

June 6, 1961

T. W. F. FOSTER ET AL

2,987,391

METHOD FOR MELTING AND TREATING ALUMINUM

Filed Nov. 22, 1957

6 Sheets-Sheet 2

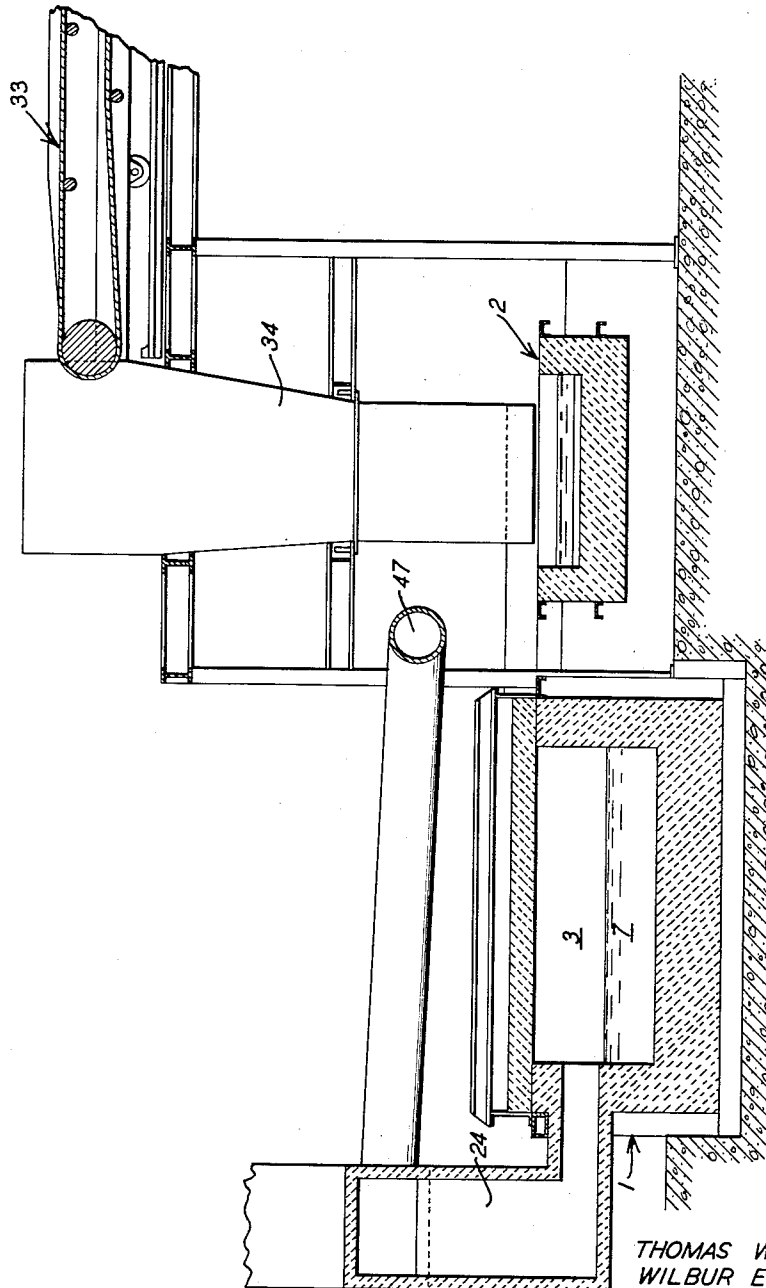


Fig. 2.

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6 Sheets-Sheet 3

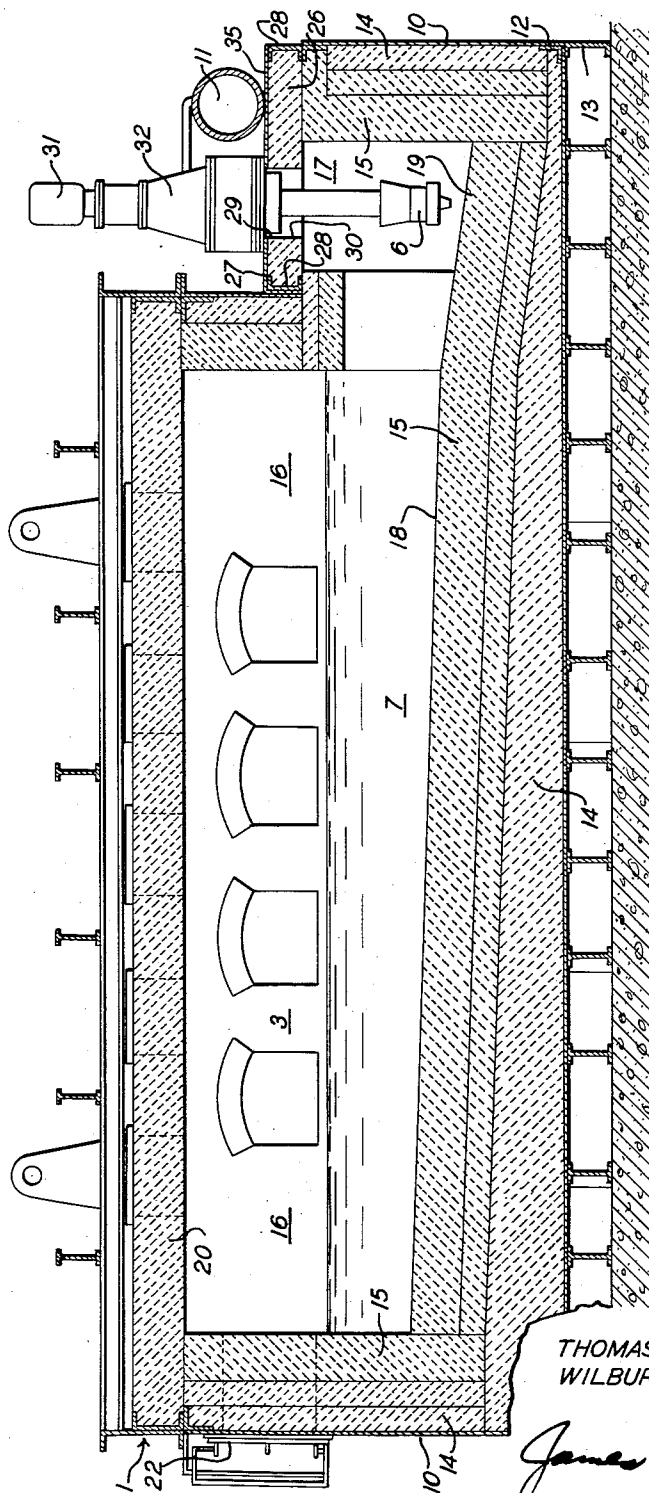


Fig. 3.

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6 Sheets-Sheet 4

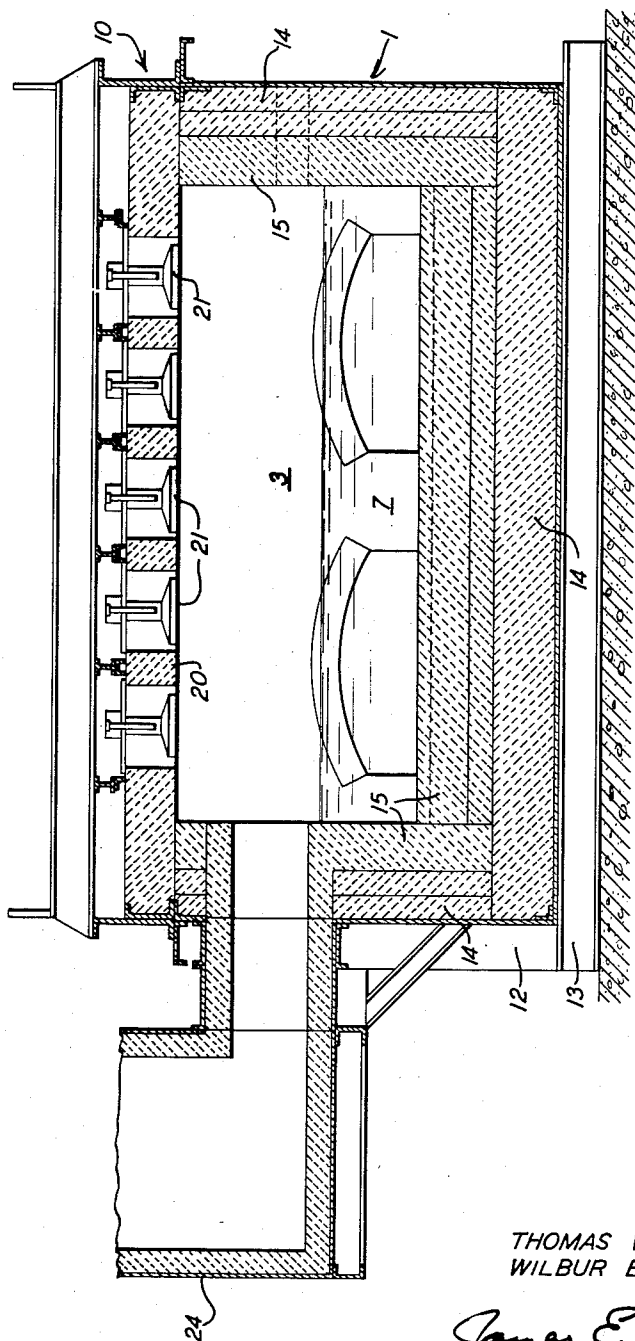


FIG. 4

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6 Sheets-Sheet 5

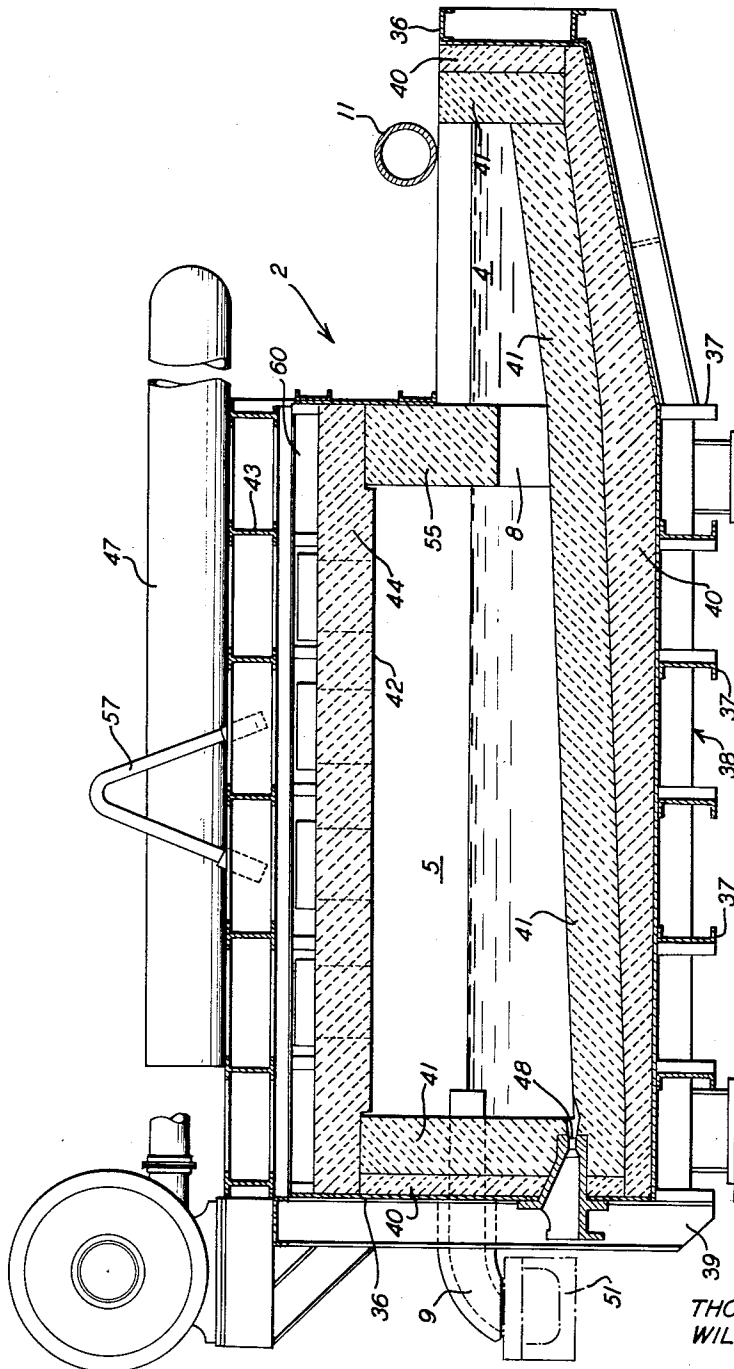


FIG. 5.

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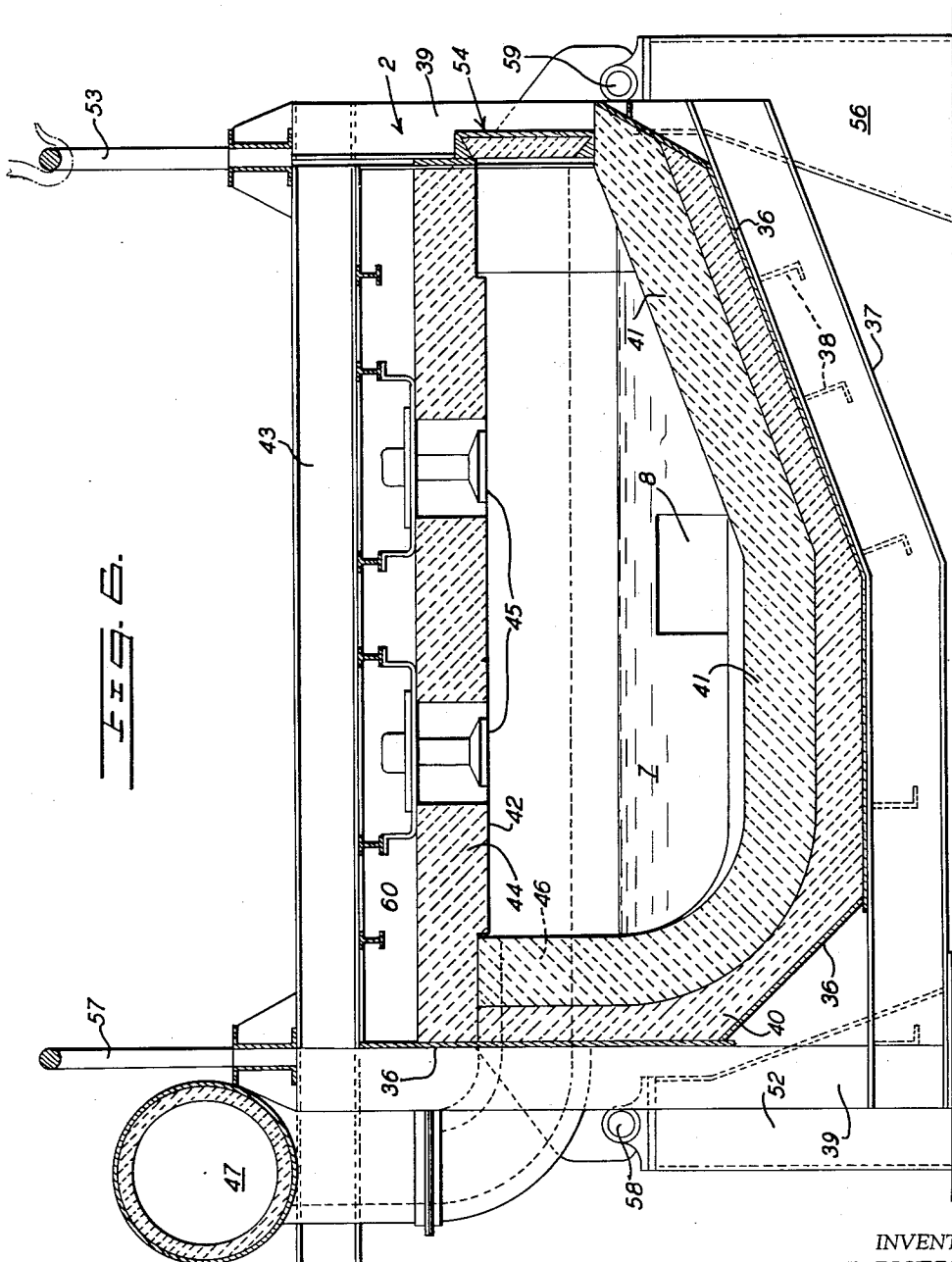
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METHOD FOR MELTING AND TREATING ALUMINUM

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6 Sheets-Sheet 6



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METHOD FOR MELTING AND TREATING
ALUMINUM

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11 Claims. (Cl. 75—68)

This invention relates to a method and apparatus for recovering metal from finely divided material. More particularly, this invention relates to an improved method and apparatus for recovering metal from finely divided scrap material such as aluminum saw chips, swarf, scalplings, foil, etc.

As used herein, the term "aluminum" includes pure aluminum, aluminum of commercial purity containing the usual impurities and aluminum alloys.

The melting of finely divided aluminum material has always presented a problem since finely divided scrap, such as saw chips, swarf, scalplings, foil, borings and turnings all have a high surface area to weight ratio. Accordingly, finely divided aluminum oxidizes readily when heated in an oxidizing atmosphere. As the oxide coating increases in thickness around a small particle of aluminum, it is increasingly difficult to separate the metal from its oxide.

In the past, many different methods have been used to handle such finely divided aluminum scrap. One practice was to charge these scalplings into suitable furnaces wherein they were hand puddled to minimize melt loss. Another method of the prior art involved compressing this finely divided scrap into briquettes which were then charged directly into the aluminum remelt furnaces wherein the metal alloys are made up for casting into ingots.

Such prior art practices possess certain inherent disadvantages with regard to melt losses and high labor expense. Hand puddling for melting finely divided aluminum scrap requires a substantial amount of hand labor. Further, careful puddling is required. Negligence results in substantial losses due to oxidizing which causes the formation of large amounts of dross and skim. Since hand puddling requires a liquid metal heel, change from one alloy to another requires complete draining of the furnace to prevent mixing. Because of the cost of draining the furnace between alloys, it is the usual practice to mix alloys which results in a mixed composition, low grade material. Where the finely divided scrap is briquetted and charged directly into remelt furnaces, excessive amounts of skim and dross are formed and must be removed. The metal contained in the skim and dross can only be recovered at substantial expense.

Accordingly, it is an object of this invention to provide a novel method and apparatus for recovery of aluminum metal from finely divided aluminum metal scrap which eliminates or substantially reduces the disadvantages of the prior art.

It is a further object of this invention to provide a novel method and apparatus for recovery of metal from finely divided metal scrap, which is characterized by high percentage of recovery and low operational expense.

It is a further object of this invention to provide a method for recovering aluminum from finely divided scrap, characterized by low operating expense per pound of metal processed.

It is a still further object of this invention to provide a method and apparatus for recovering aluminum from finely divided aluminum metal scrap wherein said finely divided scrap may be processed directly with a minimum of handling before melting.

It is a further object of this invention to provide a meth-

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od and apparatus for recovering aluminum metal from finely divided aluminum metal scrap, characterized by high percentage of recovery and low operational expense.

It is a still further object of this invention to provide a method and apparatus for recovering aluminum metal from finely divided aluminum scrap, characterized by ease of changing from one alloy to another without making mixed composition, low grade material.

Other objects and advantages of this invention will become more apparent from the following description and accompanying drawings.

This invention broadly comprises the melting of finely divided aluminum scrap material such as saw chips, swarf, scalplings, foil, etc., in a salt mixture of suitable composition. In accordance therewith, a body of fused salt having a density less than that of the aluminum metal to be recovered is heated in a chamber to a temperature sufficient to melt the aluminum metal. The heated fused salt is withdrawn from the chamber and introduced into a second chamber in a manner to create an agitated condition therein. Such agitation may be created by the use of a high velocity stream in introducing the molten salt into the second chamber. In addition, agitation may be created by introducing the molten salt into the second chamber in a manner characterized by free falling from a point above the normal surface of the fused salt in the second chamber.

The scrap aluminum is introduced into the second chamber and is intimately mixed with fused salt by the flow of the fused salt in the second chamber. The mixture of fused salt and aluminum is passed into a third chamber through a passage below the surface of the fused salt in the second and third chambers; that is, the mixture of fused salt and metal is passed into the third chamber from below the surface of the fused salt in the second chamber into the third chamber and below the surface therein. The aluminum melts due to the heat present in the fused salt, and the resulting globules of aluminum settle to the bottom of the third chamber since the fused salt is of a lower density than the molten metal. The molten metal collects in a pool on the bottom of the third chamber, which will be referred to as the settling chamber, while the fused salt rises to the surface in the third chamber. The fused salt is withdrawn from the surface of the salt in the third chamber and returned to the body of molten salt in the first-mentioned chamber. The molten aluminum is withdrawn from the bottom of the third chamber by passage through a suitable opening in said third chamber.

In normal operation, fused salt is preferably continuously withdrawn from the first-mentioned chamber and introduced into the second chamber, while fused salt is continuously withdrawn from the third chamber and returned to the first-mentioned chamber thus providing continuous circulation of molten salt.

In order to accomplish melting of aluminum scrap in practical quantities without circulating the fused salt at an excessive rate, it is desirable to maintain the temperature of the fused salt an appreciable amount above the melting point of aluminum. Accordingly, the fused salt should be maintained at a temperature not less than about 1300° F. The preferred salt composition employs the eutectic mixture comprising 44% by weight of sodium chloride and 56% by weight of potassium chloride. This eutectic mixture of sodium chloride and potassium chloride has a melting point of 1225° F.

While the preferred salt composition would involve use of the eutectic mixture of sodium chloride and potassium chloride melting at 1225° F., satisfactory results may be obtained with other salt mixtures. Melting points of 1300° F. or less may be achieved with sodium chloride, potassium chloride mixtures comprising from 15% to

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65% by weight sodium chloride and from 85% to 35% by weight potassium chloride.

While mixtures of sodium chloride and potassium chloride provide the desired temperature range for treatment of finely divided aluminum as outlined above, mixtures containing these constituents alone do not affect the protective oxide coatings on the finely divided aluminum. By including a small but effective amount of a fluoride constituent in the molten salt embodying the principles of this invention, a flux is produced which permits stripping the oxide coating from the particles of finely divided aluminum. One fluoride constituent which can be employed for this purpose is cryolite, and it has been found that a very small amount of cryolite, for example, 2.5% to 5% by weight of total flux, is effective. Accordingly, the preferred flux for use with this invention consists essentially of a mixture of sodium chloride, potassium chloride and a fluoride constituent wherein the sodium chloride and potassium chloride are proportioned with respect to each other in amounts of from 15% to 65% by weight of sodium chloride and 85% to 35% by weight of potassium chloride, and the fluoride constituent is present in a small but effective amount.

While cryolite has been referred to specifically, other fluoride constituents, such as aluminum fluoride and sodium fluoride, may be employed. Although a large quantity of the fluoride constituent may be employed, such fluorides are generally expensive and, accordingly, the lowest amount of fluoride which will effectively serve the purpose of attacking the oxide coatings is preferred.

Processing of finely divided aluminum metal may be continuous or semi-continuous by adding the finely divided aluminum metal to the second chamber either continuously or semi-continuously and withdrawing molten metal from the bottom of the third chamber in either a continuous or a semi-continuous manner.

A skim of aluminum oxides and fused salt is generally formed in the processing of finely divided aluminum scrap metal by this method, which skim has a density less than that of the aluminum and greater than that of the clean fused salt. Accordingly, a layer of such skim is formed in the third or settling chamber between the aluminum on the bottom and the clean fused salt on the top. After a period of time, when the skim in the intermediate layer of the third or settling chamber has accumulated to a considerable degree, charging of finely divided aluminum is stopped and the clean molten salt in the top layer is withdrawn by a suitable means, such as by decanting. Next, all of the molten metal is drained from the bottom of the third chamber after which the skim is removed from the third chamber by suitable means.

To begin operation again, all that is necessary is to fill the second and third chambers with fused salt from the first chamber. Finely divided aluminum scrap may then be added to the second chamber, and the cycle is repeated as above.

By the use of the method and apparatus of this invention all of the metal melting is accomplished below the salt surface; thereby the metal is protected from the products of combustion, and accordingly, very high recovery rates are obtainable. Further, when it is desired to change alloys, it is only necessary to drain the settled pool of metal from the bottom of the settling chamber, after which finely divided scrap of a new alloy may be immediately added to the mixing chamber. This is a very important feature where numerous alloys must be processed through the same equipment.

The accompanying drawings illustrate a presently preferred embodiment of the apparatus of this invention and a presently preferred method of operation.

FIGURE 1 is a plan view with parts removed for purposes of clarity of a presently preferred apparatus em-

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bodiment the principles of this invention for melting finely divided metal scrap.

FIGURE 2 is a transverse elevational view, in section with parts removed for purposes of clarity of the apparatus of FIGURE 1, taken along the line 2—2 of FIGURE 1.

FIGURE 3 is a longitudinal elevational view of the salt melting receptacle of this invention in section with parts removed for purposes of clarity, taken along line 3—3 of FIGURE 1.

FIGURE 4 is a transverse elevational view in section of the salt melting receptacle of this invention taken along the line 4—4 of FIGURE 1.

FIGURE 5 is a longitudinal elevational view in section with parts removed for purposes of clarity of the metal melting receptacle of FIGURE 1 taken along the line 5—5 of FIGURE 1.

FIGURE 6 is a transverse elevational view in section of the metal melting receptacle of FIGURE 1 taken along line 6—6 of FIGURE 1.

Referring now more particularly to the drawings in which the same reference numerals have been applied to various corresponding parts and with particular reference to FIGURES 1 and 2, the apparatus embodying the principles of this invention includes a salt melting and heating receptacle 1 defining a chamber 3 provided with heating means, such as gas burners, electric resistance means, etc., for heating a body of fused salt 7 therein, and a metal melting receptacle 2. The metal melting receptacle 2 shown in FIGURE 5 and FIGURE 6 is provided with a partition 55 dividing receptacle 2 into two chambers, a mixing chamber 4 and a settling chamber 5. Partition 55 has an opening 8 defined in the lower portion thereof which provides a passage between mixing chamber 4 and settling chamber 5. By means of a suitable pump 6 shown in FIGURE 3, preferably of the type known as a sump pump, and a conduit 11, fused salt 7 may be transferred from salt melting and heating receptacle 1 into mixing chamber 4 of the metal melting receptacle 2. Fused salt 7 is returned from settling chamber 5 to salt melting receptacle 1 by means of conduit 9, and trough 51 shown in FIGURES 1 and 5.

Pump 6 and conduit 11 are selected to provide a discharge velocity into mixing chamber 4 sufficient to create agitation in mixing chamber 4. According to a preferred embodiment of this invention, conduit 11 discharges the fused salt at a point above the normal level of the surface of fused salt 7 in metal melting receptacle 2 from which point the stream of fused salt falls freely into the mixing chamber 4 whereby increased agitation is achieved. Finely divided metal scrap can be charged into the mixing chamber by suitable means such as conveyor 33 and chute 34 shown in FIGURES 1 and 2. Finely divided aluminum scrap that is discharged by conveyor 33 into chute 34 will drop into the mixing chamber 4. The salt entering the mixing chamber 4 agitates the finely divided aluminum scrap in the mixing chamber whereby the aluminum scrap is thoroughly mixed with the fused salt 7. Accordingly, no hand puddling action is required. The chips and the salt are carried by the salt current through opening 8 in the lower portion of partition 55 into the settling chamber 5. The aluminum metal chips are melted by the hot salt 7 and the resulting globules of fused aluminum, which has a higher density than the fused salt 7, settles to the bottom. In addition, the salt has a fluxing action which releases the small particles of metal from their oxide coatings and thus aids in the agglomeration of the molten metal. The molten aluminum metal may be removed from the settling chamber by suitable means such as a tap hole 48 positioned in close proximity to the floor of settling chamber 5.

With reference more particularly to FIGURES 3 and 4, it will be seen that salt melting receptacle 1 comprises a shell 10 of suitable material, such as steel, supported by suitable framing members 12 and 13 of suitable material

such as steel. The walls and floor of salt melting and heating receptacle 1 are lined with a suitable insulating refractory 14. The innermost portion of the walls which contact the molten salt are lined with a suitable salt and heat resistant material 15, such as super duty fireclay brick. The chamber 3 of salt melting and heating receptacle 1 includes a heating zone 16 and a pumping zone 17. The pumping zone 17 is illustrated in cross section in FIGURE 3; the heating zone is illustrated in cross section in FIGURES 3 and 4. From the longitudinal elevation of FIGURE 3, it can be seen that the floor 18 of salt melting receptacle 1 has a recess 19 in the pumping zone 17 to permit pumping out of nearly all the flux in chamber 3. The heating zone 16 is provided with a roof 20 of suitable refractory material, such as super duty fireclay brick. Suitable heating means, such as radiant type gas burners 21, are provided in roof 20. Other methods of heating could be used; for example, gas-fired submerged tubes or electric resistance heating by submerged electrodes.

In order to clean out salt melting receptacle 1, suitable access doors 22 are provided. In order to vent the products of combustion, a suitable exhaust stack 24 is provided.

The top or roof 35 of pumping zone 17 comprises a slab of suitable insulating refractory material 26, supported by channel type framing members 28. Mounted on framing members 28 is a suitable plate 27. Plate 27 and refractory material 26 have matching openings 29 and 30, respectively, to provide for pump 6. Pump 6 is driven by suitable means such as an electric motor 31 through a suitable coupling and a shaft (not shown) within a suitable housing 32. Fused salt from the discharge of pump 6 is conducted to the mixing chamber 4 of metal melting receptacle 2 by means of conduit 11.

With reference to FIGURE 6, it will be seen that metal melting receptacle 2 resting on trunnions 52 and 56 comprises a shell 36 of suitable material such as steel supported by suitable framing members 37, 38 and 39 also of suitable material such as steel. Shell 36 is lined with a layer of suitable insulating refractory material 40 and a layer 41 of suitable refractory material such as super duty fireclay brick. With particular reference to FIGURES 5 and 6, metal melting receptacle 2 is divided into two chambers, a mixing chamber 4 and a settling chamber 5 by a partition 55 of suitable refractory material, such as super duty fireclay brick. An opening 8 is provided in the lower portion of partition 55 to provide a passage between mixing chamber 4 and settling chamber 5. Mixing chamber 4 is open at the top to provide for introduction of the finely divided aluminum scrap. Chamber 5 is provided with a roof 42 comprising suitable refractory material 44 supported by suitable framing members such as steel I beams 43 and 60 and may be provided with suitable heating means such as gas burners 45.

In order to provide for exit of undesirable gases, etc., an exhaust port 46 and a flue 47 are provided over settling chamber 5. In order to tap off the molten metal from the settling chamber 5, a suitable tap hole 48 is provided which may be plugged by suitable means such as doughballing. Doughballing comprises the use of a plug substantially the size of the tap hole which is covered by a wet mixture of refractory material known as "dough," which is forced into tap hole 48 whereby the "dough" bakes in place. When the metal is tapped, i.e., the tap hole 48 is opened, the metal flows into suitable molds such as pig mold 49 through a trough 50 shown in FIGURE 1. The molten salt in metal melting receptacle 2 is returned to the salt melting and heating receptacle 1 by means of an overflow conduit 9 of suitable material which is resistant to molten salt. The conduit 9 discharges the molten salt into the chamber 3 of salt melting and heating receptacle 1 by means of a refractory lined trough 51.

A skim is formed in the operation which has a density

between that of aluminum and the salt and accordingly, a layer is formed in the settling chamber between the molten aluminum on the bottom and the clean salt on the top. This skim must be removed periodically. In order to remove the skim, the pump is shut off to stop the salt discharge into chamber 4. All of the clean salt is decanted through conduit 9 into the salt melting chamber 16 to minimize salt consumption. The decanting can be accomplished with the presently preferred apparatus by tilting the metal melting receptacle 2 with a suitable means such as a crane, shown in phantom in FIGURE 6, lifting one side of the receptacle 2 with hook 53, thereby causing receptacle 2 to pivot about trunnion pin 58 supported on trunnions 52. After all of the clean salt is decanted, the metal melting receptacle 2 is lowered so that it again rests on trunnions 52 and 56. All the molten metal is drained from under the skim. The skim is then removed through a suitable opening such as door 54 by tilting the metal melting receptacle 2. Tilting is accomplished by lifting one side of receptacle 2 with hook 57, using a lifting means such as a crane, shown in phantom in FIGURE 6, causing receptacle 2 to pivot about trunnion pin 59 supported on trunnion 56.

By way of example, an apparatus of the type shown in FIGURES 1-6 and described above was employed. The salt used consisted of 50% potassium chloride, 45% sodium chloride and 5% cryolite. The burners were lighted and the salt melting receptacle heated. When the salt melting receptacle had reached the desired temperature, salt (NaCl) and muriate of potash (KCl) were deposited in the salt heating receptacle in a ratio of 45:50 parts by weight, and the receptacle was filled with the salt mixture which had reached a temperature of 1450° F. The metal melting receptacle was heated. The pump was started and the metal melting receptacle was filled with the fused salt. The salt mixture overflowed and returned to the salt melting receptacle whereby circulation was begun.

After circulation was established, more salt was deposited into the salt heating and melting receptacle to replace that which filled the metal melting receptacle to bring the system up to operating level. In addition, cryolite was added slowly to the hot salt in the mixing chamber of the metal melting furnace in an amount sufficient to produce a salt mixture containing 5% cryolite. The furnaces were stirred to get the cryolite into the flux. When the salt temperature in the entire system had been raised to between 1400° F. and 1450° F., the melting of finely divided aluminum scrap was started. The finely divided metal scrap was added at a rate sufficiently low that the temperature in the two receptacles was not lowered below 1350° F. at any time. After sufficient metal had been charged, the tap hole was opened, and the metal in the settling chamber was tapped into a pig mold.

During the period of operation a wide variety of saw chips and scalplings were melted, which varied from clean and dry to wet and oily. The only trouble that was encountered was the splattering of hot salt caused by charging chips that had visible droplets of water on them. Varied charging methods and melting conditions were tried. The salt was not detrimentally affected by any of the above-mentioned materials or methods.

After several days of operation, preparations were made for the first removal of skim during the test. At this time, 4320 pounds of chips had been processed. There were 385 pounds of sludge and salt that was removed as skim, or approximately 9% of the charged chip weight.

In order to remove the skim, the pump was shut off and the clean salt allowed to drain back into the salt heating receptacle. The clear salt that remained in the settling chamber was withdrawn. Next, the metal tap hole was opened and the metal allowed to drain into a pig mold. After all metal had been removed, the skim

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was removed. Additions of salt were made in the salt melting receptacle during this operation.

After the skim was drained, the tap hole was cleaned and doughballed, the pump was started, and the circulating system was re-established.

To bring the system up to operating level, further additions of salt (NaCl), muriate of potash (KCl), and cryolite were made. It should be noted that no salt was added for several days subsequent to the salt addition shortly after pumping was started.

Melting operations were stopped after the sixth day. The results of this test were as follows:

(1) A total of 5270 pounds of finely divided aluminum was charged and 5130 pounds of aluminum metal recovered. The process loss, including oil and water, was 140 pounds, for an over-all recovery of 97.4%.

(2) The salt remaining in the furnace after three days was exceptionally clean, and there was no indication that the salt could not be used indefinitely.

(3) Metal separation was very good even with fine saw chips and there was no indication of metal carryover during the melting process.

It is to be understood that various changes and modifications may be made in the foregoing method and apparatus without departing from the spirit of the invention and the scope of the appended claims. Although the invention is described in particular in regard to the melting of finely divided metal, such as aluminum chips, borings, foil, etc., the invention should not be construed as limited thereto. The method and apparatus of the invention are also applicable to recovering metal from scrap material wherein the metal pieces are of substantial size.

What is claimed is:

1. A method of melting aluminum metal comprising the steps of providing a body of fused salt in a first chamber, said salt consisting essentially of a mixture of sodium chloride, potassium chloride and a fluoride constituent and having a density less than that of said metal and being at a temperature sufficient to melt said metal, such salt adapted to strip oxide coating from the aluminum, withdrawing said fused salt from said first chamber and introducing the salt into a second chamber in a manner to create agitation therein, introducing aluminum metal into said agitated fused salt in said second chamber thereby causing intimate mixture of said fused salt with said metal in said second chamber, passing salt and metal into a third chamber from below the surface of the fused salt in said second chamber into the third chamber and below the surface therein, substantially all of said metal fusing in said second and third chambers, the resulting globules of fused metal settling to the bottom of said third chamber and said fused salt rising to the surface thereof, and withdrawing fused salt from the surface of the salt in said third chamber and returning said salt to the body of molten salt in said first chamber.

2. The method of claim 1 wherein said body of fused salt is heated to a temperature of not less than about 1300° F.

3. The method of claim 1 wherein the sodium chloride and potassium chloride are proportioned with respect to each other in amounts of from 15% to 65% by weight of sodium chloride and 85% to 35% by weight of potassium chloride, and the fluoride constituent is present in a small but effective amount to permit stripping of oxide coating from aluminum metal.

4. The method of claim 1 wherein said fused salt is heated in said first-mentioned chamber to a temperature between 1400° F. and 1450° F. and said aluminum metal is added in said second chamber at a rate sufficiently low so that the temperature of the fused salt in all three chambers is not lowered below 1350° F.

5. A method of melting aluminum metal comprising the steps of providing a body of fused salt in a first chamber, said salt having a density less than that of said alu-

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minum metal and being of a temperature of not less than about 1300° F. and consisting essentially of a mixture of sodium chloride, potassium chloride and a small but effective amount of fluoride constituent to permit stripping of oxide coating from the aluminum, continuously withdrawing salt from said first chamber and introducing the withdrawn salt into a second chamber at a velocity sufficient to create agitation therein, introducing aluminum metal into said agitated fused salt thereby causing intimate mixing of said fused salt with said aluminum in said second chamber, passing said mixture of fused salt and aluminum into a third chamber from below the surface of the fused salt in said second chamber into the third chamber and below the surface therein, substantially all of said aluminum fusing in said second and third chambers and the resulting globules of aluminum settling to the bottom of said third chamber and the fused salt rising to the surface thereof, and continuously withdrawing fused salt from the surface of the salt in said third chamber and returning said salt to the body of fused salt in said first chamber thereby maintaining a continuous circulation of the fused salt.

6. The method of claim 5 including the additional step of withdrawing said fused aluminum from the bottom of said third chamber.

7. The method of claim 5 wherein fused metal is continuously withdrawn from the bottom of said third chamber.

8. The method of claim 5 including the additional step of periodically removing a mixture of aluminum oxides and fused salt from said third chamber.

9. The method of claim 5 wherein the sodium chloride and potassium chloride are proportioned with respect to each other in amounts of from 15% to 65% by weight of sodium chloride and 85% to 35% by weight of potassium chloride and the fluoride constituent is derived from an addition of cryolite in amount of about 2.5 to 5% based on the total weight of fused salt.

10. A method of melting finely divided aluminum metal comprising the steps of heating a body of fused salt having a density less than that of said aluminum metal in a first chamber to a temperature of not less than about 1300° F., said salt consisting essentially of the mixture of sodium chloride, potassium chloride and a small but effective amount of fluoride constituent adapted to strip oxide coating from the aluminum, continuously withdrawing said heated fused salt from said first chamber and introducing the withdrawn salt into a second chamber in a manner characterized by free-falling from a point above the normal surface of said fused salt in said second chamber whereby substantial agitation is created, introducing aluminum metal into said agitated fused salt thereby causing intimate mixing of said fused salt with said finely divided aluminum in said second chamber, passing said mixture of fused salt and finely divided aluminum into a third chamber from below the surface of the fused salt in said second and third chambers, substantially all of said aluminum fusing in said second chamber into the third chamber and below the surface therein, the resulting globules of fused aluminum settling to the bottom of said third chamber and the fused salt rising to the surface thereof, and continuously withdrawing fused salt from the surface of the salt in said third chamber and returning said salt to the body of fused salt in said first chamber thereby maintaining a continuous circulation of the fused salt.

11. The method of claim 10 wherein the sodium chloride and potassium chloride are proportioned with respect to each other in amounts of from 15% to 65% by weight of sodium chloride and 85% to 35% by weight of potassium chloride and the fluoride constituent is derived from an addition of cryolite in amount of about 2.5 to 5% based on the total weight of fused salt.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,987,391

June 6, 1961

Thomas W. F. Foster et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 44, for "receptavle" read -- receptacle --;
column 6, line 13, for "tunnion" read -- trunnion --; column 7,
line 47, after "passing" insert -- said mixture of fused --;
line 66, after "from" insert -- the --; column 8, lines 57 and
58, strike out "and third chambers" and insert instead -- into
the third chamber and below the surface therein --; lines 59
and 60, strike out "chamber into the third chamber and below
the surface therein" and insert instead -- and third chambers --.

Signed and sealed this 17th day of April 1962.

(SEAL)

Attest:

ESTON G. JOHNSON

Attesting Officer

DAVID L. LADD

Commissioner of Patents