

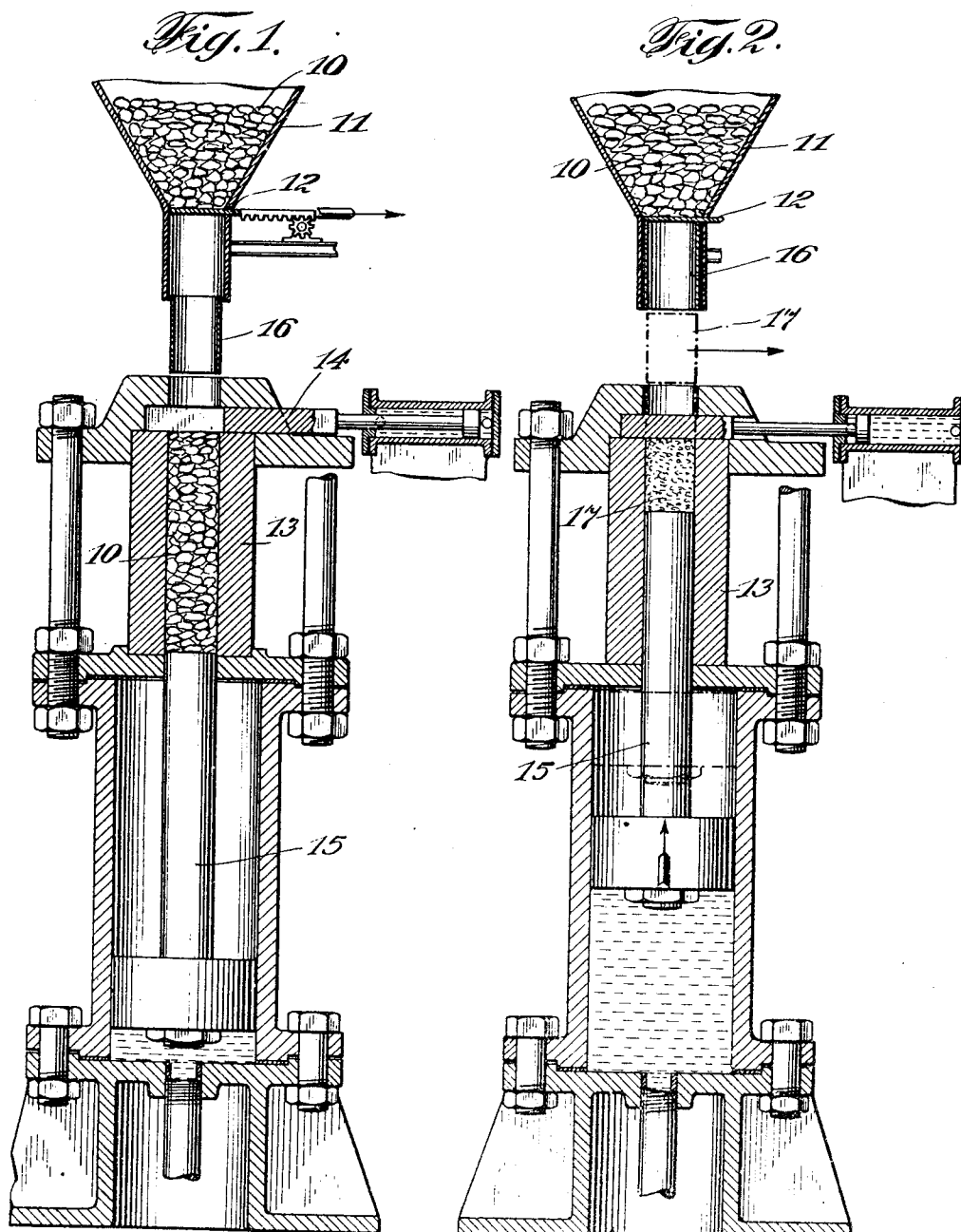
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H. H. STOUT

1,822,939

PROCESS FOR TREATING METALS

Original Filed May 28, 1926 4 Sheets-Sheet 1



Harry H. Stout
INVENTOR
BY
Frank J. Stout
ATTORNEY

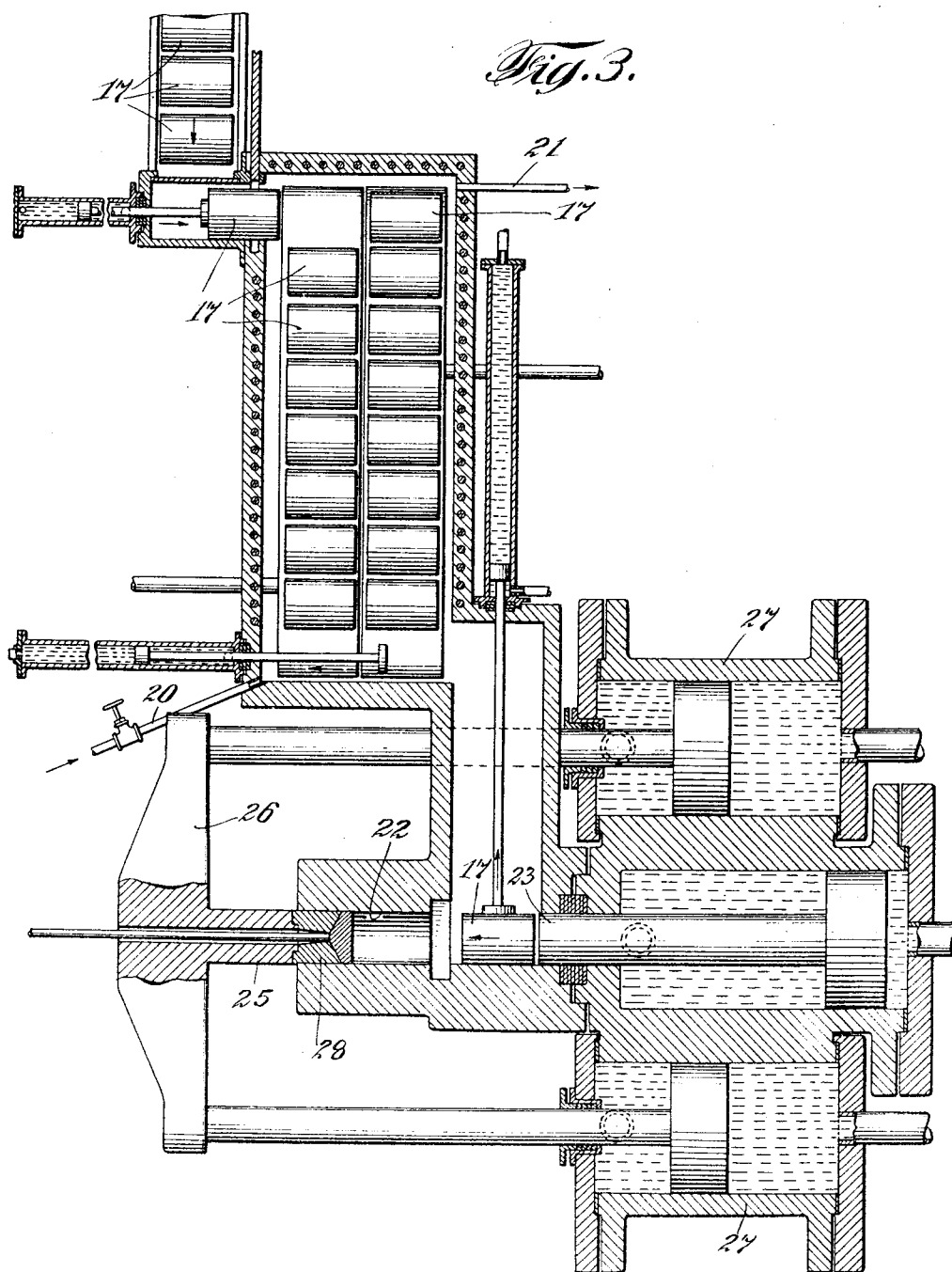
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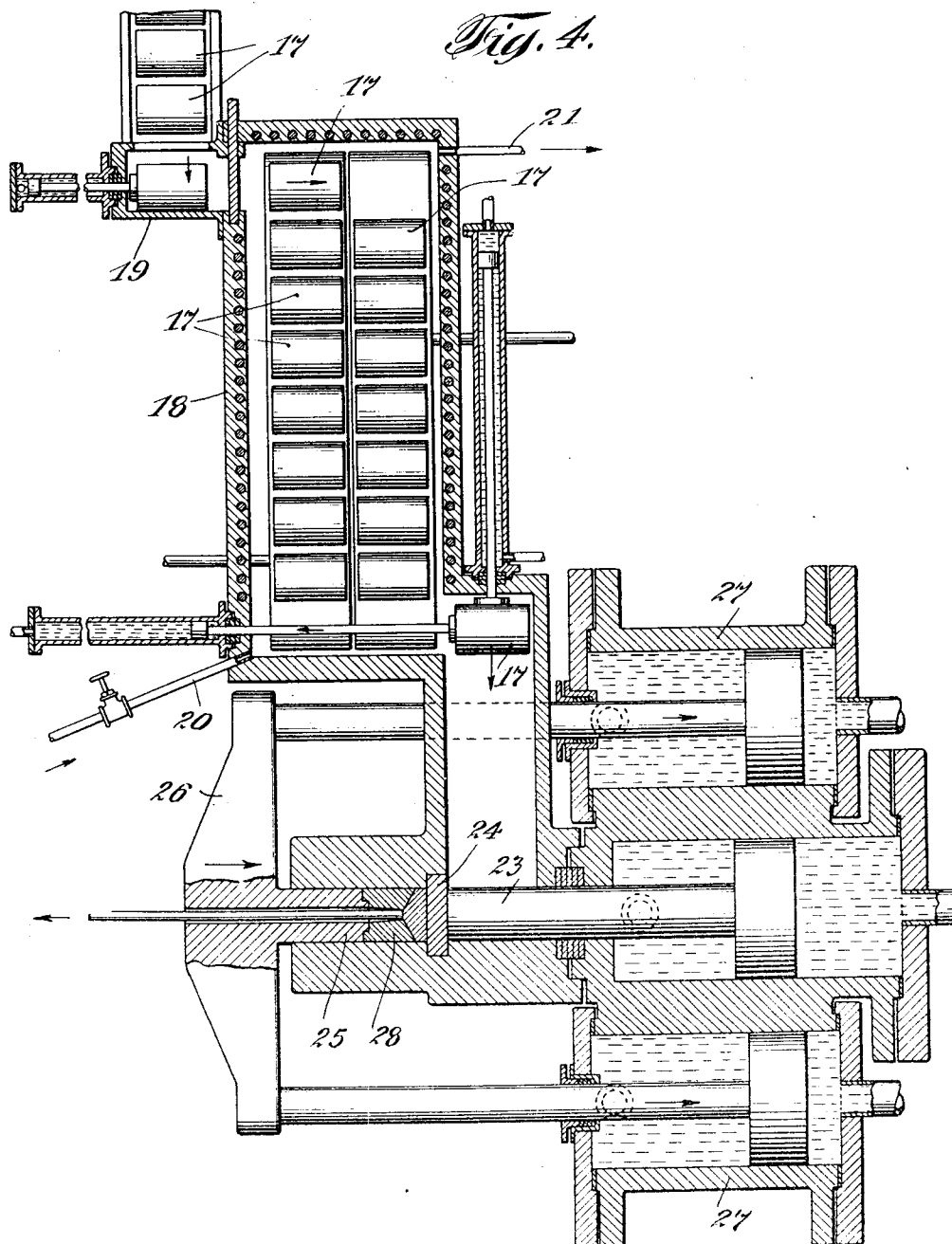
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4 Sheets-Sheet 3



INVENTOR
Harry H. Stout
BY
Frank Stout
ATTORNEY

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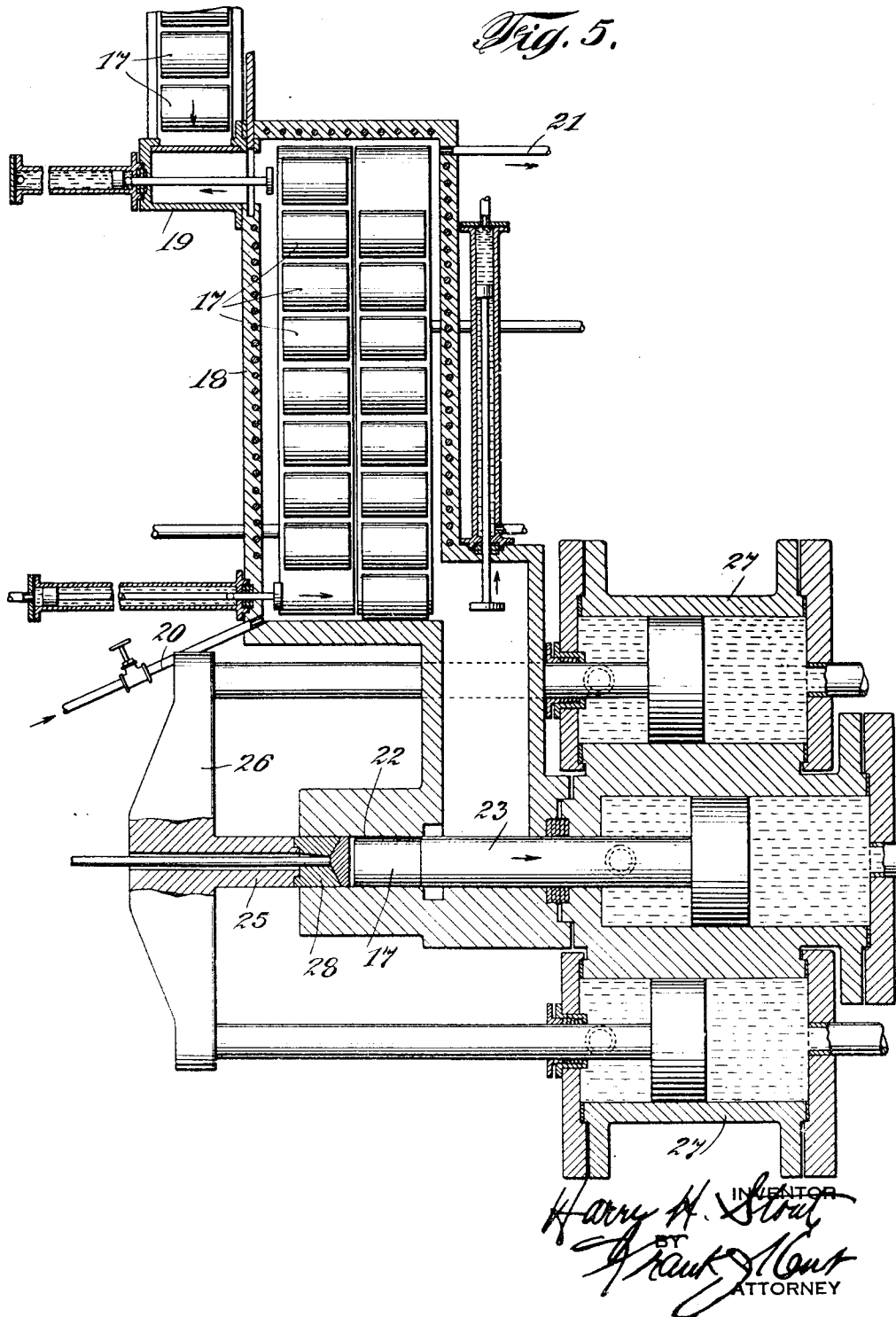
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PROCESS FOR TREATING METALS

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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

HARRY H. STOUT, OF CLIFTON, ARIZONA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
COALESCENCE PRODUCTS COMPANY, INC., A CORPORATION OF NEW YORK

PROCESS FOR TREATING METALS

Continuation in part of application Serial No. 111,887, filed May 28, 1926. This application filed August 15, 1928. Serial No. 299,665.

This invention relates to a method of treating metals for the purpose of producing a purified, homogeneous mass.

A particular object is the treatment of metallic particles with suitable fluids at temperatures below the melting point of the metal being treated to remove impurities that may be present between the crystals of the metal.

A further feature of the invention resides in subjecting the metal, purified as above or in any suitable manner, to mechanically applied pressure at suitable temperatures below the melting point of the metal in order to coalesce the particles into a homogeneous mass, and cause new crystal grain growth throughout the mass.

The invention further contemplates the utilization of mechanically applied pressure to simultaneously coalesce and extrude the metal in the form of a rod or bar.

In the drawings:

Fig. 1 is a cross-section through a bailing press, showing the parts in preliminary position.

Fig. 2 is a view similar to Fig. 1 but with the parts in a different position.

Fig. 3 is a horizontal section through apparatus for cleaning and coalescing the particles.

Fig. 4 is a view similar to Fig. 3 but with the parts in another operative position.

Fig. 5 is a view similar to Fig. 3 but with the parts in still another operative position.

This application is in part a continuation of copending application Ser. No. 111,887, filed May 26, 1926.

The invention is adapted for use with various metals, particularly copper and zinc, and will be disclosed in detail as applied to copper.

The process can be applied to any form of solid copper, such as broken cathodes, scrap copper, shotted copper, etc. These forms of copper ordinarily contain impurities located between the crystals of pure copper. In particular, cathode copper contains copper sulphate and other impurities from the electrolyte.

It has been found that under suitable con-

ditions it is possible to cause a cleaning fluid to permeate between the crystals to remove the impurities and clean the surfaces of the crystals.

If the metal is thereafter suitably handled to prevent the return of impurities, and is subjected to suitable elevated temperatures below the melting point of the copper and to mechanically applied pressure, the mass of particles can be coalesced into a homogeneous mass. The resulting piece of metal will be of very high purity and will have superior physical properties.

In treating certain kinds of copper, such as broken brittle cathode, it is more convenient to first bale the separate particles into a billet, and a press for this purpose is illustrated in Figs. 1 and 2. The broken cathode, indicated at 10, is fed into hopper 11 in a charge equal in weight to that desired for the resulting billet. The gate 12 is then drawn back and the charge dropped into the body 13 of the press. The head block 14 is then moved to the closed position of Fig. 2, and the plunger 15 is actuated to apply pressure to the charge. After the desired degree of compression has been obtained the plunger is backed away, head block 14 is withdrawn, extension sleeve 16 is raised, and plunger 15 again advanced to eject the formed billet 17 to the dotted line position of Fig. 2.

The billets are then transferred to the mechanism illustrated in Fig. 4 for treatment. Reference character 18 indicates a gas-tight electrical furnace in which the billets are treated to the action of a cleaning fluid at an elevated temperature below the melting point of copper. A gas lock 19 permits the feeding of billets into the furnace without the escape of fluid from the furnace. The cleaning fluid, which is preferably hydrogen or blue water gas, enters by inlet 20 and is withdrawn through outlet 21. Other suitable cleaning fluids may be used, such as nitrogen, steam, carbon dioxide, and hydrocarbon gases, and in each case the cleaning fluid must be free from any substance that would injuriously affect the finished copper.

The billets are moved through the furnace

by any preferred conveyor system (not shown) and are meanwhile heated to about 1500° F. During the passage through the furnace the cleaning fluid permeates the mass of the billet, removing impurities and cleaning the crystal surfaces.

The billet must now be maintained in a neutral or non-injurious atmosphere while it is being pressed into a solid mass. In the apparatus illustrated the billet is passed through a receiving chamber filled with the cleaning fluid to a preliminary position in front of the coalescing chamber 22. The feed plunger 23 now pushes the billet into the coalescing chamber, and the sliding head block 24 (Fig. 4) for the coalescing chamber is closed and supported in any suitable manner, as by the plunger 23. The coalescing plunger 25 is now moved toward the right by means of yoke 26 and hydraulic cylinders 27, pressing the apertured die block 28 against the billet. This movement of the plunger 25 compresses the billet and coalesces the particles thereof. At the same time the solidified copper is extruded through the apertured die block in a rod or wire of a shape corresponding to the aperture in the die block.

The stroke of the coalescing plunger is stopped before the entire billet has been extruded, and when it is approximately in the position of Fig. 4. The head block 24 is removed and feed plunger 23 is used to push back the unextruded stub to the left of the coalescing chamber, as shown in Fig. 5. A fresh billet is then fed into the coalescing chamber, and the process is repeated. In this way each new billet is coalesced with the stub of the last billet to form a continuous solid mass.

Summarizing the process, it may be said to consist of the following steps:

1. (Optional.) Pressing broken copper while cold into billets.
2. Treating with cleaning fluid at an elevated temperature below the melting point of the copper to remove impurities.
3. Maintaining the copper out of contact with injurious substances and subjecting it to mechanically applied pressure sufficient to bring into physical contact all faces of the copper particles, to drive out the gas from between the particles and to induce new crystal grain growth across the old particle faces.
4. (Optional.) Extruding the copper through a die.

By using this process it is possible to produce a copper of the purity of 99.995 per cent.

While a preferred apparatus for carrying out the process has been disclosed herein, it should be understood that various changes may be made in the layout and in the mechanical details.

I claim:

1. The process of refining a metal which

consists of treating the crystalline metal to remove impurities from crystal surfaces, the treatment being carried out at a raised temperature below the melting point of the metal, maintaining the metal thereafter and until the end of the process in a suitable gaseous atmosphere which will pass out of the metal without leaving blow holes or adversely affecting the physical properties of the metal, and then subjecting the metal to mechanically applied pressure sufficient to press the cleaned surfaces into close adhesive contact.

2. The process of refining a metal which consists of treating the crystalline metal to remove impurities from crystal surfaces, the treatment being carried out at a raised temperature below the melting point of the metal, maintaining the metal thereafter and until the end of the process in a suitable gaseous atmosphere which will pass out of the metal without leaving blow holes or adversely affecting the physical properties of the metal, and then subjecting the metal to mechanically applied pressure sufficient to press the cleaned surfaces into close adhesive contact, the pressing being effected at a suitable raised temperature below the melting point of the metal.

3. That process which comprises treating the surface of a plurality of separate metallic pieces to remove surface impurities, thereafter maintaining the pieces in a non-injurious atmosphere which prevents return of the surface impurities, and subjecting the particles, while maintained in said non-injurious atmosphere, to mechanically applied pressure sufficient to press surfaces of the pieces into intimate contact, while subjecting the pieces to a temperature sufficient to cause crystal grain growth across the old surface boundaries.

4. That process which comprises treating the surface of a plurality of separate metallic pieces to remove surface impurities, thereafter maintaining the pieces in a non-injurious atmosphere which prevents return of the surface impurities, and subjecting the particles, while maintained in said non-injurious atmosphere, to mechanically applied pressure to coalesce the particles and to extrude them as a solid mass.

5. The process of producing a solid mass practically pure copper which comprises removing impurities from copper particles, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, and subjecting the particles, while maintained in said non-injurious atmosphere, to pressure sufficient to integrate the same, while subjecting the particles to a temperature sufficient to cause crystal grain growth across the old surface boundaries.

6. The process of producing a solid mass of

practically pure copper which comprises removing impurities from copper particles by means of a reducing gas, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, and subjecting the particles, while maintained in said non-injurious atmosphere, to pressure sufficient to integrate the same, while subjecting the particles to a temperature sufficient to cause crystal grain growth across the old surface boundaries.

7. The process which comprises removing impurities from copper particles, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, heating the particles to a temperature sufficient to cause crystal grain growth and applying pressure sufficient to coalesce the particles into a solid mass and to simultaneously extrude the mass.

8. The process which comprises removing impurities from copper particles by means of a reducing gas, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, heating the particles to a temperature sufficient to cause crystal grain growth and applying pressure sufficient to coalesce the particles into a solid mass and to simultaneously extrude the mass.

9. The process which comprises removing impurities from copper particles, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, subjecting a charge of the particles to simultaneous heat and pressure sufficient to cause crystal grain growth and coalesce the particles into a solid mass and to simultaneously extrude the mass, and similarly coalescing and extruding a second charge against the end of the first charge to produce a continuous homogeneous piece.

10. The process which comprises removing impurities from copper particles, thereafter maintaining the particles in a non-injurious atmosphere which prevents return of the impurities, a charge of the particles being maintained in an extrusion chamber at an elevated temperature below the melting point of the copper while sufficient pressure is applied to cause crystal grain growth and coalesce the particles into a solid mass and to simultaneously extrude the mass, stopping the extrusion at a suitable point to leave a stub of the first charge in the extrusion chamber, inserting a second charge of the particles into the extrusion chamber, bringing about suitable conditions of heat and pressure to cause the second charge to coalesce with itself and with the first charge while continuing the extrusion to cause both charges to issue as a continuous, homogeneous mass of copper.

11. The method of producing a solid metallic mass from an aggregate of smaller metallic particles which comprises, first cleansing the surface of the particles by treatment with

suitable fluid at a suitable raised temperature below the melt point of the particles, and thereafter, and until the process is complete, maintaining the cleansed particles in a medium which will not permit the return to the surface of the particles of sufficient impurities to prevent coalescence in the next step of the process, and submitting the aggregate of cleaned particles to pressure, at a raised temperature below the melt point of the particles, sufficient to coalesce the particles into a solid mass by causing crystal grain growth to take place across all adjacent particle boundaries.

12. The method of producing a solid metallic mass from an aggregate of smaller metallic particles, which comprises, first cleansing the surface of the particles by treatment with suitable fluid at a suitable raised temperature below the melt point of the particles, and thereafter, and until the process is complete, maintaining the cleansed particles in a medium which will not permit the return to the surface of the particles of sufficient impurities to prevent coalescence in the next step of the process, and submitting the aggregate of cleaned particles to pressure, at a raised temperature below the melt point of the particles, sufficient to coalesce the particles into a solid mass by causing crystal grain growth to take place across all adjacent particle boundaries and to extrude the mass, and similarly coalescing and extruding a second charge against the end of the first charge, thereby causing crystal grain growth across the original boundary between the first and second charges and producing a single, homogeneous piece.

13. The method of producing a solid mass of copper which comprises heating an aggregate of copper particles to an elevated temperature below the melting point of copper, treating the aggregate with fluid suitable to permeate the aggregate and to remove impurities from the surfaces of individual particles, and thereafter and until the end of the process maintaining the aggregate in a medium that will not permit the return to the surfaces of the particles of impurities sufficient in amount to prevent complete subsequent grain growth between all adjacent particle surfaces, and subjecting the aggregate at an elevated temperature below the melting point of copper to pressure sufficient to coalesce all of the particles by causing crystal grain growth across all the old boundaries between particles and to extrude the mass and similarly coalescing and extruding a second charge against the end of the first charge, thereby causing crystal grain growth across the original boundary between the first and second charges and producing a single, homogeneous piece.

14. The method of producing a solid mass of copper which comprises compressing

- broken brittle cathode copper into a billet, heating the billet to an elevated temperature below the melting point of copper, treating the billet with a fluid that is reducing to oxides of copper and that is suitable for removing impurities from the surfaces of individual particles within the billet, and thereafter until the process is complete, maintaining the billet in a medium that is non-injurious to the copper, and subjecting the billet, at a temperature of approximately 1500° F. to pressure sufficient to press all of the particles of the billet into close contact, thereby causing crystal grain growth to take place across all the adjacent particle boundaries and producing a homogeneous mass of copper.
15. The method of producing a solid mass of copper which comprises compressing broken brittle cathode copper into a billet, heating the billet to an elevated temperature below the melting point of copper, treating the billet with a fluid that is reducing to oxides of copper and that is suitable for removing impurities from the surfaces of individual particles within the billet, and thereafter and until the process is complete, maintaining the billet in a medium that is non-injurious to the copper, subjecting the billet, at a temperature of approximately 1500° F. to pressure sufficient to press all of the particles of the billet into close contact, thereby causing crystal grain growth to take place across all the adjacent particle boundaries and producing a homogeneous mass of copper, extruding the mass, coalescing a second charge against the end of the first charge and extruding the second charge to form the two charges into a single, homogeneous piece.
16. The process of extruding a metal body which comprises providing an extrusion chamber having an extrusion opening smaller than the bore of the chamber, maintaining within the chamber an atmosphere non-injurious to the metal and which will prevent the return of surface impurities to a charge of metal within the chamber, passing a charge of cleansed metal into the chamber, subjecting the charge to heat and pressure sufficient to extrude part of the charge, releasing the pressure while a stub of the charge remains in the bore of the chamber, passing a second charge into the chamber, subjecting the second charge to heat and pressure sufficient to coalesce the second charge with the stub of the first charge and to extrude the second charge, thereby causing crystal grain growth across the original boundary between the first and second charges and extruding both charges, and similarly joining and extruding successive charges to produce a continuous metal body.
17. The process of extruding copper which comprises providing an extrusion chamber having an extrusion opening smaller than the bore of the chamber, maintaining within the chamber an atmosphere non-injurious to copper and which will prevent the return of surface impurities to copper within the chamber, passing a charge of cleansed copper into the chamber, subjecting the charge to heat and pressure sufficient to extrude part of the charge, releasing the pressure while a stub of the charge remains in the bore of the chamber, passing a second charge into the chamber, subjecting the second charge to heat and pressure sufficient to coalesce the second charge with the stub of the first charge and to extrude the second charge, thereby causing crystal grain growth across the original boundary between the first and second charges and extruding both charges, and similarly joining and extruding successive charges to produce a continuous mass of copper.
- In testimony whereof I affix my signature.
HARRY H. STOUT.