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54 **Vertical type pressure casting method.**

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73 Proprietor: **TOYOTA JIDOSHA KABUSHIKI
KAISHA**
**1, Toyota-cho Toyota-shi
Aichi-ken 471 (JP)**

72 Inventor: **Masaoka, Toshika**
**6-14, Miyukihonmachi Toyota-shi
Aichi-ken (JP)**
Inventor: **Ota, Atsushi**
**530, Toyota-cho Toyota-shi
Aichi-ken (JP)**
Inventor: **Tokui, Masaaki**
**4-43-14, Ogawa-cho Toyota-shi
Aichi-ken (JP)**

74 Representative: **Grams, Klaus Dieter, Dipl.-Ing.
et al**
**Patentanwaltsbüro Tiedtke-Bühling-Kinne-
Gruppe-Pellmann-Grams-Struif Bavariaring 4
D-8000 München 2 (DE)**

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Description

The present invention relates to a vertical type pressure casting method according to the pre-characterizing portion of claim 1. Such a casting method is disclosed in EP—A—0085726, published 17.8.83.

As is generally known, there are various kinds of cast products. Among these, cast products of a light alloy such as aluminum alloy have generally been manufactured by gravity casting, low-pressure casting and pressure die casting.

However, because of the following problems, these casting methods do not yield high quality cast products and the productivity cannot be improved.

In gravity casting and low-pressure casting, the melt is not forcibly pressurized, so that so-called shrinkage holes occur in it in the solidifying step. Consequently, sound products cannot be obtained. Moreover, the solidifying rate in these casting methods is low, decreasing the productivity.

In pressure die casting, the sleeve-charging percentage is 50—70, and, moreover, the melt is introduced into cavities under pressure at a high rate. Accordingly, the gas in certain portions of the passage for the melt, such as gates, and in the cavities is liable to mix with the melt, decreasing the reliability of the quality of the products.

With a view to eliminating the above-mentioned inconveniences, a vertical type die casting method has been developed, which has a sleeve-charging percentage of 100, and in which the melt is pressurized without mixing with gas in the gates and cavities. However, this casting method also has some problems which have not yet been completely solved with respect to soft materials for obtaining high-quality products, namely the casting conditions in relation to the casting mechanism. Thus, the advantages of this casting method cannot be utilized effectively.

It is an object of the present invention to provide a vertical type pressure casting method, which is able to supersede the above-mentioned methods of gravity casting, low-pressure casting and pressure die casting for all materials, especially for soft materials.

This problem is solved by the features of the characterizing portion of Claim 1.

Further modifications of the method according to the invention arrive from the subclaims.

Brief description of the drawings

The accompanying drawings show an embodiment of the present invention, wherein:

Figure 1 is a schematic diagram of a vertical type pressure casting apparatus;

Figures 2, 3 and 4 illustrate the process for pouring the melt through gates into cavities;

Figure 5 is a diagram illustrating the relation between the speed of downward movement of the plunger tip and the length of a period of time from the commencement of downward move-

ment of the plunger unit and the opening of the gates by a counter-tip; and

Figure 6 is a graph showing percentages of inferior products in the embodiment and a conventional method.

Detailed description of the preferred embodiment

An embodiment of the present invention will now be described with reference to the accompanying drawings.

Figure 1 shows a vertical type pressure casting apparatus used in the method according to the present invention. A lower mold 1 and an upper mold 2 are clamped together to form cavities 3. Gates 4 for the cavities 3 face the interior of a sleeve 5. A counter-tip 7 connected to a hydraulic cylinder 6, and a plunger tip 9 connected to a hydraulic cylinder 8 are provided opposing each other in lower and upper positions, respectively, in the sleeve 5 such that the counter-tip 7 and plunger tip 9 can be moved up and down therein. A solenoid in a changer-over valve 10 connected to hydraulic cylinder 6 is controlled by a limit switch 12 with respect to a dog 11 provided on the rod of plunger tip 9.

The melt 15 is poured from a melt inlet port 13 into the sleeve 5 by a ladle 14.

The above apparatus is designed so that the ratio of the volume (cm^3) of the product to the cross-sectional area (cm^2) of the gates 4, which is one of the construction parameters of the apparatus, is 20—40.

The operational conditions and a program device for the present invention to be practiced by using the apparatus of this construction are set to attain the following: The plunger tip 9 is moved downward to lower the counter-tip 7 through the dog 11 and limit switch 12. The relation between the speed V [m/sec] at which the plunger tip 9 moves downward and the length of time T [sec] from the commencement of the downward movement of the plunger tip 9 to the opening of the gates 4 by the counter-tip 7, is set to an optimal value with reference to the information shown in Figure 5. Namely, the speed, at which the plunger tip 9 moves down is set to a level between the upper limit level in an upper limit speed curve R_1 , above which the plunger tip 9 moves down too fast and reaches the upper surface of the melt 15 in the sleeve 5 to start the pressure-filling operation before the gates 4 have been opened by the counter-tip 7, and a lower limit level in a lower limit speed curve R_2 , above which the plunger tip 9 reaches the upper surface of the melt 15 in the sleeve 5 after the gates 4 have been fully opened by the counter-tip 7 allowing the melt 15 to flow into the cavities 3 by the force of gravity until the flow of melt 15 has stopped, whereby the melt 15 can be fed to the cavities 3 calmly and continuously at a low rate.

According to the experimental results, the percentage distribution of acceptable cast products with respect to the whole number of cast products obtained under different conditions is as shown in the data in Figure 5.

- A: not less than 90%
- B: 50—90%
- C: 20—50%
- D: not more than 20%

This relation between the speed of the plunger tip 9 and the length of a period of time between the commencement of the downward movement of the plunger tip 9 and the opening of the gates 4 can also be set differently by varying not only the cross-sectional area of the gates 4 but also the temperatures of the molds 1, 2 and melt 15.

After the cross-sectional area of the gates 4 and the temperatures of the molds 1, 2 and melt 15 have been determined, the percentage of the melt 15 to be fed into the cavities 3 by the force of gravity before the plunger tip 9 reaches the upper surface of the melt 15 in the sleeve 5 is set to 20—70, and the speed of the melt 15 through the gates 4 during the feeding of the melt 15 to the cavities 3 by the force of gravity is set to not less than 0.1 m/sec with the speed of the melt 15 through the gates 4 when pressure-filling the cavities 3 using the plunger tip 9 set to 0.4—0.8 m/sec.

The molds 1, 2 are clamped as shown in Figure 1 with the casting apparatus set in accordance with the above-mentioned casting conditions and the program device, and the hydraulic cylinder 6 is actuated to close the gates 4 with the counter-tip 7. The hydraulic cylinder 8 is then actuated to set the plunger tip 9 to an initial attitude position.

A predetermined amount of melt 15 is then poured from the melt inlet port 13 into the sleeve 5, and a button for a control unit (not shown) is pressed to actuate the hydraulic cylinder 8 to start the casting operation.

First, when the plunger tip 9 starts being moved downward at a predetermined speed with the dog 11 coming into contact with the limit switch 12, the counter-tip 7 is moved downward at a predetermined time by operation of the change-over valve 10 before the plunger tip 9 has reached the upper surface of the melt 15 in the sleeve 5 as shown in Figure 2, in accordance with the relation between the set speed and time shown in Figure 5, to open the gates 4. The melt 15 then starts flowing from the gates 4 into the cavities 3 by the force of gravity.

After a predetermined period of time has passed, the plunger tip 9 reaches the upper surface of the melt 15 (which is, of course, flowing into the cavities 3 by the force of gravity) in the sleeve 5. At this time, the percentage of the melt 15 placed in the cavities 3 is 20—70 as mentioned above.

The melt-feeding by the force of gravity is then changed to pressure-filling as shown in Figure 4. The speed of the melt 15 through the gates 4 during pressure-filling by the plunger tip 9 is set to 0.4—0.8 m/sec as mentioned above.

Thus, in the casting operation as a whole according to the present invention, the melt 15 in the sleeve 5 is fed into the cavities 3 by its own weight, i.e. by the force of gravity, in the initial

stage, and under pressure by the plunger tip 9 before the gravity-feeding operation has finished. Since this casting operation is conducted in accordance with the above-mentioned numerically limited conditions, the melt 15 fills the cavities 3 relative calmly and continuously at a low rate without permitting gas to enter the melt 15.

When the ratio of the volume (cm³) of products at the gates 4 to the cross-sectional area (cm²) of the gates 4 is less than 20, the melt 15 flows into the cavities 3 by its own weight too quickly, or the gravity-feeding time becomes short, so that the optimum range is narrow. When this ratio exceeds 40, the injection of the melt 15 into the cavities 3 by the force of gravity progresses too slowly, and the percentage of melt 15 put in the cavities 3 by the force of gravity becomes low, so that the melt 15 which has passed through the gates 4 is disordered, causing gas to mix the melt 15 and cold shut to occur.

When a point representing the relation between the speed of plunger tip 9 and the length of the period of time between the commencement of a downward movement of the plunger tip 9 and the opening of the gates 4 by the counter-tip 7 is above the maximum speed curve R₁, shown in Figure 5, the pressure-filling operation starts too early as mentioned before. When this point is below the minimum speed curve, R₂ the filling of the melt 15 by the force of gravity stops, before the pressure-filling operation starts. Either of these cases yields defective cast products.

When a gravity-feeding operation is shifted to a pressure-filling operation, the melt 15 should be placed in the cavities 3 relative smoothly, quietly, at a low rate, and in a continuous manner. When the percentage of the melt 15 which flows into the cavities 3 by the force of gravity, a gravity-feeding percentage, is lower than 20, the pressure-filling operation starts too early. When this percentage exceeds 70, the gravity-feeding operation is carried out excessively. Therefore, in either of these cases, the gravity-feeding operation cannot be shifted to the pressure-filling operation immediately and smoothly, so that gas mix the melt 15 and cold shut occurs.

When this casting apparatus is designed so that, a pressure-filling operation is not conducted during a gravity-feeding operation only, i.e. the melt 15 flows into the cavities 3 by only the force of gravity, a percentage of melt 15 to be placed in the cavities 3 by the force of gravity is set to at least 30 and then pressure filling is conducted supplementarily. When the percentage of melt 15 to be placed in the cavities 3 by the force of gravity is set in this manner, gas can be prevented from entering the melt 15.

Consequently, when the casting apparatus is designed so that the percentage of melt 15 to flow into the cavities 3 by the force of gravity only is below 30, the pressure-filling operation is conducted excessively. In this case, no optimum range of casting conditions is available.

When the speed of the melt 15 through the

gates 4 during the pressure-filling operation is below 0.4 m/sec, the melt 15 does not flow in a satisfactory manner, and when this speed exceeds 0.8 m/sec, a gas enters the melt 15.

A comparison between the results in different modes M of casting methods, namely a conventional method L₁ of die casting and a method L₂ used in an experiment conducted in accordance with the above embodiment of the present invention, the percentage E of inferior products, especially, a percentage F of inferior products due to the leakage of pressure and a percentage G of inferior products which fail to pass an X-ray inspection, shows as is clear from Figure 6 that the percentages F, G in the method L₁ are far higher than those in the method L₂, the casting method according to the present invention permits obtaining extremely good products.

As described above, by the present invention faultless products which have basically high quality can be manufactured, and it has excellent effect.

Moreover, the casting conditions can be set or determined easily, and the time and cost for conducting experiments and modifying the metal molds can be reduced to a remarkable extent.

Since the gates 4 are formed in such a manner that a ratio of volume (cm³) of products to a cross-sectional area of the gates (cm²) is 20—40, gas does not mix in the melt 15, and no cold shut occurs. Therefore, faultless products can be obtained.

The speed at which the plunger tip 9 is moved down until the counter-tip 7 is displaced to open the gates 4 is set to an optimum level which makes the plunger tip 9 to reach the upper surface of the melt 15 in the sleeve 5 between the time the melt 15 starts flowing into the cavities 3 by the force of gravity, and the time, at which the gravity-feeding of the melt 15 is finished. Accordingly, a very high percentage of satisfactory products can be obtained.

When the percentage of the melt 15 to be placed in the cavities 3 by the force of gravity only is set to not less than 30% and the percentage of the melt 15 to flow into the cavities 3 by the force of gravity before the plunger tip 9 reaches the upper surface of the melt 15 in the sleeve 5 is set experimentally to 20—70, an operation for feeding the melt 15 into the cavities 3 by the force of gravity can be shifted relative smoothly, quietly, at a low rate and in a continuous manner to an operation for pressure-filling the cavities 3 therewith. This allows faultless products to be obtained.

Since the speed of the melt 15 through the gates 4 during the pressure-filling operation is set to 0.4—0.8 m/sec, gas does not enter the cavities 3, and the melt 15 can be put into the cavities 3 in a desired manner as mentioned above.

Claims

1. A vertical type pressure casting method having the steps of closing gates (4) to cavities (3)

with a counter-tip (7) after molds (1, 2) have been clamped, pouring melt (15) into a sleeve (5) with a plunger tip (9) therein in a lifted state, displacing said counter-tip (7) to open said gates (4) and allow the melt (15) to flow into said cavities (3) via said gates (4) by the force of gravity, and thereafter pressurizing the melt (15) in said sleeve (5) by moving said plunger tip (9) downward to fill said cavities (3) with said melt (15), characterized in that a casting program device is used, by which program device said gates (4) are opened by said counter-tip (7) after said plunger tip (9) has started moving downward, and the speed of said plunger tip (9) during the period of time from the commencement of its downward movement to the opening of said gates (4) is set to a speed between the speed at which said plunger tip (9) would reach the melt (15) in said sleeve (5) when or before said gates (4) are opened by said counter-tip (7), and the speed at which said plunger tip (9) would reach the melt (15) at the time the melt (15) stops flowing into said cavities (3) by the force of gravity alone.

2. A vertical type pressure casting method according to Claim 1, wherein said gates (4) are formed in such a manner that a ratio of the volume of products to the cross-sectional area of said gates (4) is 20—40 (volume of products (cm³)/cross-sectional area (cm²)=20—40), the percentage of melt (15) to flow into said cavities (3) by the force of gravity alone is set to not less than 30, the percentage of the melt (15) to be fed into said cavities (3) by the force of gravity before said plunger tip (9) reaches the melt (15) in said sleeve (5) is set to 20—70, the speed of the melt (15) through said gates (4) during the pressure-filling of said cavities (3) by said plunger tip (9) is set to 0.4—0.8 m/sec.

3. A vertical type pressure casting method according to Claim 1 or 2, wherein the speed of the melt (15) through said gates (4) during the feeding of the melt (15) into said cavities (3) by the force of gravity is set to not less than 0.1 m/sec.

Patentansprüche

1. Vertikal-Druckgußverfahren mit den Verfahrensschritten des Verschließens von Anschnittöffnungen (4) zu Formhohlräumen (3) mit einem Gegenkolben (7), nachdem Formteile (1, 2) zusammengespannt worden sind, des Gießens einer Schmelze (15) in einen Behälter (5), wobei ein Druckkolben (9) sich darin in angehobenem Zustand befindet, des Verschiebens des Gegenkolbens (7) zum Öffnen der Anschnittöffnungen (4) und um der Schmelze (15) zu gestatten, infolge der Gravitationskraft durch die Anschnittöffnungen (4) in die Formhohlräume (3) zu fließen, und der anschließenden Druckaufbringung auf die Schmelze (15) in dem Behälter (5) durch Abwärtsbewegen des Druckkolbens (9), um die Formhohlräume (3) mit der Schmelze (15) zu füllen, dadurch gekennzeichnet, daß eine Guß-Steuer-Vorrichtung verwendet wird, daß aufgrund dieser Guß-Steuer-Vorrich-

tung die Anschnittöffnungen (4) mittels des Gegenkolbens (7) geöffnet werden, nachdem der Druckkolben (9) begonnen hat, sich abwärtszubewegen, und daß die Geschwindigkeit des Druckkolbens in der Zeitspanne vom Beginn seiner Abwärtsbewegung bis zum Öffnen der Anschnittöffnungen (4) auf eine Geschwindigkeit festgesetzt wird, die zwischen der Geschwindigkeit, bei der der Druckkolben (9) die Schmelze (15) in dem Behälter erreichen würde, wenn oder bevor die Anschnittöffnungen (4) mittels des Gegenkolbens (7) geöffnet werden, und der Geschwindigkeit liegt, bei der der Druckkolben (9) die Schmelze (15) zu dem Zeitpunkt erreichen würde, an dem die Schmelze (15) aufhört, allein infolge der Gravitationskraft in die Formhöhlräume (3) zu fließen.

2. Vertikal-Druckgußverfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Anschnittöffnungen (4) in der Weise ausgebildet sind, daß das Verhältnis des Volumens der Gußkörper zu der Querschnittsfläche der Anschnittöffnungen (4) 20 bis 40 beträgt (Volumen der Gußkörper (cm³)/Querschnittsfläche (cm²)=20 bis 40), daß der Prozentsatz an Schmelze (15), die allein infolge der Gravitationskraft in die Formhöhlräume (3) fließt, auf nicht weniger als 30 festgesetzt ist, daß der Prozentsatz an Schmelze (15), die den Formhöhlräumen (3) infolge der Gravitationskraft zugeführt wird, bevor der Druckkolben (9) die Schmelze (15) in dem Behälter (5) erreicht, auf 20 bis 70 festgesetzt wird, daß die Geschwindigkeit der Schmelze (15) durch die Anschnittöffnungen (4) während des Füllens der Formhöhlräume (3) infolge der Druckaufbringung mittels des Druckkolbens (9) auf 0,4 bis 0,8 m/sec festgesetzt ist.

3. Vertikal-Druckgußverfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Geschwindigkeit der Schmelze (15) durch die Anschnittöffnungen (4) während der Zuführung der Schmelze (15) zu den Formhöhlräumen (3) infolge der Gravitationskraft auf nicht weniger als 0,1 m/sec festgesetzt ist.

Revendications

1. Un procédé de moulage vertical sous pression comportant les étapes suivantes:

— Fermer des trous de coulée (4) débouchant dans des cavités (3) par une tête de plongeur antagoniste (7) après avoir assemblé les parties d'un moule (1, 2), on coule une matière fondue (15) dans un alésage (5) pendant qu'une tête de plongeur (9) se trouve en position haute dans cet alésage, on déplace

ladite tête de plongeur antagoniste (7) pour ouvrir lesdits trous de coulée (4) et permettre à la matière fondue (15) de couler dans lesdites cavités (3) en traversant lesdits trous de coulée (4) par la force de gravité, puis on met sous pression la matière fondue (15) dans ledit alésage (5) en déplaçant ladite tête de plongeur (9) vers le bas, afin de remplir lesdites cavités (3) de matière fondue (15) caractérisé en ce qu'il consiste à utiliser un dispositif de programmation de moulage qui contrôle l'ouverture des trous de coulée (4) par l'intermédiaire de la tête de plongeur antagoniste (7) lorsque ladite tête de plongeur (9) a commencé à descendre;

— Ajuster la vitesse de ladite tête de plongeur (9) pendant la période entre le commencement de son mouvement descendant et l'ouverture desdits trous de coulée (4) à une valeur comprise entre la vitesse à laquelle ladite tête de plongeur (9) atteindrait de matière fondue (15) dans ledit alésage (5) au moment de l'ouverture ou avant l'ouverture desdits trous de coulée (4) par la tête de plongeur antagoniste (7) d'une part, et la vitesse à laquelle ladite tête de plongeur (9) atteindrait la matière fondue (15) au moment où l'écoulement de la matière fondue (15) dans les cavités (3) par la seule force de gravité est terminé d'autre part.

2. Un procédé de moulage vertical sous pression selon la revendication 1, dans lequel les trous de coulée (4) présentent une configuration telle que le rapport du volume de pièces à la surface de section desdits trous de coulée (4) soit de 20—40 (volume de pièces en cm³ à la surface de section en cm²=20—40), la proportion de matière fondue (15) s'écoulant dans les cavités (3) par la seule force de gravité étant ajustée à une valeur non inférieure à 30%, la proportion de matière fondue (15) introduite dans les trous de coulée (3) par la force de gravité avant que ladite tête de plongeur (9) n'atteigne la matière fondue (15) dans ledit alésage (5) étant ajustée à une valeur comprise entre 20 et 70%, et la vitesse d'écoulement de la matière fondue (15) à travers les trous de coulée (4) au cours de son injection dans lesdites cavités (3) par ladite tête de plongeur (9) étant ajustée à une valeur comprise entre 0,4 et 0,8 m/s.

3. Un procédé de moulage vertical sous pression selon la revendication 1 ou 2, caractérisé en ce que la vitesse d'écoulement de la matière fondue (15) à travers les trous de coulée (4) au cours de l'introduction de la matière fondue (15) dans lesdites cavités (3) par la force de gravité est ajustée à une valeur non inférieure à 0,1 m/s.

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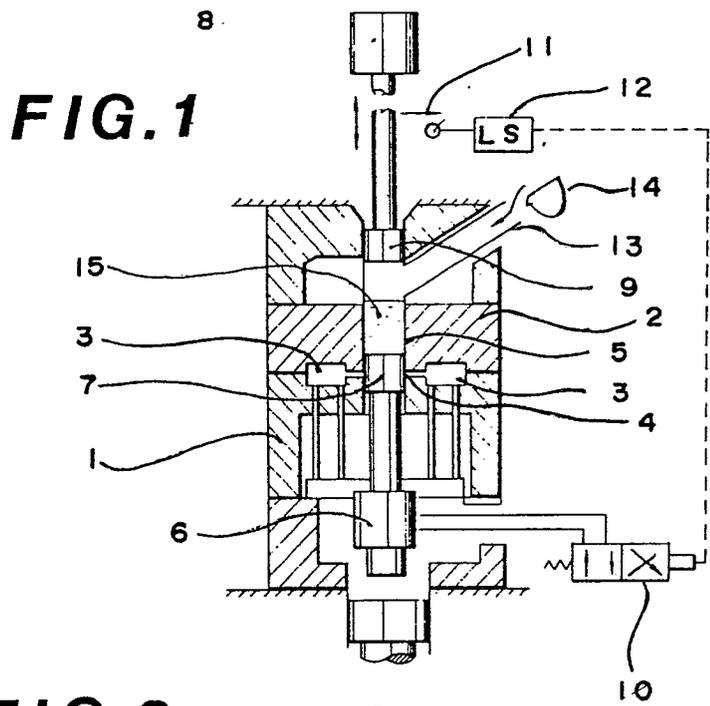


FIG. 2

FIG. 3

FIG. 4

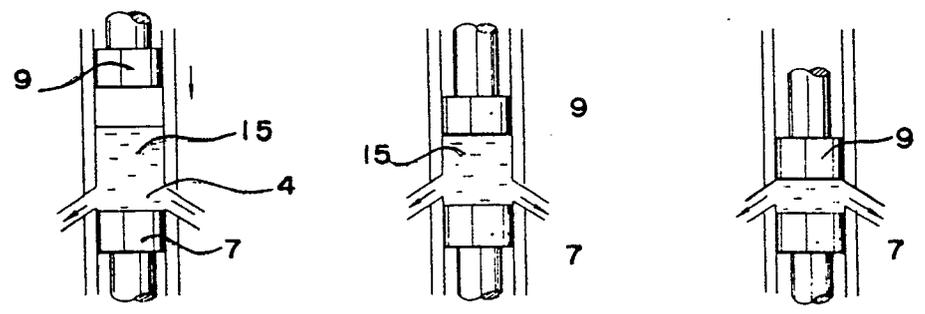


FIG. 5

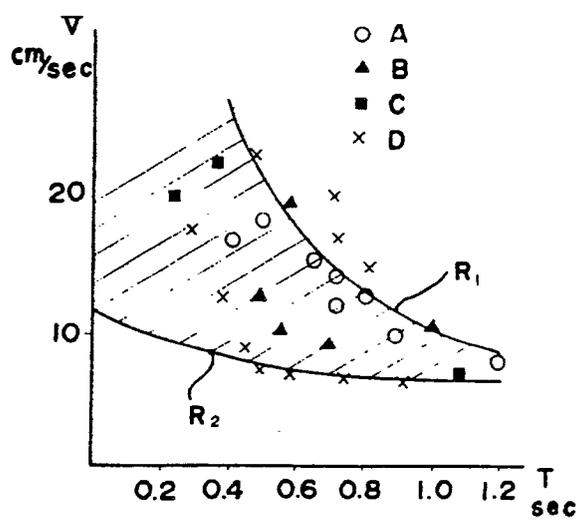


FIG. 6

