

P. BOHIN.
MANUFACTURE OF METAL CASTINGS.
APPLICATION FILED MAR. 9, 1907.

930,828.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

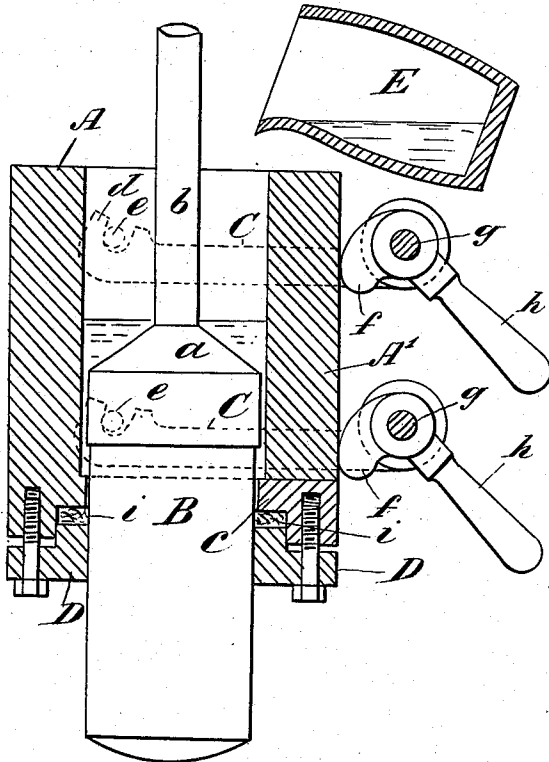


Fig. 2.

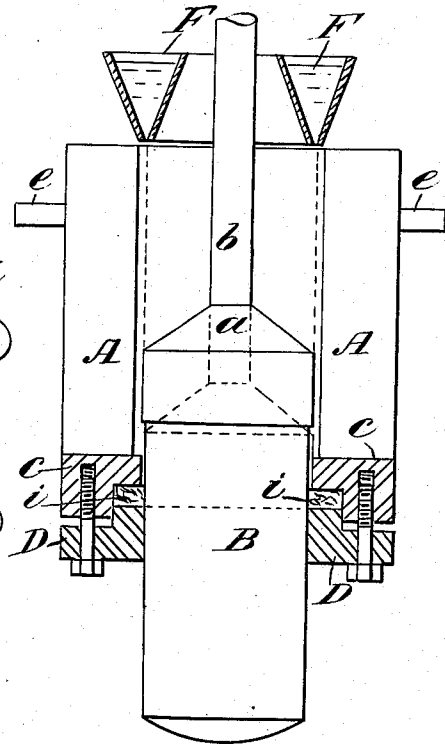


Fig. 3.

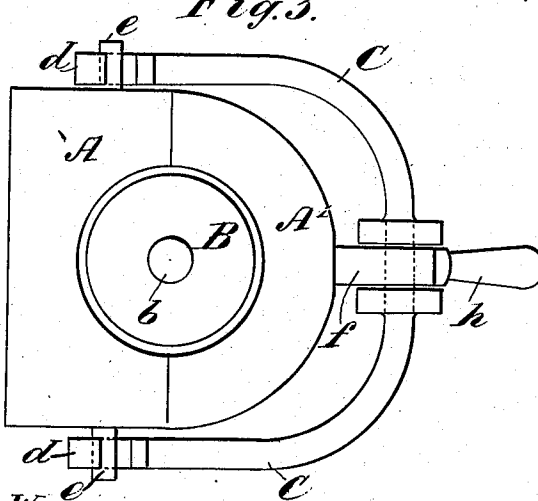
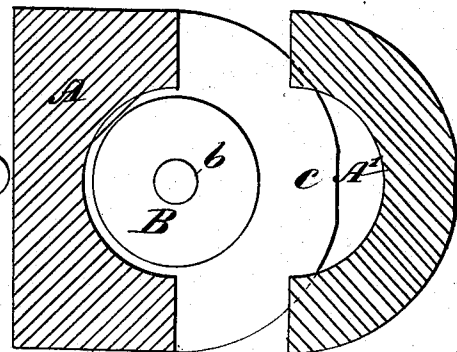


Fig. 4.



Witnesses
E. H. Hiram
William J. Firth

Inventor
Paul Bohin
by J. B. Beringer
Attorney

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2 SHEETS—SHEET 2.

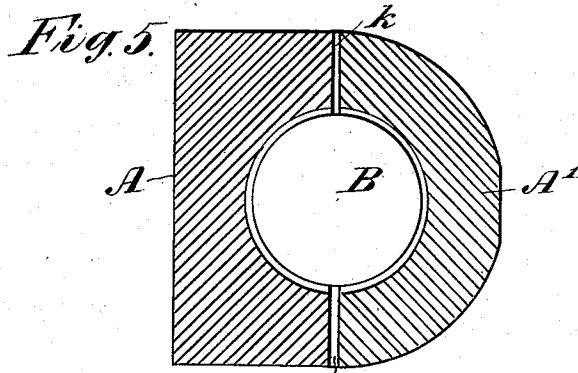


Fig. 6. *Fig. 7.*

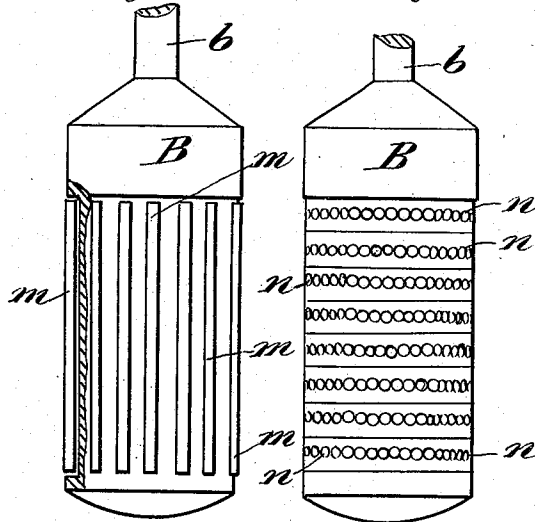
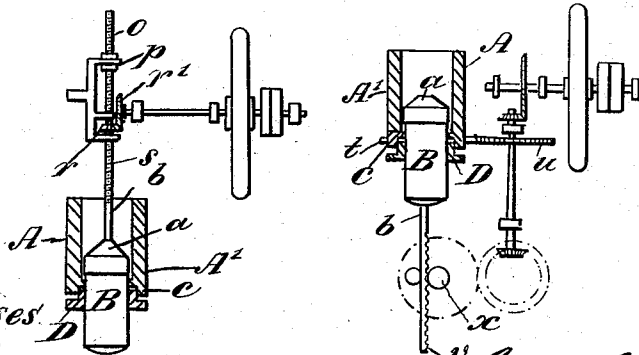


Fig. 8. *Fig. 9.*



Witnesses
F. H. Wiman
William J. Firth

Inventor.
Paul Bohin
by J. H. Spence
Attorney.

UNITED STATES PATENT OFFICE.

PAUL BOHIN, OF PARIS, FRANCE.

MANUFACTURE OF METAL CASTINGS.

No. 930,828.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, PAUL BOHIN, a citizen of the French Republic, and a resident of Paris, France, have invented certain improvements in the Manufacture of Metal Castings, of which the following is a specification.

This invention relates to the casting of metals and alloys in the form of very thin cylinders and sheets with the object of dispensing with the successive rollings to which it is necessary to subject the metal by the processes at present in use; these rollings necessitate a considerable expenditure of motive power and it is necessary to re-heat the metal between the different rolling operations which causes a large amount of work and greatly increases the cost of labor.

The process forming the subject of this invention allows of at once producing very thin sheets or tubes of the metals thus avoiding the expense of rolling and the many various manipulations, moreover the metal obtained is of a superior quality to that which results from successive rolling of thick castings because there is an absolutely complete homogeneity throughout the very slight thickness of metal, the crystallization being quite uniform, while with existing processes there is a considerable difference of crystallization between the outer surfaces of the metal and the center of the cast mass, the imperfections in this crystallization of the mass not being completely avoided by the ultimate rolling which does not succeed in uniting the different crystals together. On the contrary, with the new process the cast metal becomes compressed at the actual moment when it becomes cool under the slight thickness which is given to it and it is subjected to a kind of tempering which compels the molecules of the metal to be compressed together and form very fine grain thereby giving to the metal a quality hitherto unknown.

In order to carry out this manufacture of thin metal or alloy without rolling, the applicant combines a cylindrical vertical chamber, or mold designed to receive the molten metal, with a core or piston arranged in the said chamber and only leaving a very small space between the core and the interior of the mold. One of the parts is movable with relation to the other; at the same time there is a longitudinal displacement, for example of the core in the mold, there is also a rotary

displacement of the said core in the mold so that the molten metal which covers the core is induced, when the core rises, to come and fill the narrow annular space between the core and the mold. This metal thus progressively fills the annular space at the same time that it is subjected to the action of a double mechanical working due to the longitudinal displacement combined with the rotation. Or the core may be fixed and the mold arranged to move, or the two parts may be movable, one of them being longitudinally displaced and the other having a rotary movement imparted to it.

The accompanying drawing represents by way of example a machine for carrying out this manufacture of thin metal tubes or sheets.

Figure 1 is a vertical section. Fig. 2 is a vertical section in a plane perpendicular to that of Fig. 1. Fig. 3 is a plan of Fig. 1. Fig. 4 is a plan, the two parts constituting the mold being separated from each other. Fig. 5 is a sectional view taken transversely through a modified form of the apparatus suitable for the manufacture of thin metal sheets or plates. Figs. 6 and 7 represent in elevation two arrangements of the piston, the surface of which is composed of movable elements. Figs. 8 and 9 show, by way of example and on a small scale, two methods of operating the machine.

The apparatus consists of two parts, a mold A and a core 8; these two parts may be of any suitable metals, or they may be wholly or partly made of refractory material. Particularly for the manufacture of tubes of metal having a rather high melting point such as steel, the core can advantageously be made of refractory material such as graphite, refractory stone or earth, agglomerated refractory material, or carborundum. The mold is advantageously made of metal with an inner lining of refractory composition, a mold thus made offering the proper resistance for the work. Similarly the core or piston may have its conical head *a* made of refractory material because it is this which is more directly subjected to the action of the heat of the molten metal; its peripheral surface can also be formed with a thickness of refractory material.

The rod *b* which actuates the piston or core B may operate above, as in Fig. 1, or below the mold; whether the rod thus acts by traction or by pressure the effect pro-

duced will be the same; as has been already explained this rod receives at once a rectilinear movement of displacement and a movement of rotation so that the core B starting from its lowermost position, which is indicated by the dotted lines in Fig. 2, progressively rises in the cylinder or mold while at the same time it turns in the mold, the molten metal which is above being, so to speak, thinly rolled between the piston or core B and the cylinder or mold A as fast as it flows into the annular space between the mold and the core.

The mold is itself formed in two parts, namely a fixed part A which forms one half of the mold and the other A¹ which forms the other half; the part A has at its lower end a squared base *c* which is semi-circular and upon which rests the shell A¹ constituting the other half of the mold. The two parts A and A¹ constituting the mold are moved toward each other through the medium of stirrups C which are provided at the ends of the two branches with hooks *d* which embrace trunnions *e* formed on the fixed part A. In the middle of each stirrup C is a cam *f* mounted upon a pivot *g* and which is operated by means of a lever *h* in order to bring the two parts A, A¹ of the mold exactly one against the other.

The lower part of the mold receives a plate D which is fixed by bolts or otherwise against the part A and the squared part *c* which is fixed thereto; a hermetic lining *i* of suitable material, such for example as asbestos, insures the tightness of the joint, this elastic lining being applied against the outer surface of the piston or core B.

The molten metal is introduced in the mold A, A¹ through the top when the core or piston B is in the position shown in Fig. 2. The molten metal can thus be poured in by means of a ladle or crucible E as shown in Fig. 1. Or as shown in Fig. 2 a circular hopper F may with advantage be employed, the lower part of which is reduced in size and provided with small vertical holes which are very near the walls of the mold; in this manner the molten metal descends almost against the wall of the mold above the annular space between the mold and the core; and the section of the small delivery holes may be such that the molten metal thus descends in the apparatus in proportion as the core rises while turning in the mold. In this manner the metal is, so to speak, seized between the mold and the core and it becomes solid almost as fast as it arrives between the core and the mold of the apparatus. Moreover, the said perforated hopper which thoroughly distributes the metal retains any slag which may arise in the melting of the metal.

When the casting is completed it is only necessary to raise the levers *h* so that the

cams *f* shall cease to press against the part A¹ of the mold when the latter can be withdrawn, the core being then disengaged from the cylindrical tube which has just been produced. This tube becomes free and it can be withdrawn from the part A of the mold.

At the commencement of the operation the piston or core is lowered into the mold so that only the conical head is partially above the bottom of the mold; it is however preferable that the upper ring of the cylindrical part should be rather above the bottom of the mold. The major part of the core starting from the bottom is of a diameter slightly less than the upper diameter up to the height of the asbestos joint *i* when the core or piston is thus at the lower end of its stroke. This slight reduction of diameter is necessitated by the fact that when cooling the metal cylinder shrinks and the consequence of this would be to cause an energetic tightening of the metal cylinder obtained upon the core if this reduction did not exist. Moreover the length of the said reduced part and the extent of the reduction vary according to the thickness of the metal required to be obtained and also according to the metals and alloys which it is required to treat.

To manufacture thin sheets instead of tubes the part A¹ of the mold (as shown in the horizontal section at Fig. 5) has diametral strips *k* which divide the metal cylinder into two or more parts. The operation being effected as hereinbefore explained, two half cylinders are obtained which are separated from one another by the edges of the strips *k*, which fill the space comprised between the inner surface of the mold and the outer surface of the core. Or only one strip *k* may be employed when a sheet will be produced the width of which will be equal to the circumference of the cylinder. After taking the sheet out of the mold it only remains to straighten the half cylinders, or fractions of cylinder, or the cylinder thus obtained with heat or cold according to the nature of the metal.

By this process metal sheets can be produced having any required design and also detached pieces can be produced; these designs being formed in the mold will be reproduced as cleanly as with the ordinary molds.

The core or piston B instead of being cylindrical as shown in Figs. 1 and 2 may be provided on its periphery with steel cylinders or rods *m* (see Fig. 6) inserted in suitable recesses in the surface of the cylinder without it being possible for them to become disengaged therefrom; through the rotary movement imparted to the piston to the mold while it is rising these small vertical cylinders exert upon the metal being

formed into a tube while it is solidifying, a rolling the effect of which is to bring the molecules of the metal intimately together and to consequently give it exceptional qualities of hardness and homogeneity.

Instead of thus distributing a ring of vertical rods over the surface of the cylinder one or more superposed rings of balls may, as shown in Fig. 7, be arranged on the surface of the core B, the said balls being freely located in recesses in the core; these balls of steel or other hard material will in rolling within the tube cause a kind of rolling by compression as fast as the metal sheet is produced thus improving the quality of the metal.

For the manufacture of tubes or plates with certain metals or alloys it may be advantageous to cool the mold or the core or both. It will only be necessary to arrange around the mold or in the thickness of the latter a circulation of water or other cooling fluid. The core would be hollow or at least would also contain a circulation for the cooling fluid.

With molds of large dimensions cylinders of large diameter can be produced, 750 millimeters in diameter for example, with a thickness of 2 to 5 millimeters and with a length or height of 1.50 m. or even more. The cylinders thus produced may be cut with circular cutters and be afterward drawn so as to obtain long lengths of wire with all possible alloys. Laminated strips of very great length can be also drawn from these cut cylinders.

As already explained the core B may be actuated by its rod either from the top or bottom. Fig. 8 shows diagrammatically an arrangement in which the rod *b* of the core is terminated at its upper end by a screw threaded portion *o* which passes through a nut *p* so that if the rod turns it will rise in its nut. The rotation of the rod is produced by means of a bevel gear *r*, *r*¹, a snug in the interior of the boss *r* being engaged in a long groove *s* which allows the longitudinal displacement of the rod *b* during its rotation. The shaft of the pinion *r*¹ can directly receive motion from a motor and it is advantageous that the said shaft should carry a strong fly-wheel for insuring a uniform and regular motion of the apparatus during the whole travel of the core in its mold.

The core may be fixed and the mold would then be movable and would turn as it descends. Or the two principal parts of the apparatus, that is to say, the mold and the core, can be arranged to be put in movement. An arrangement of this kind is shown diagrammatically in Fig. 9; the mold A is provided at its lower part with a toothed ring *t* with which gears a pinion *u* the shaft of which is set in movement through the medium of bevel gear driven by a motor.

While the mold is turning the core or piston rises within the mold; its rod *b* is toothed in the form of a rack at *v* so as to engage with a pinion *x* the shaft of which is operated by gearing connected to the mechanism which causes the mold to turn.

It should also be mentioned that the mold and the core, for certain uses and for the treatment of certain metals and alloys, may both have a certain rotary movement, the two movements taking place in opposite directions or even in the same direction but with different tangential speeds.

Claims.

1. An apparatus of the character described comprising two members capable of relative turning movement, one of said members being a hollow mold and the other member a core adapted to be housed within the mold, one of said members being capable of endwise movement relatively to the other member, and rotative parts carried by one of said members and adapted for rolling contact upon the metal introduced between said members.

2. An apparatus of the character described comprising two members one of which is a hollow sectional mold and the other of which is a core adapted to be housed within said mold, one of said members being provided with a jacket adapted for the circulation of a cooling fluid.

3. An apparatus of the character described comprising two members, one of which is a hollow mold and the other of which is a core insertible in the mold, said members being spaced apart when the core is housed in the mold by a chamber adapted to receive metal, means for moving one member endwise relatively to the other, whereby the core is caused to traverse the mold in the direction of its length, and means for rotating one member relatively to the other, said last-named means being capable of operation simultaneously with the operation of the first-named means throughout a sufficient extent of said relative endwise movement to permit the metal between the members to be rolled progressively from end to end of the mold.

4. An apparatus of the character described comprising two members, one of which is adapted for endwise movement relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within the hollow mold and provided with a laterally projecting portion adapted to traverse the mold when one member is moved relatively to the other.

5. An apparatus of the character described comprising two members, one member being a hollow mold and the other member being a core adapted to be housed in said mold, means for rotating one member rela-

tively to the other one of said members being capable of endwise movement relatively to the other member during the rotation of one member relatively to the other, and said core being provided with a laterally projecting portion adapted, when one member is moved endwise relatively to the other during such relative rotative movement, to traverse the hollow mold in the direction of its length.

6. An apparatus of the character described comprising two members, one of which is adapted for endwise movement relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within the hollow mold and provided with a laterally projecting portion formed from material more refractory than the substance of the core and adapted to traverse the mold in the direction of its length when one member is moved relatively to the other.

7. An apparatus of the character described comprising two members capable of relative turning movement, one member being a hollow mold and the other member being a core adapted to be housed in said mold, one of said members being capable of endwise movement relatively to the other member, and said core being provided with a laterally projecting portion formed from material more refractory than the substance of the core and adapted to traverse the mold in the direction of its length when one member is moved relatively to the other.

8. An apparatus of the character described comprising two members capable of relative turning movement, one of said members being capable of endwise movement during the turning movement of one member relatively to the other, one of said members being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a laterally projecting portion adapted to traverse the mold in the direction of its length when one member is moved endwise relatively to the other.

9. An apparatus of the character described comprising two members capable of relative turning movement, one of said members being capable of endwise movement during the turning movement of one member relatively to the other, one of said members being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a laterally projecting portion formed from material more refractory than the substance of the core and adapted, when one member is moved endwise relatively to the other, to traverse the hollow mold in the direction of its length.

10. An apparatus of the character described comprising two members, one of which is capable of endwise movement relatively to the other, one member being a hollow mold and the other member being a core

adapted to be housed within said mold and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length.

11. An apparatus of the character described comprising two members capable of relative turning movement, one member being capable of endwise movement relatively to the other, and one member being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length.

12. An apparatus of the character described comprising two members, one of which is capable of endwise movement relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length, said lateral projection being formed from material more refractory than the substance of the core.

13. An apparatus of the character described comprising two members capable of relative turning movement, one member being a hollow mold and the other member being a core adapted to be housed within said mold, one of said members being capable of endwise movement during the turning of one member relatively to the other, and said core being of cylindrical form in cross section and being adapted to exert a rolling influence upon the casting when one member is turned relatively to the other.

14. An apparatus of the character described comprising two members capable of relative turning movement, one member being capable of endwise movement relatively to the other during the turning of one member relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within said mold and being provided with a projection which is extended in annular form around the sides of the core and is directed toward the walls of the mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length to exert a rolling influence upon the casting when one member is turned relatively to the other.

15. An apparatus of the character de-

scribed comprising two members capable of relative turning movement, one member being capable of endwise movement relatively to the other during the turning of one member relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within said mold and having its sides fitted accurately for sliding movement upon the walls of the mold at its lower part, and having, at its upper part, a portion of increased diameter which forms a projection extended laterally beyond the sides of the core but out of contact with the walls of the mold, said laterally projecting portion being adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length.

16. An apparatus of the character described comprising two members capable of relative turning movement, one of said members being a hollow mold and the other member a core adapted to be housed within said mold, and rotative parts carried by one of the members and projecting beyond the surface thereof for rolling contact upon the metal introduced between said members.

17. An apparatus of the character described comprising two members capable of relative turning movement, one of said members being capable of endwise movement relatively to the other during the turning of one member relatively to the other; one member being a hollow mold and the other member being a core adapted to be housed within said mold, and a part mounted to turn upon the core and projecting therefrom toward the walls of the mold and adapted, when one member is moved endwise relatively to the other, to traverse the mold in the direction of the length thereof for rolling contact upon the metal introduced between the members.

18. An apparatus of the character described comprising two members, one of which is capable of endwise movement relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the

mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length, and rotative parts mounted to turn upon the core and projecting therefrom toward the walls of the mold and also adapted, when one member is moved endwise relatively to the other, to traverse the mold in the direction of the length thereof.

19. An apparatus of the character described comprising two members capable of relative turning movement, one member being capable of endwise movement relatively to the other, one member being a hollow mold and the other member being a core adapted to be housed within said mold and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the mold and is adapted, during the endwise movement of one member relatively to the other, to traverse the mold in the direction of its length, and rotative parts mounted to turn upon the core and projecting therefrom toward the walls of the mold and also adapted, when one member is moved endwise relatively to the other, to traverse the mold in the direction of the length thereof.

20. An apparatus of the character described comprising two members capable of relative turning movement, one member being a hollow mold and the other member being a core adapted to be housed within said mold, and provided with a lateral projection which is extended around the sides of the core and is directed toward the walls of the mold, and a part mounted to turn upon the core adjacent to said lateral projection and directed toward the walls of the mold and adapted, when one member is turned relatively to the other, for rolling contact upon the metal introduced between the members.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

PAUL BOHIN.

Witnesses:

ARMENGAUD, Jeune,
HERNANDO DE SOTO.