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CONTINUOUS CASTING WITH CONTROLLED FEEDING FROM PREDETERMINED SUPPLY

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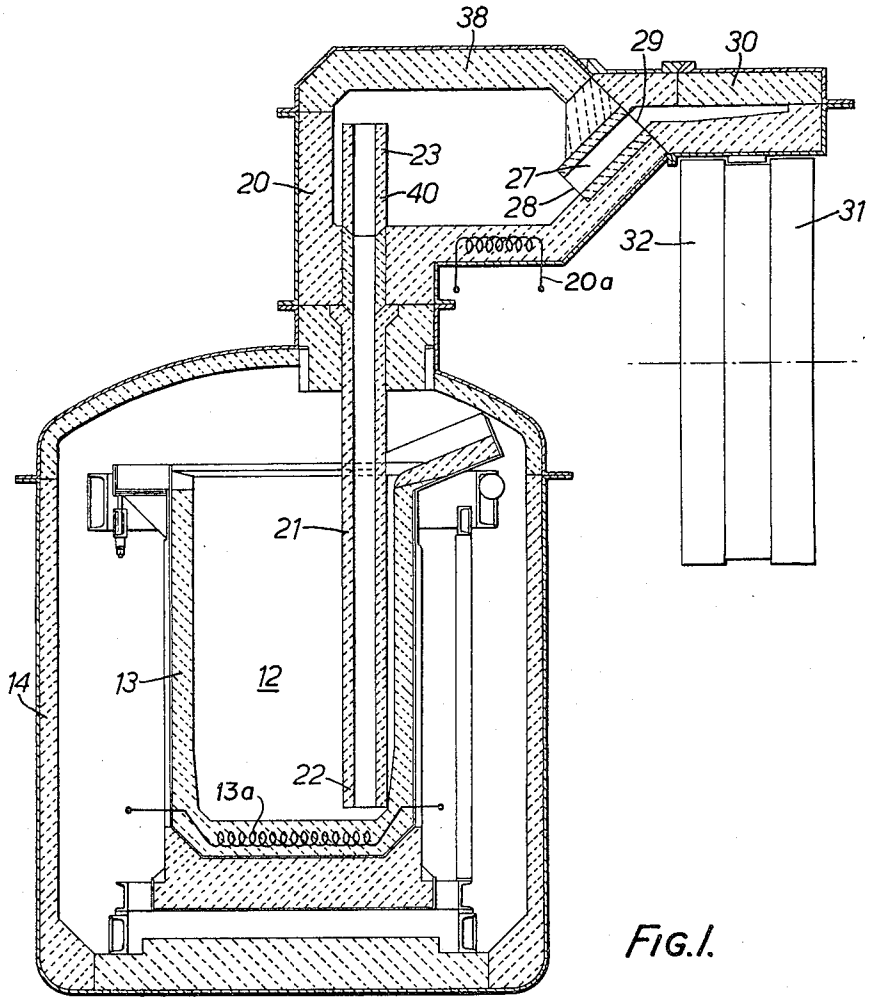

FIG. 1.

INVENTOR
D. R. NEWSOME
BY
Holcombe, Wetherill & Brisebois
ATTORNEYS

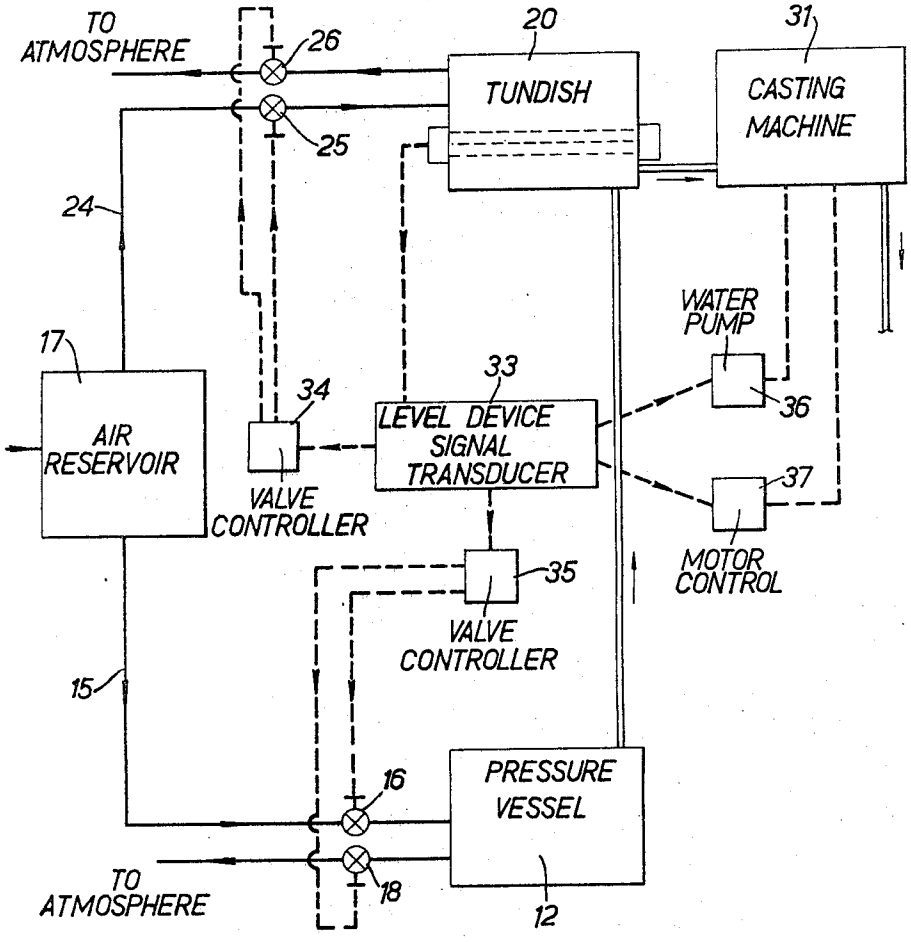

FIG. 2.

INVENTOR
D. R. NEWSOME
BY
Holcombe, Wetherill & Brisebois
ATTORNEYS

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CONTINUOUS CASTING WITH CONTROLLED FEEDING FROM PREDETERMINED SUPPLY

David Russell Newsome, Sheffield, England, assignor to Davy and United Engineering Company, Limited, Sheffield, Yorkshire, England

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8 Claims. (Cl. 164—155)

This invention relates to apparatus for feeding flowable material particularly suited to feeding molten metal to a continuous casting machine.

According to the invention there is provided apparatus for feeding flowable material from a container holding a predetermined amount of said material to a utilisation device said apparatus comprising a reservoir for said material connected by flow passages to said container and said device, means for applying gas under pressure to cause said material to flow from said container into said reservoir, means for applying gas under pressure to said reservoir to cause said material to flow from said reservoir to said utilisation device, and means for regulating the gas pressure applied to both said container and reservoir in dependence upon the level of material in said reservoir in a sense to maintain said level substantially constant.

In the application of the invention to feeding molten metal to a continuous casting machine the container may comprise a holding vessel for molten metal located in a pressure vessel, and connected to a tundish serving as the reservoir, and a common source of pressurised gas may serve for supplying pressurised gas to the pressure vessel to force metal from the holding vessel into the tundish and for providing a pressure in the tundish to force molten metal from the tundish to a continuous casting machine.

The tundish and holding vessel are preferably made of refractory or other insulating material and include heating means for controlling the temperature of the molten metal. In a preferred form the holding vessel is a mains frequency induction furnace.

Preferably gas is supplied to the pressure vessel at a substantially constantly increasing pressure to compensate for the reduction in heat in the holding vessel as the metal is fed out, and the rate of increase of the pressure is automatically controlled to keep the level of molten metal in the tundish constant. If the level of metal in the tundish is kept constant and the pressure in the tundish is kept constant the rate of flow from the tundish to a launder supplying the continuous casting machine should also be constant. A nucleonic level detector in the tundish may be used as a final control both on the pressure in the pressure vessel and in the tundish.

An embodiment of apparatus, in accordance with the invention, will now be described, by way of example only, with reference to the drawings accompanying the provisional specification of which:

FIGURE 1 is a vertical section through a molten metal holding vessel and tundish for feeding a continuous casting machine, and

FIGURE 2 shows a diagrammatic control circuit for the metal feeding apparatus of FIGURE 1.

A body of molten metal **12** is contained in a holding vessel **13**, in the form of a mains frequency induction furnace, heated by coil **13***a* which is enclosed in a pressure vessel **14**. The pressure vessel is connected by line **15** through variable throttle **16** to a pressurised gas reservoir **17**. The pressure vessel also has an outlet to atmosphere through a variable throttle **18**.

Bolted to the top of the pressure vessel is a refractory lined tundish **20** heated by coil **20***a*. A vertical pipe **21**, made from high alumina brick or castable refractory, connects the holding vessel **13** and tundish **20**; the lower end **22** of the pipe **21** is located just above the bottom of the holding vessel while the upper end **23** projects into the tundish above the working level of molten metal therein. The tundish is connected by line **24** through a variable throttle **25** to the gas reservoir **17**, and has an outlet to atmosphere through a variable throttle **26**. The outlet from the tundish is an inclined passage **27** having its entrance **28** below the working level of molten metal in the tundish and its outlet **29** above that level. The outlet **29** connects with the inlet of a launder **30** which is arranged to direct the metal flow through 90° before feeding it to a continuous casting machine **31**. In the embodiment shown the casting machine takes the form of a grooved rotatable wheel **32** which co-operates with an endless moving band which seals the groove. It should be understood however that the casting machine may be of other forms such as a conventional open-ended reciprocating mould. Located in the tundish is a nucleonic level detector (not shown) which is arranged to signal the metal level in the tundish to a level device signal transducer **33**, which in turn is connected by a valve controller **34** to the valves **25** and **26** controlling the pressure in the tundish and by a valve controller **35** connected to the throttle **16** and **18** to control the pressure in the pressure vessel **14**. The level device signal transducer is also connected to the water pump control **36** of the casting machine and to the motor control **37** of the casting machine to control the speed of casting operation of the machine and the rate of cooling.

The lid **38** of the tundish is removable and the upper section **40** of the pipe **21** is also detachable to allow metal in the tundish to flow back into the holding vessel **13** at the end of a casting operation.

In operation the holding vessel **13** is filled with molten metal, which is maintained at the desired casting temperature by induction heating. The apparatus is suitable for casting a variety of metals such as ferrous metals or aluminum. In the case of steel for example, the metal temperature will be maintained between 1550° C. and 1600° C. when the holding vessel is full the pressure vessel is pressurised to force metal up the pipe **21** into the tundish. When the metal has reached a predetermined level in the tundish the automatic control can be switched on. This applies a small pressure in the tundish forcing the metal up the passage **27** into the launder and into the casting machine. The pressure in the pressure vessel is continuously increased at a substantial constant rate to keep a constant flow from the holding vessel to the tundish. The nucleonic level detector detects any variation in level and feeds back to the throttles **16** and **25** to keep the flow into the casting machine constant. Towards the end of the cast when the holding vessel is nearly empty the pressure is maintained constant in the holding vessel and increased in the tundish to discharge as much as possible into the casting machine. The pressures are then released, the machine being stopped and the tundish emptied by pulling out the section **40** of the inlet pipe.

In one example, with a holding vessel capacity of six tons, a cast strip section 8 inches x ¾ inches and a casting speed of 18 ft. per minute the pressure in the holding vessel was initially brought to 25 p.s.i., and during casting was increased at the rate of 0.4 p.s.i. per minute while the pressure in the tundish was held substantially constant at less than 5 p.s.i.

It will be seen that such a feeding device is very suitable for automatic control and in particular the final control is extremely near the casting machine. If it is necessary to stop the flow of metal to the casting machine at any time this can be done immediately by releasing the pressure in the tundish.

It will be appreciated that whilst described above in connection with the feeding of molten metal the invention is equally of application in feeding any flowable material.

I claim:

1. Apparatus for continuously feeding flowable material from a container holding a predetermined amount of said material to a device for imparting a shape to said material, said apparatus comprising a reservoir for said material connected by flow passages to said container and said device, means for applying gas under pressure to cause said material to flow continuously from said container into said reservoir, means for applying gas under pressure to said reservoir to cause said material to flow continuously from said reservoir to said device, and means for regulating the gas pressure applied to both said container and reservoir in dependence upon the level of material in said reservoir to maintain said level substantially constant.

2. Apparatus as claimed in claim 1 wherein the means for applying gas under pressure to said container is arranged progressively to increase the pressure applied to compensate for the progressive reduction in head of material in the container as the material is fed out of it.

3. Apparatus as claimed in claim 1 for feeding molten material wherein said container and reservoir are provided with means for maintaining said material in molten state.

4. Apparatus as claimed in claim 1 including a level detector associated with said reservoir and arranged to provide signals indicative of the material level in said reservoir and wherein said regulating means is responsive to the signals from said detector to regulate said pressures.

5. Apparatus as claimed in claim 4 including means responsive to signals from said detector to regulate the speed of operation of said device to maintain said level constant.

6. Apparatus as claimed in claim 1 for feeding molten material wherein said container is constituted by a furnace enclosed in a pressure vessel and said regulating means is arranged to control the inflow and outflow of pressurised gas into and from said vessel.

7. Apparatus as claimed in claim 1 for feeding molten material wherein said reservoir is constituted by a heated tundish and said regulating means is arranged to control the inflow and outflow of pressurised gas into and from said tundish.

8. Apparatus as claimed in claim 7 wherein said device is a continuous casting machine.

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J. SPENCER OVERHOLSER, *Primary Examiner.*

R. D. BALDWIN, *Assistant Examiner.*