FIG. **2** illustrates the adjustment of the variable lever arm; and

FIG. **3** shows an electric stroke-control system for the equalization cylinder.

DESCRIPTION

A tundish **1** receives melt **2** from a ladle (not shown in the drawing). Through a pouring tube **3** located at the bottom of the tundish **1**, melt **2** flows into an oscillating mold **4**. The discharge opening of the pouring tube **3** is at all times, also during the up-and-down movement of the mold **4**, submerged

below the melt level S. As shown diagrammatically, the mold **4** is driven up and down by a motor **5** through gearing **6** and a disk cam **7**. A cooling system (not shown) in the mold **4** causes the melt **2** to cool and solidify into a strand **8** which, driven by pinch rolls **10**, is withdrawn downward at constant speed. Some of the pinch rolls **10** are likewise driven by the motor **5** through gearing **11**. Disposed at the height of the melt level S is a level-measuring system comprising a radioactive isotope **12** as transmitter and a scintillation counter **13** as receiver. The space **14** between the tundish **1** and the mold **4** is sealed and filled with a protective gas under constant pressure that prevents oxidation of the melt surface. The pressure is set by a melt level controller in such a way as to counteract the ferrostatic head in pouring tube **3** and tundish **1** in order that a given melt level may be maintained. Variation of the melt level is accomplished by actuating a control valve **15** so as to raise the gas pressure by admitting gas from an accumulator **16** if it is desired the melt level S is to drop, or so as to allow protective gas to escape if it is desired the melt level S is to rise.

When the seal D of the sealed space **14** is located outside of the mold walls **4**, the space **14** undergoes continuous geometrical variation as the mold oscillates; but the gas quantity contained therein remains constant. The melt level then constantly varies with the frequency of the mold stroke, and the inflow varies at the same rate.

To overcome these difficulties, the space **14** is connected to the cylinder space **18***a* of an equalization cylinder **18**. Said cylinder **18** is pivotally connected to the frame of the machine. The piston rod **19** of the piston **18***b* which moves in the cylinder **18** is pivotally connected to one end of a double-armed lever **20** while the other end of the lever **20** is connected to the mold **4**. The ratio of the lever arms must be such that the combined volume of cylinder space **18***a* and sealed space **14** is the same at every instant during the mold movement. When the mold **4** is raised, the volume of gas displaced from space **14** is then able to pass into cylinder space **18***a*. When the mold **4** is lowered, the process is reversed. To permit the ratio of the lever arms to be varied, stepless adjustment of the pivotal connection between piston rod **19** and lever arm **20** is provided by an elongated hole **20***a*, as shown in FIG. **2**. To maintain the level of the melt **2** constant, the actual value determined by the level-measuring system **12** and **13** is fed to a level controller **21** which compares the actual value of the level with its required value, obtained from the level set point transmitter **22**, and, when the actual value differs from the required value, actuates the control valve **15** so as to raise or lower the gas pressure in space **14**, thereby raising or lowering the level of the melt **2**.

FIG. **3** illustrates a further embodiment of an electric stroke-control system for the equalization piston **18***b* in which the distance traveled by the mold during its oscillation is measured in impulses through a rack-and-pinion arrangement **30** by a pickup **31** and, through a receiver **32**, a rotary transducer **33** is excited which, through a steplessly variable transmission **34**, drives the piston rod **19** of the piston **18***b* of the equalization cylinder **18** by means of a rack-and-pinion arrangement **35**.

What is claimed is:

1. In a continuous casting apparatus including a tundish, a chilled mold mounted below said tundish, and means for oscillating said mold with respect to said tundish, the improvement comprising means for sealing the space between the tundish and the upper end of the mold, means for filling said space with a protective has and maintaining said gas under a predetermined constant pressure, a pressure equalization chamber communicating with said space, and piston means within said chamber responsive to oscillations of said mold for varying the volume of said chamber in inverse relation to variations in the volume of said space as the mold is oscillated.

2. Apparatus as claimed in claim **1** including means operatively connecting said piston to said mold for actuation thereby.

3. Apparatus as claimed in claim 2 in which said means operatively connecting said piston to said mold comprises a two-armed lever having one end connected to said piston and the other end connected to said mold.

4. Apparatus as claimed in claim 2 in which said means operatively connecting said piston to said mold is adjustable to alter the stroke of said piston.

5. Apparatus as claimed in claim 2 in which said means operatively connecting said piston to said mold includes electrical means for sensing the oscillating movements of said mold, and electrical means controlled thereby for actuating said piston.