Oct. 31, 1950

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PUMP

2,528,210

Filed Dec. 6, 1946

2 Sheets-Sheet 1

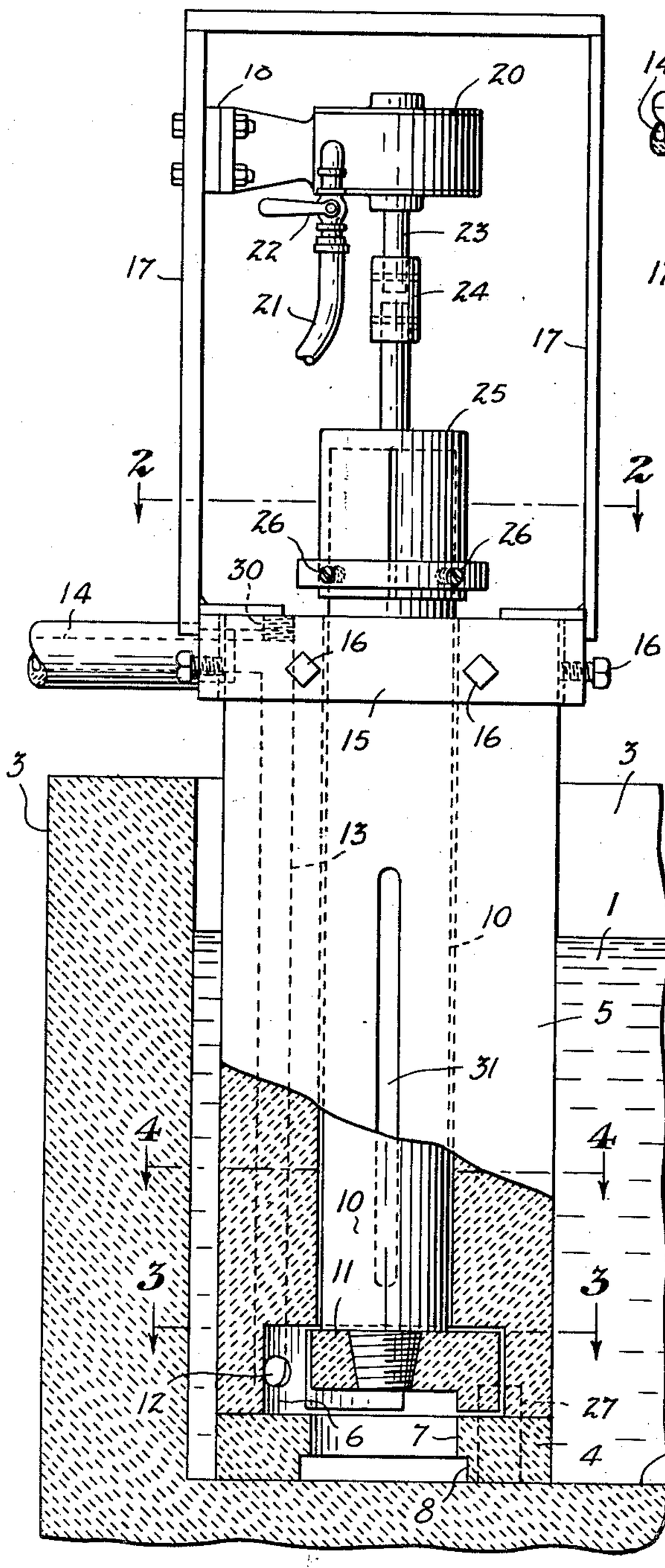

Fig. 1

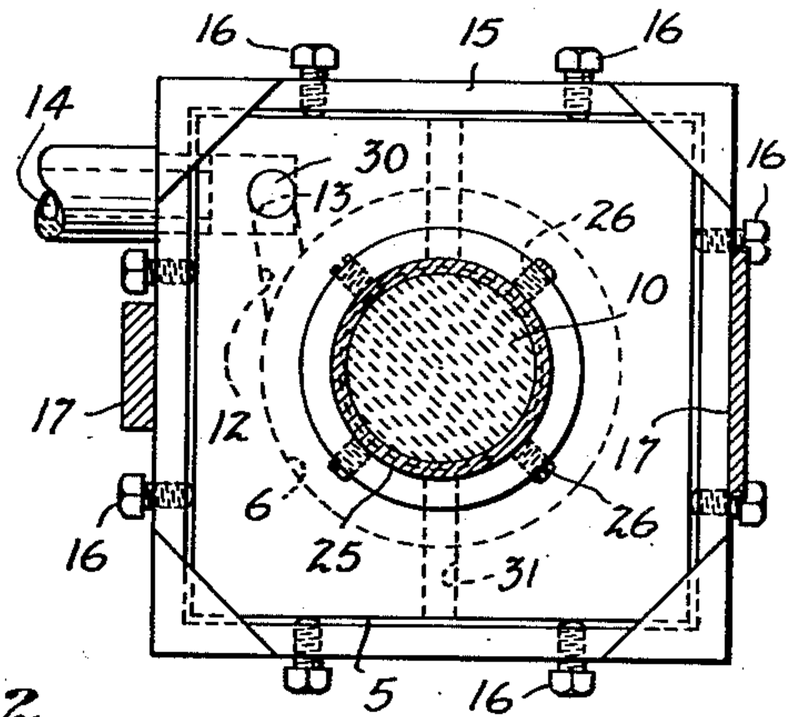

Fig. 2

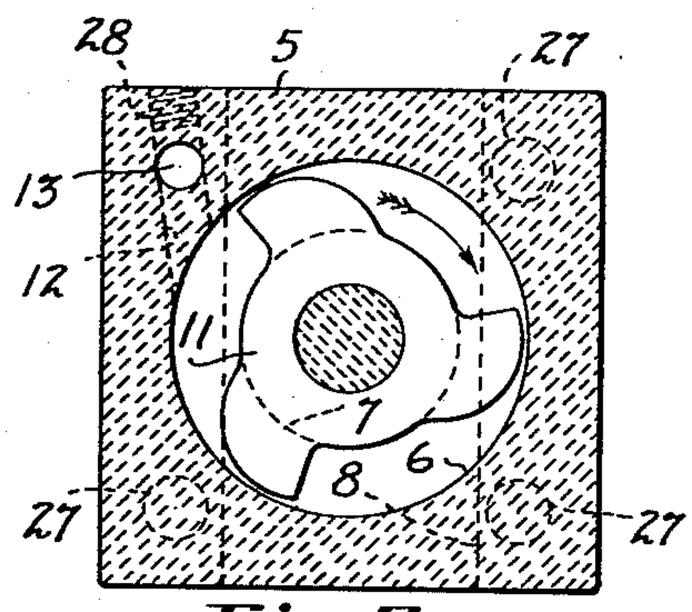

Fig. 3

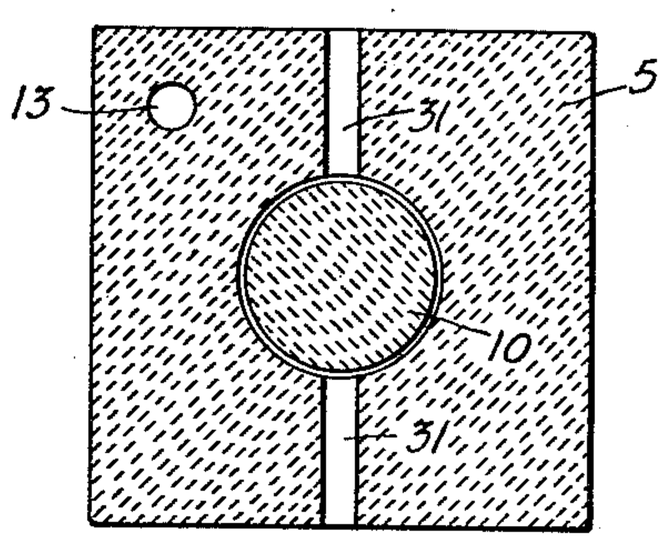

Fig. 4

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2 Sheets-Sheet 2

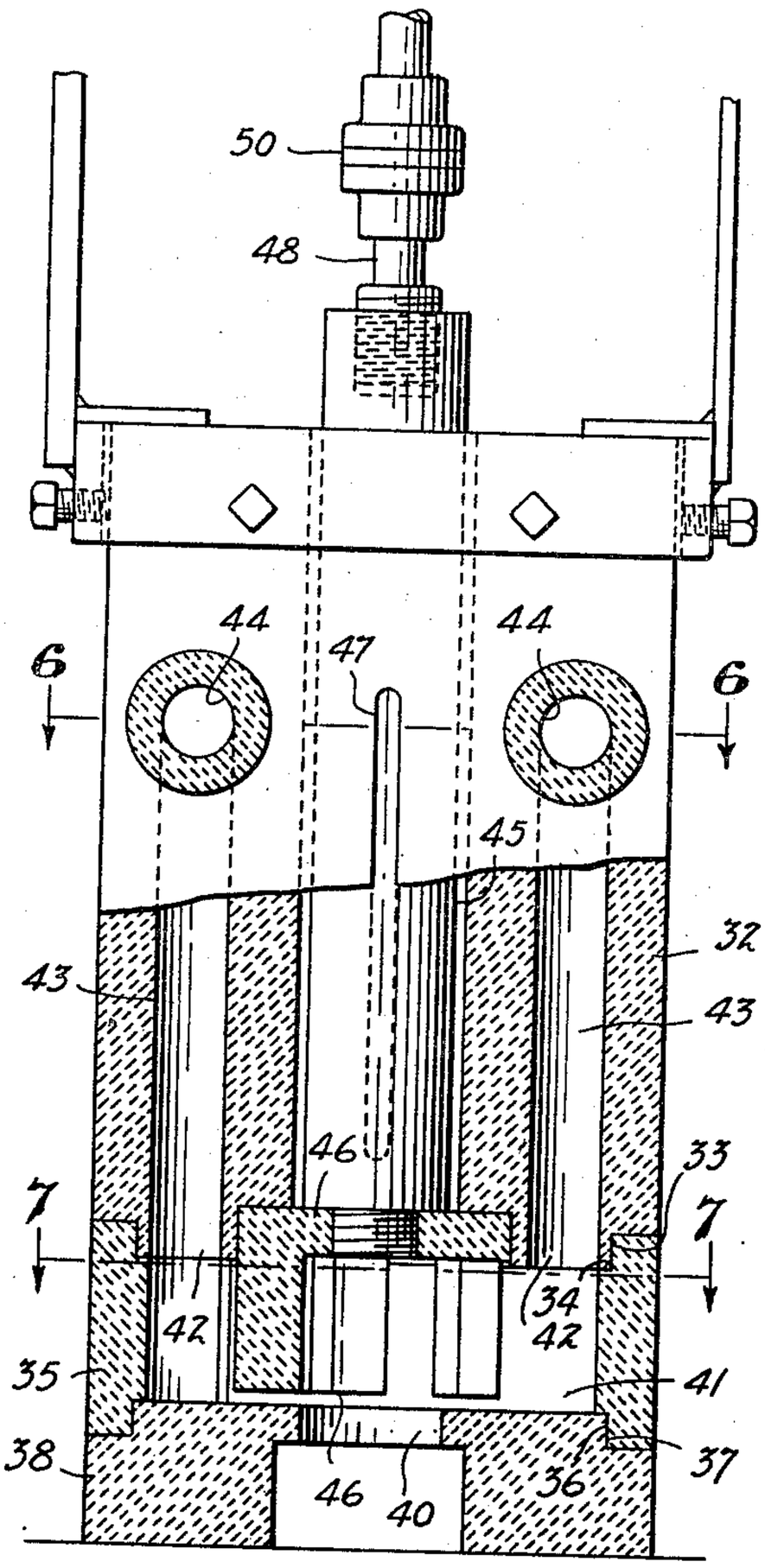

Fig. 5

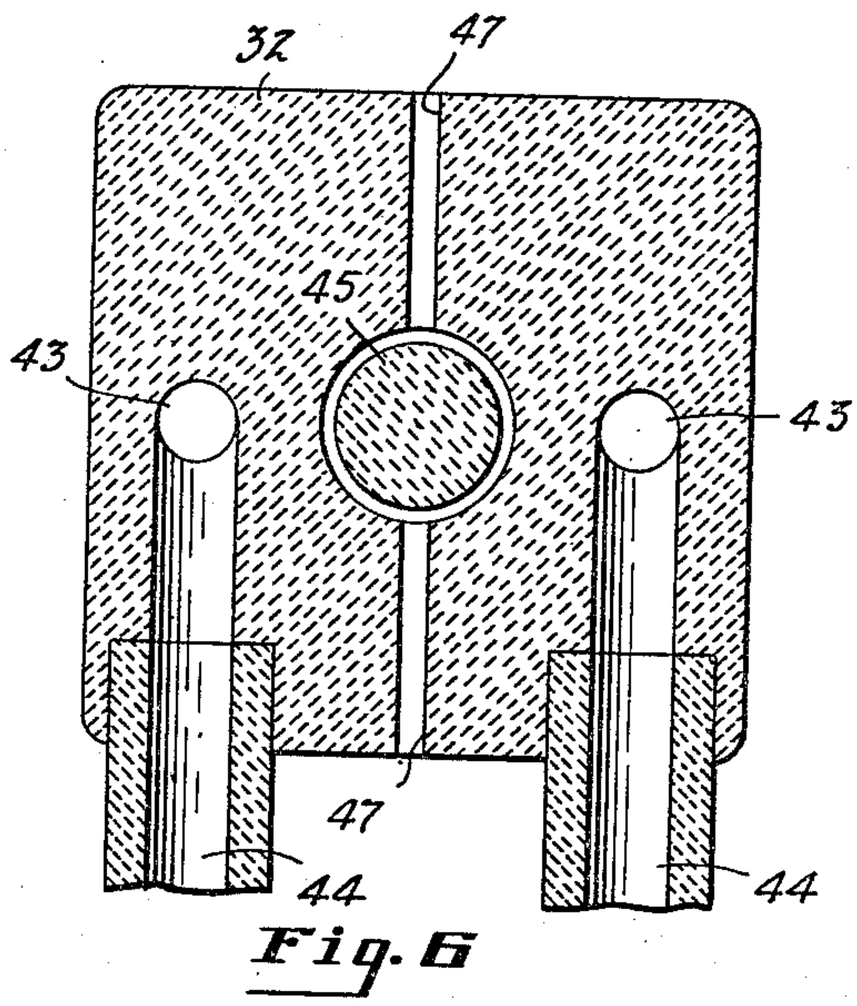

Fig. 6

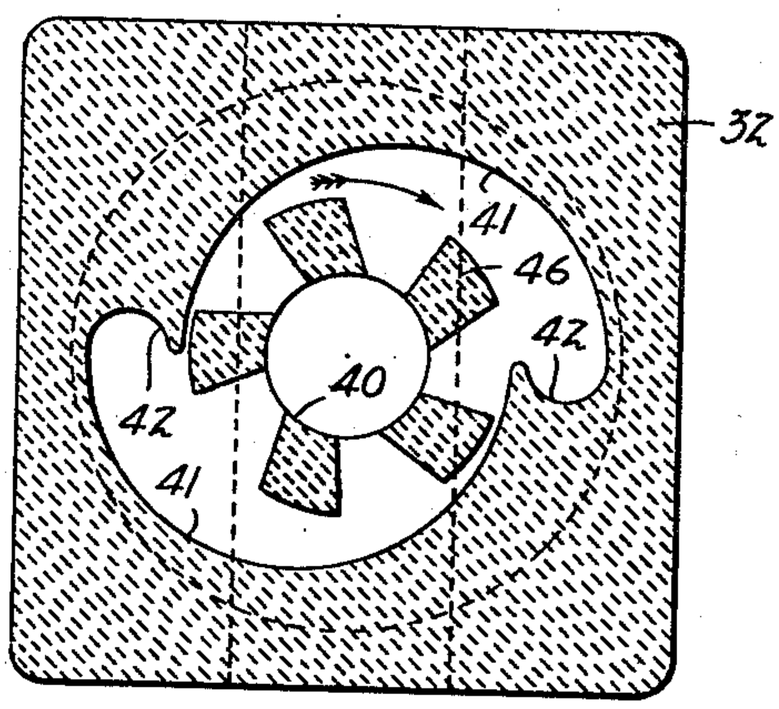

Fig. 7

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2,528,210

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2,528,210

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Application December 6, 1946, Serial No. 714,463

2 Claims. (Cl. 222—385)

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The present invention relates to a pump for lifting and conveying molten metal, and in particular to a pump, portions of which are adapted to be immersed in a molten metal bath, to pump molten metal.

Many attempts have been made over long periods of time to develop satisfactory ways of pumping molten metal to locations where work is to be done with the metal or to the metal. However, the great difficulty has been to provide a pump in which the parts exposed to contact with the molten metal will resist the deleterious attack thereof. In the case of molten aluminum, metal pump parts are unsatisfactory since relatively high melting point metals, such as iron, are dissolved when in contact with molten aluminum in spite of the fact that the molten aluminum may be at a temperature of approximately one-half of that at which iron melts. In this situation iron is introduced into the aluminum and it is well-known that for most purposes any substantial quantity of iron constitutes an undesirable impurity in aluminum or its alloys. In the same way many molten metals attack other metals and refractory materials to varying extents.

It is, therefore, an object of the present invention to provide a pump for conveying molten metal in which the parts of the pump exposed to contact with the molten metal comprise a material which will resist the deleterious attack of such molten metal.

Another object is to provide a pump for molten metal, adapted to be partially immersed in a molten metal bath, which is portable and may be readily moved for use in varying locations as desired.

A further object is to provide a pump for molten metal having relatively few parts and of such a design that the parts may be easily removed and replaced when they become defective.

Another object of the present invention is to provide a pump for molten metal which will lift the desired quantities of molten metal from a bath and convey the same to a desired location, including points considerably above the level of the molten metal bath.

Other objects and advantages will become apparent from the following detailed description accompanied by the drawings in which:

Figure 1 is an elevational view, with parts broken away, of a pump embodying the present invention partially immersed in a molten metal bath;

Fig. 2 is a horizontal sectional view taken substantially on line 2—2 of Fig. 1 showing details of the pump construction;

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Fig. 3 is a horizontal sectional view taken substantially on line 3—3 of Fig. 1 illustrating one form of the pump chamber and the impeller;

Fig. 4 is a horizontal sectional view taken substantially on line 4—4 of Fig. 1;

Fig. 5 is an elevational view with parts broken away of a modified form of pump embodying the present invention;

Fig. 6 is a horizontal sectional view, taken substantially on line 6—6 of Fig. 5, to illustrate the arrangement of the outlet in the modified form of pump; and

Fig. 7 is a horizontal sectional view, taken substantially on line 7—7 of Fig. 5, illustrating details of the chamber and impeller in the modified form of pump shown in Fig. 5.

The numeral 1 in Fig. 1 illustrates a bath of molten metal disposed in a suitable container such as a holding furnace or the like having a floor 2 and side walls 3 lined with a material having refractory properties and resistive to attack by the molten metal.

One embodiment of a pump made according to the present invention is shown in position partially submerged in the molten metal bath, and it may be seen that the form illustrated comprises a base portion 4 which rests on the floor 2 of the container for the molten metal bath. Resting on the base 4, or secured thereto, is a casing portion 5 having a chamber 6 disposed in the lower portion thereof. The chamber 6 is in communication with the molten metal bath through an intake passage 7 formed as an axial aperature through the base 4 which merges with a transverse passage 8 which extends from side to side of the base portion 4.

If it be desired to have the inlet to the pump draw up molten metal from a substantial distance above the bottom of the molten metal chamber, the base portion 4 may be provided with leg portions to raise the inlet, or the pump may rest on any other suitable support disposed substantially above the bottom of the molten metal bath.

Journaled in the casing portion 5 is a shaft 10 which is secured at its lower end to a suitable impeller 11 adapted to rotate within the chamber 6. The chamber 6 is also provided with an outlet port 12 which leads to a suitable conduit 13 extending to a point above the molten metal bath. In the form of the invention shown in the drawing, the conduit 13 is formed as a passage through the body portion of the casing 5 and

extends upwardly to a point near the top portion of the casing where it joins a horizontal conduit portion 14 which leads to the point to which it is desired to convey the molten metal. The conduit 13 could equally well comprise a separate tube or pipe independent of the casing 5.

At the top of the casing 5 a collar 15 is disposed and may be adjustably secured to the casing by setscrews 16. The collar 15 carries frame members 17 which extend upwardly and may be connected to their top ends to provide a superstructure sufficiently strong to support a source of power to drive the impeller. By fabricating the collar 15 so that it is larger than the casing 5 and securing it to the casing by setscrews 16, the superstructure above the casing is adjustably located with respect to the casing so that the source of power for the impeller may be accurately alined with the axis of rotation of the shaft to prevent vibration, wear or other objectionable results of misalinement. The use of a flexible coupling in the shaft is advisable to overcome the effects of misalinement.

Fig. 1 shows a bracket 18 secured to one of the frame members 17 and adapted to carry an air motor 20 through which air may be supplied from a suitable source (not shown), through a hose 21 which is controlled by a suitable valve 22. The compressed air passing through the hose 21 and into the air motor 20, drives the motor shaft 23 which is connected through a flexible coupling indicated by the numeral 24 to a split collar 25 which may be slipped over the upper end of the shaft 10 and firmly held thereto by setscrews 26. Many other types of drive may be utilized with equally satisfactory results.

The portions of the pump which are adapted to be exposed to contact with the molten metal or which are adapted to be immersed in the molten metal bath, such as the base 4, the casing 5, the impeller 11 and shaft 10, and the surfaces of the intake 7, outlet 12, and conduit 13, are all formed of a suitable material which will resist corrosive attack of the molten metal.

The above mentioned parts may be fabricated from a refractory material, that is, a material having a high resistance to disintegration by either corrosive or erosive attack from a bath of molten metal, and having a capacity to remain relatively stable and not introduce contaminants into the molten metal. A carbonaceous refractory material, such as graphite, silicon carbide or the like, has been found to be highly resistant to attack by molten aluminum. Pump parts composed of such a carbonaceous refractory material may be made by mixing ground graphite or silicon carbide with a fine clay binder, forming the part and baking. Such parts may also be made by mixing ground silicon carbide with a temporary binder such as pitch, tar, etc., molding or otherwise forming the article to the desired shape and heating it at sufficient temperature to recrystallize the silicon carbide, at which temperature the temporary bonding material substantially disappears.

The formed article is relatively brittle but may be subjected to simple machining operations. For example, in fastening the base portion 4 to the casing portion 5, one or more holes may be drilled through the base portion 4 and into the casing 5 and the two pieces secured together by dowels 27, preferably composed of the same material, as shown in Figs. 1 and 3. In forming the outlet port 12 from the chamber 6, a hole may be drilled through the casing 5 at the desired

point and the casing wall closed by the use of a plug indicated by the numeral 28 in Fig. 3. Also, in forming the conduit 13 the casing may be drilled until the drilled hole intersects the end of the outlet port 12 and the casing wall opening may then be sealed by a plug indicated by the numeral 30 in Fig. 1.

Similarly the impeller 11 may be made as an integral part of shaft 10 or may be formed separately and secured to the shaft 10. The drawings indicate in Figs. 1 and 5 the impeller as separately formed. If desired, suitable threads may be molded into the impeller while it is being formed and also onto an end of the shaft, or threads may be machined after the shaft and impeller have been formed.

The casing 5 may be provided with one or more slots 31 which extend from a point above the chamber 6 through the casing wall and expose the shaft 10 to the outside of the casing. In the pump shown in Figs. 1 to 4 of the drawings, two diametrically opposed slots 31 are provided, as may be seen in Fig. 4. The number, size, and spacing of the slots 31 may be adjusted according to the characteristics of the pump and the use to which it is to be put. Considerable pressure is generated by the impeller 11 in the chamber 6, and as a result of this pressure, molten metal may be forced upwardly through the casing around the periphery of the shaft 10. The slots 31 through the casing permit this metal to pass freely to the exterior of the casing and relieve the pressure, thus preventing the passage of metal up the shaft until it reaches a sufficiently cool zone where it could solidify and impair the operation of the pump. The slots 31 also serve to bring larger surface areas of the shaft and casing into contact with the molten metal as soon as the pump is immersed, so that such parts are quickly heated and do not chill metal from the bath to a point where it might congeal and cause freezing of the pump parts.

In the form of pump shown in Figs. 5, 6, and 7, a casing portion 32 is provided with a boss 33 on its under side to interfit with a recess 34 in a member 35 which comprises an extension of the casing 32. The member 35 is in turn provided with a recess 36 at its under side to accommodate a boss 37 carried by a base portion 38. The interfitted portions of the case 32, member 35, and base 38 provide a means of interlocking these members to secure them together against relative lateral movement, so that when the pump is immersed in a molten metal bath these portions are secured against disassembly due to currents or movement through the bath. If desired, these parts of the pump may be more securely connected by the use of dowel pins, or other interconnecting means, extending between the members, similar to the construction utilized in the form of pump shown in Figs. 1 to 4.

The base 38 has extending therethrough an intake passage 40 which is in communication with the molten metal bath and with a chamber 41 in the casing 32. In cross section the chamber 41 is shaped in the form of two volutes, each of which is in communication with an outlet 42 and leads to outlet conduits 43 formed within the casing 32. As shown in Fig. 5, the conduits 43 extend upwardly through the body of the casing. Molten metal flowing through the conduits 43 leaves the casing through horizontal portions 44 of the conduits 43 which convey the metal to the desired location.

A shaft 45 is journaled in the casing 32 for ro-

tation and is connected at its lower end to an impeller 46 of a type differing from that shown in Figs. 1 through 4. The impeller in the modified form of pump is shown as comprising an upper cylindrical portion having spaced depending vanes extending substantially to the bottom of the chamber 41, the arrangement and cross section of which may best be seen in Fig. 7.

To prevent molten metal from being forced up the shaft 45, due to the pressure developed in the chamber 41 to a point where it may congeal and cause freezing of the shaft with respect to the casing, a pair of slots 47 through the casing wall may be provided as shown in Fig. 7. Thus, any molten metal forced up the shaft may flow through the slots and return to the molten metal bath. The shaft 45 may be connected at its upper end to a drive shaft 48 which may be driven through a flexible coupling, indicated by the numeral 50, by any suitable source of power. In this modified form of pump the component parts thereof, which are subject to attack by the molten metal being pumped, are also formed of a suitable refractory material. The number of parts is few and their design relatively simple. Further, they are designed so that they may be readily secured together by nonmetallic means which are not subject to attack by the molten metal. The interfitting of the parts is sufficiently secure to prevent accidental disassembly of the pump but at the same time permits replacement of worn parts or cleaning of the parts to be easily and quickly accomplished.

It will thus be seen that by the use of the present invention, a pump for molten metal is provided in which no parts exposed to contact with molten metal under normal use are formed of a metal subject to attack by the molten metal. A pump having metal parts exposed to the action of the molten metal is undesirable and even impractical in that frequent replacement of the parts which corrode or deteriorate due to the attack of the molten metal is necessary. In addition the corrosive action generally introduces impurities into the molten metal bath and in many cases this fact would prohibit the use of such a pump. Molten aluminum tends to attack and cause disintegration of metals commercially suitable for forming pumps or parts thereof to be submerged in the molten aluminum, even though the molten aluminum is at a temperature considerably below the melting point of the metal in contact therewith. The pump of the present invention can be used to pump aluminum without replacement of the parts for relatively long periods of time and further the molten aluminum will not become contaminated from dissolving of the pump parts in contact therewith.

The advantages of a pump embodying the present invention are numerous. When used to convey molten metal from a molten metal bath to a point outside the bath, the material is withdrawn from a point beneath the surface of the molten metal bath and will, therefore, be relatively free from slag or other contaminants which are generally lighter than the molten metal and rise to the surface of the molten metal bath. Also, the molten metal may be conveyed in a closed conduit and is, therefore, free from oxidation which occurs in conveying molten metal in open conduits or containers. The desired quantity of molten metal may be pumped to a location where work is to be done with the metal or to the metal. By way of example, a pump embodying the present invention is extremely useful for lifting molten metal directly from a molten metal bath to a point considerably above the level of the molten metal bath and conveying the molten metal to an ingot mold, casting mold, die or the like. The pump is relatively small and requires no extensive installation. It is, therefore, readily portable and may be removed from place to place as desired. It is only necessary to immerse the pump in the bath of molten metal, connect it to a suitable source of power, and to an outlet leading to the desired location and pumping may begin. The form of pump shown in Figs. 5 through 7 is capable of producing two streams of molten metal simultaneously which is highly advantageous in a number of applications.

It will be understood that the foregoing description of preferred embodiments of the invention is not intended to limit the scope of the invention as described and claimed in the following claims.

What I claim is:

1. Apparatus for raising molten metal from one level to a higher level comprising refractory walls defining the bottom and sides of a reservoir for holding molten metal up to a predetermined maximum level therein, and a rotary submersible pump including an elongated casing supported on the bottom of said reservoir with its longitudinal axis projecting upwardly therefrom above said predetermined maximum level, said casing being substantially uniform in its transverse dimensions from top to bottom thereof and substantially free from transversely projecting parts below said predetermined maximum level, a cylindrical bore extending longitudinally through said casing from the top to adjacent the bottom thereof, a pump chamber in the lower end of said casing, a rotatable drive shaft extending downwardly through the bore of said casing and carrying at its lower end an impeller disposed for rotation with the shaft in said pump chamber, an opening through said casing into said pump chamber for admitting molten metal to be pumped from the reservoir, and a molten metal discharge conduit extending from said chamber upwardly through said casing inside the outer surface thereof to a point above said maximum level of molten metal in the reservoir, all parts of said pump below said predetermined maximum level being substantially entirely composed of a refractory material selected from the group consisting of graphite and silicon-carbide.

2. Apparatus for raising molten metal from one level to a higher level comprising refractory walls defining the bottom and sides of a reservoir for holding molten metal up to a predetermined maximum level therein, and a rotary submersible pump including an elongated casing supported on the bottom of said reservoir with its longitudinal axis projecting upwardly therefrom above said predetermined maximum level, a cylindrical bore extending longitudinally through said casing from the top to adjacent the bottom thereof, a pump chamber in the lower end of said casing, said casing being substantially uniform in transverse dimensions from the top thereof to the bottom of said chamber so as to be free from transversely projecting parts subject to being broken off, a rotatable drive shaft extending downwardly through the bore of said casing and carrying at its lower end an impeller disposed for rotation with the shaft in said pump chamber, an opening through said casing into said pump chamber for admitting molten metal to be pumped from

the reservoir, and a molten metal discharge conduit extending from said chamber upwardly through said casing inside the outer surface thereof to a point above said maximum level of molten metal in the reservoir, all parts of said pump below said predetermined maximum level being substantially entirely composed of a refractory material selected from the group consisting of graphite and silicon-carbide.

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