Oct. 27, 1964 G. E. SNOEYENBOS ETAL 3,153,925

FRICTION AND ADHESION TESTING MACHINE AND METHOD

Filed June 29, 1961 3 Sheets-Sheet 1

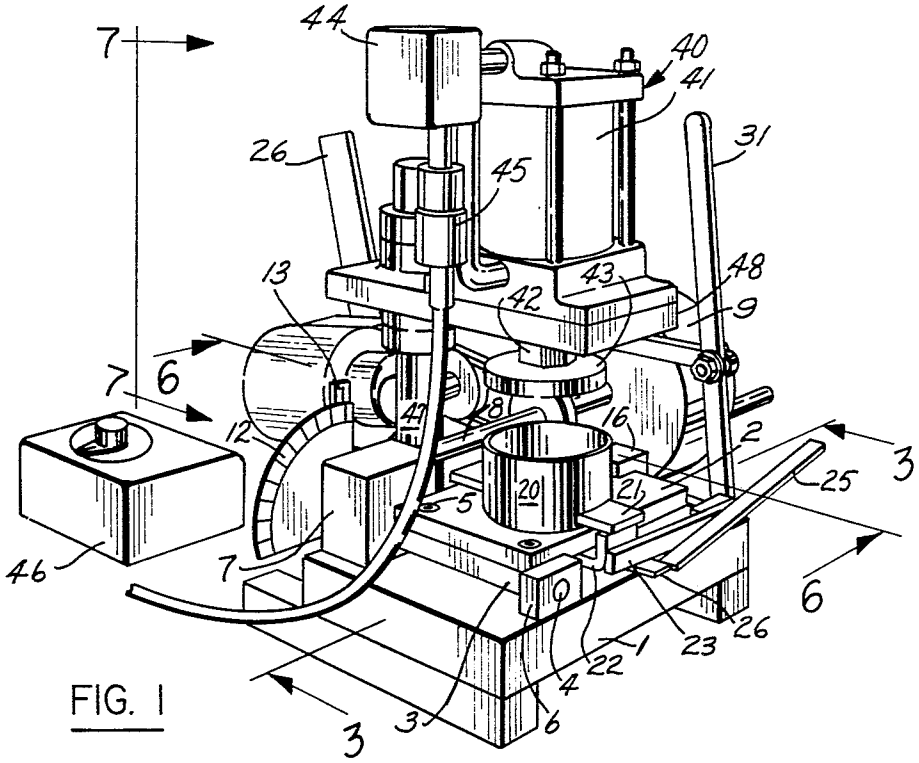

FIG. 1

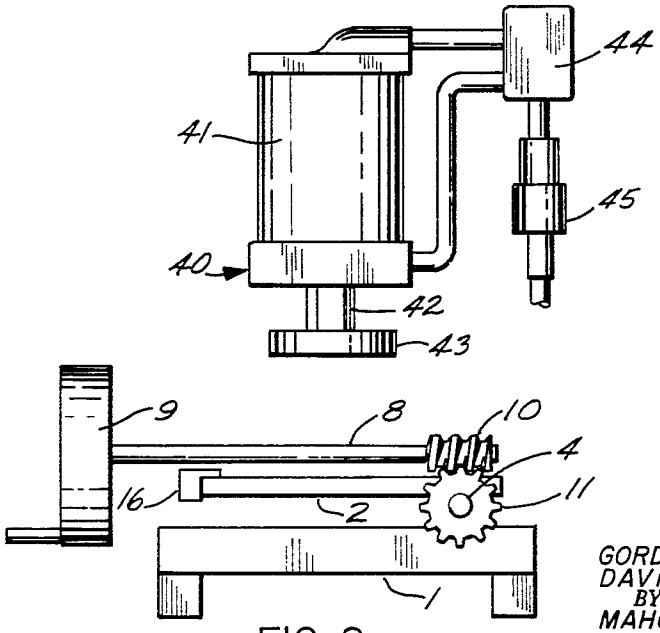

FIG. 2

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FRICTION AND ADHESION TESTING MACHINE AND METHOD

Filed June 29, 1961 3 Sheets-Sheet 2

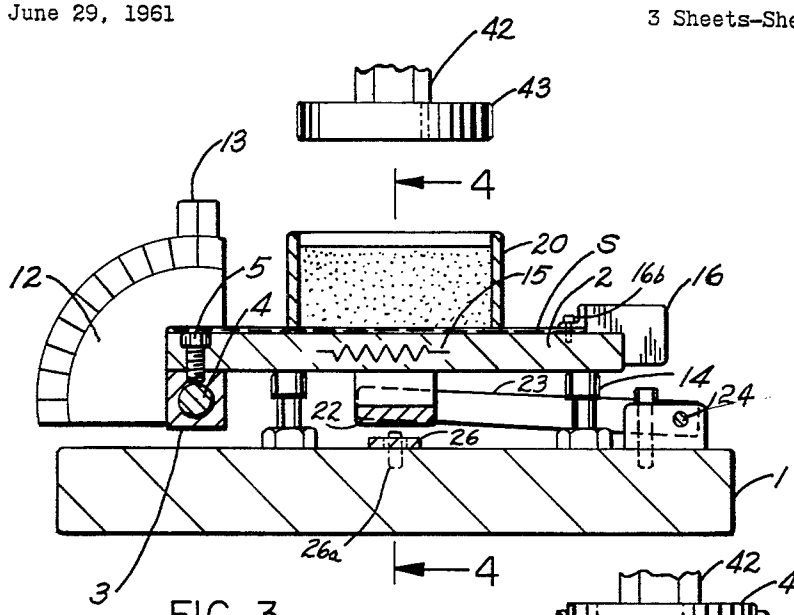

FIG. 3

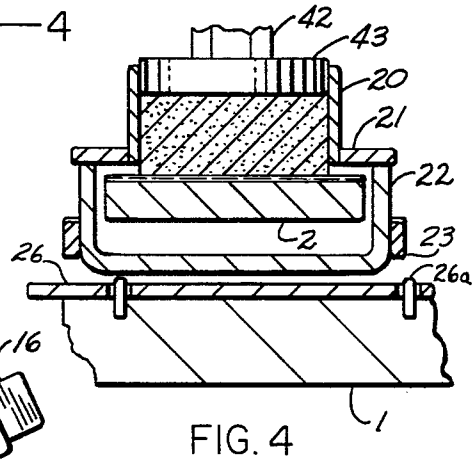

FIG. 4

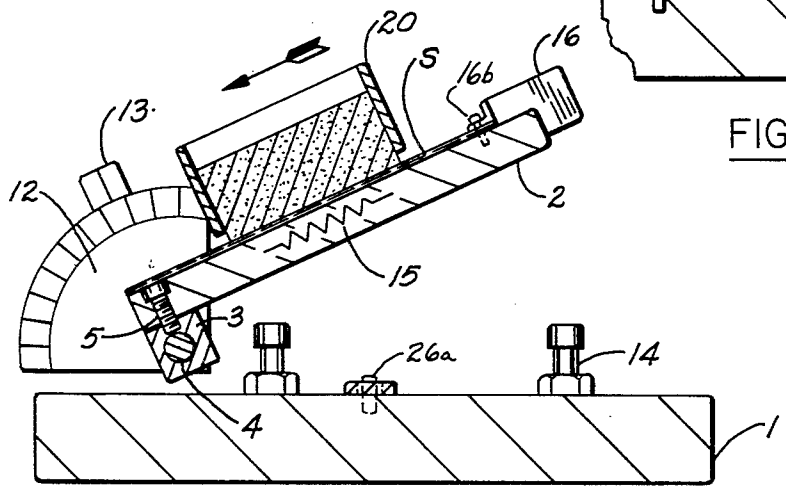

FIG. 5

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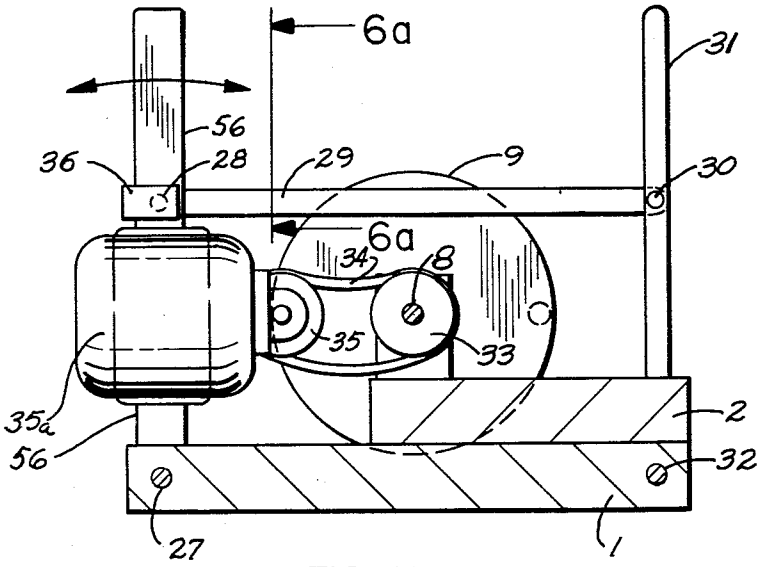


FIG. 6

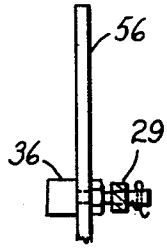


FIG. 6a

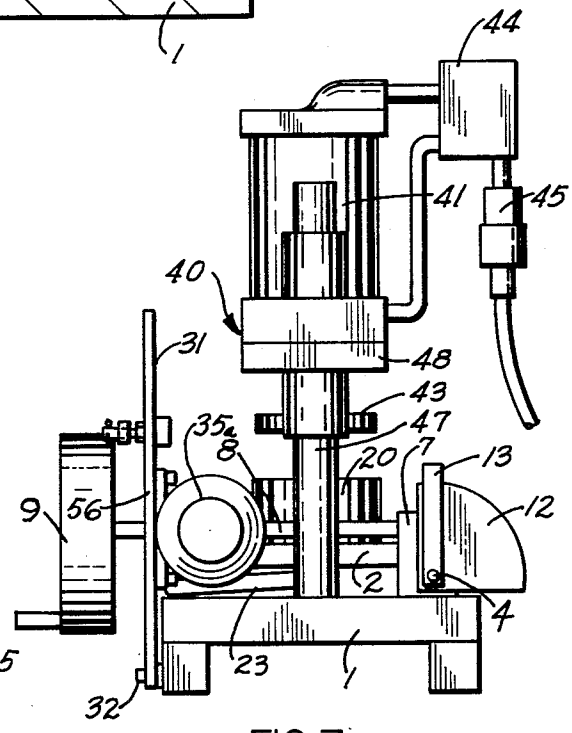
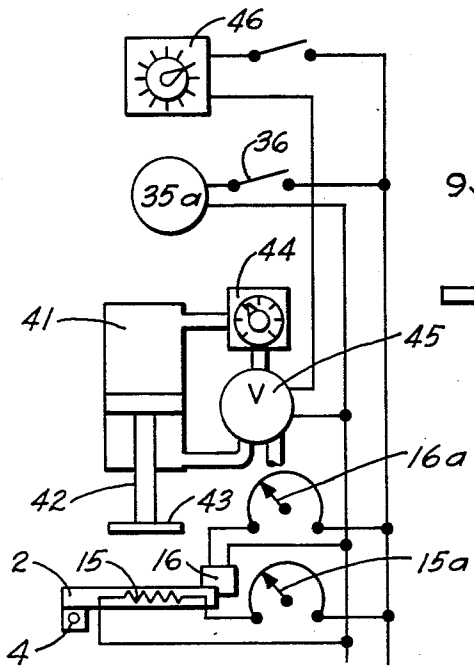


FIG. 7

FIG. 8



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FRICTION AND ADHESION TESTING MACHINE AND METHOD

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12 Claims. (Cl. 73—9)

This invention relates to a friction and adhesion testing machine and method. It has to do, more particularly, with a machine and method which is especially useful for studying factors affecting adhesion between sand molds and patterns for foundry operations although this invention is not limited to that use.

This machine and method was developed to find ways of reducing the "sticking" of sand molds to associated patterns or the tendency for sand molds not to draw cleanly from the patterns whether they are plastic or metal.

According to the method of this invention, the machine utilized is adapted to simulate insofar as possible certain factors which in actual practice create the tendency for the sand molds to stick to the patterns and thereby prevent them from drawing cleanly from the pattern. These factors include static and dynamic friction conditions, adhesion, liquid viscosity, surface tension, etc. Temperature and contacting pressure between the sand and pattern which occur in the actual practice of making an impression of the pattern in the mold are recreated insofar as possible with this method and machine.

The testing machine according to this invention includes means for pivotally mounting a removable test plate so that it can be inclined at a progressively steeper angle. It also includes an indicating device associated with the test plate and its mounting means for indicating any angle of inclination to which it is adjusted. The test plate will be of the pattern material to be tested. The test plate may be provided with a coating, layer, or other covering, of parting material to be used on the pattern surface or other material to be tested. During the testing operations, a volume of the molding sand or other material will be disposed in contact with the surface of the test plate or coating thereon. This sand will be squeezed into contact with the surface and for this purpose the machine is equipped with a ram device for pressing the sand against the plate surface with a selected pressure. This pressure will simulate actual pressure conditions encountered in making the pattern impression. Also, the test plate of the machine will be equipped with a heating device for recreating actual temperatures encountered in the impression operation. Furthermore, the test plate will be equipped with vibrating means to simulate vibration used in separating the mold and pattern after the impression is made.

The accompanying drawings illustrate the present invention and in these drawings:

FIGURE 1 is a perspective view of the testing machine.

FIGURE 2 is a schematic view illustrating the test plate and associated parts of the machine.

FIGURE 3 is a schematic view taken substantially along line 3—3 of FIGURE 1 and illustrating an initial step in the use of the machine.

FIGURE 4 is a vertical sectional view taken along line 4—4 of FIGURE 3 with the pressing disc 43 in its lowermost position.

FIGURE 5 is a view similar to FIGURE 3 but showing

a different adjustment of the machine for the testing operation.

FIGURE 6 is a schematic view taken along line 6—6 of FIGURE 1 illustrating the drive for the test plate adjusting mechanism.

FIGURE 6a is a detail taken along line 6a—6a of FIGURE 6.

FIGURE 7 is an elevational view of the machine taken from the direction indicated by line 7—7 of FIGURE 1.

FIGURE 8 is a diagrammatic view of the control system of the machine.

With reference to the drawings and especially to FIGURE 1, the machine used in the testing operations according to this invention comprises a flat base 1 which has means for mounting a test plate 2 thereon for inclining adjustment. This means comprises a transversely extending block or bar 3 which is carried by a shaft 4 for rotation therewith about its axis. One end of the plate 2 may be removably secured as by countersunk bolts 5 to the bar 3. Thus, the plate 2 is pivoted for vertical swinging movement about the horizontal axis of the shaft 4 which is disposed transversely of the base 1. One end of the shaft 4 is rotatable in a bearing 6 carried by the base at one side thereof and the other end of the shaft is rotatably disposed in a gear box 7 carried at the opposite side of the base.

The gears in the box 7 may be actuated manually by means of a shaft 8 extending thereinto which has a flywheel and handle 9 on its outer end. The inner end of the shaft 8 has a worm 10 which meshes with a worm gear 11 keyed on the shaft 4, the worm 10 and gear 11 both being disposed in the box 7. Thus, by rotating the flywheel 9, the plate 2 can be adjusted about the axis of the shaft 4 to any selected angle of inclination and will be locked in adjusted position by the self-locking worm and gear adjusting means.

The shaft 4 projects through the gear box 7 and through an indicator dial 12 of segmental form which is fixed relative to the base 1 being carried by the gear box 7. The adjacent extremity of the shaft 4 has an indicator pointer or arm 13 keyed thereto which will be closely behind the dial 12 but will project upwardly along the edge thereof. Obviously, the segmental dial 12 will be concentric with the shaft 4. The dial may be calibrated in degrees of angles indicating the inclination of the plate 2 when it is adjusted to an inclined position about the axis of the shaft 4. Pins 14 projecting upwardly from the base 1 locate the plate 2 in its horizontal lowermost position.

The test plate 2 is provided with an electrical heating element 15 (FIGURE 3) which may be controlled by an adjustable control or rheostat 15a (FIGURE 8) so that various temperature conditions can be reproduced. A disconnect plug (not shown) may be provided at the plate 2 for the element 15. Also, the test plate 2 carries at its free end a vibrator 16 which may be of the electromagnetic type and which may be controlled by a rheostat switch 16a (FIGURE 8) to provide various degrees of vibration of the test plate. The vibrator 16 may be removably bolted to the plate 2 by bolts 16b.

A sand ring 20 is adapted to be positioned on the upper surface of the plate 2. This ring 20 is open at its top and bottom and is provided with oppositely diametrically opposed lifting lugs 21 which project outwardly beyond the corresponding side edges of the plate 2. The ring 20 will normally rest on the plate 2 but the lugs 21 are adapted to be engaged by the upper ends of a U-shaped lifting member 22 which straddles the plate 2 as shown

best in FIGURE 4. The member **22** is carried by a pair of supporting arms **23** which are pivoted by a transverse rod **24** (FIGURE 3) for vertical swinging movement on the base **1**, one of these arms being shown in FIGURE 1. For swinging the free or outer ends of these arms vertically slightly to lift the member **22**, a lever **25** is provided which is rigidly connected to a flat bar **26** that lies beneath the free ends of the arms **23**. The bar **26** is loosely fitted on locating pins **26***a* at its opposite ends which extend upwardly from the base **1**. Thus, the bar can be slightly rotated about its longitudinal axis by the lever **25** to lift the ring **20** relative to the plate **2** the slight amount necessary for a reason to be explained later. When the ring **20** is over the plate **2** and the plate is raised to an inclined position, the ring will be lifted therewith and its lugs **21** will move away from the lifting member **22**.

The shaft **4** may also be rotated to raise the test plate **2** by means of an electric motor **35***a*, as shown in FIGURE 6. This motor **35***a* is carried by an upstanding support arm **56** which is pivoted for swinging movement to the base **1** about a pivot **27**. The upper end of the arm **56** is pivoted at **28** to a connecting rod **29** which has its opposite end pivoted at **30** to an upstanding control lever **31** that is pivoted at its lower end by a pivot **32** to the opposite end of the base **1**. The shaft **8** has a pulley **33** keyed thereon which receives an endless belt **34** that also passes around a pulley **35** that is driven by the motor **35***a*. The motor **35***a* is controlled by a toggle switch **36** (FIGURES 6 and 6*a*) which is carried by the arm **56** and is actuated to engage the motor upon movement of the arm **56** to the left by means of the lever **31** which will tighten the belt **34** so that the motor **35***a* will drive the shaft **8**.

A fluid ram unit **40** is provided for squeezing the sand in the test ring **20** when it is disposed on the test plate **2** and is filled with sand. This ram is preferably of the air type and comprises a cylinder **41** which has a piston rod **42** projecting from the lower end thereof that carries a pressing disc **43** which is of such a diameter relative to the ring **20** that slight radial clearance is provided so it will freely pass into the upper open end of the ring. Pressure for the cylinder **41** is controlled by a regulator **44**, a solenoid valve **45** and a timer **46** (FIGURE 8). The entire unit is mounted for swinging movement about the vertical axis of a post **47** (FIGURES 1 and 7) which is upstanding from the base **1**. This post carries a horizontally disposed shelf **48** which is carried thereby for swinging movement thereabout. The shelf **48** supports the cylinder **41** and associated parts. Thus, the unit **40** can be swung over the test plate **2** to align the disc **43** with the ring **20** or it can be swung away to an inoperative position.

In the use of this machine according to the present invention, the test plate **2** is attached to the block **3**. This test plate will be of the pattern material to be tested, such as aluminum, chrome plate, gray iron, resins such as epoxy, etc. The plate may be tested without a coating or with a parting material coating such as a parting liquid or powder, which is indicated in FIGURE 3 as the surface coating S. This parting compound may be wiped, sprayed, dusted, or otherwise applied to the surface of the test plate. The ring or flask **20** is then placed on the surface to be tested and is filled with the molding sand as shown in FIGURE 3. The temperature control **15***a* (FIGURE 8) is set to heat the plate **2** to the desired temperature simulating that to be encountered in the pattern impressing operation. The ram **40** is swung over the plate **2** and the pressing disc **43** is aligned therewith. The timer **46** and pressure regulator **44** are then set so that the disc **43** will press down on the sand in the ring **20** for a predetermined time and at a predetermined pressure simulating the pressure encountered in the pattern impressing operation. Before the disc **43** contacts the sand, the sand ring lifting lever **25** is actuated to lift the ring **20** slightly above the plate surface. The ram then compacts the sand in the ring in this position and before the squeeze disc **43** retracts, the lever **25** is released, freeing the sand

ring, which remains supported by the sand cake. Thus, as indicated in FIGURE 4, only the lower surface of the sand and not the ring will contact the surface of the test plate. The circuit of the timer **46** is closed, the vibrator **16** is energized, and the ram unit **40** is swung away from the test plate. The drive belt **34** is engaged by the lever **31** and the toggle switch **36** is closed so as to cause the motor **35***a* to drive and to start upward swinging of the plate **2**. This is continued until the sand body slides downwardly along the surface S. At this time the drive belt **34** is disengaged to stop the upward swinging of the plate **2** and the angle indicated by the pointer **13** and dial **12** is noted. This would be the angle, the tangent of which would represent the static-coefficient of friction. The motor belt **34** is now disengaged and the switch **36** opened and the plate **2** is returned to its original horizontal position by rotating the flywheel **9**. To observe the dynamic test angle, the same operation would be repeated except that, as the plate is inclined, the sand cake is nudged downward by the hand of the operator. At some angle, the sand cake will continue to slowly slide on down the plate at constant speed. At this position, the tangent of the angle would indicate the dynamic coefficient of friction. In each test, the sand cake may be discarded and the same operation repeated several times so that the test results are reported as the average of several such determinations.

It will be apparent from the above that this invention provides a simple and inexpensive machine which can be readily employed in a simple process to test friction and adhesion as influenced by various factors encountered in the pattern impressing and molding operations. However, this invention is not limited to that particular use.

According to the provisions of the patent statutes, the principles of this invention have been explained and have been illustrated and described in what is now considered to represent the best embodiment. However, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

Having thus described this invention, what is claimed is:

1. An apparatus of the character described for testing the frictional characteristics of surfaces of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds comprising a test plate of the material from which the patterns are to be made, means for mounting said test plate for vertical swinging from a horizontal position through successive inclined positions, means for measuring the angle between said horizontal position and said successive inclined positions, a container disposed over said plate and having an open top and bottom for receiving a mass of molding sand from which said molds are to be made and disposed so that the lower surface of said mass of molding sand in said container is in contact with the surface of said plate, said container being spaced from said plate so that sand contained therein will slide relative to said plate as said plate reaches a certain inclined position, and power cylinder means disposed above said container for compacting said mass of molding sand in said container for simulating the pressure applied to molding sand when it is pressed against the surface of a pattern having the surface characteristics of said plate.

2. An apparatus according to claim 1 and including lever means adjacent said plate and engageable with said container for lifting said container from said plate during the time when pressure is applied to said mass of molding sand for leaving the lower surface of said mass of molding sand substantially free for sliding on the surface of said plate.

3. An apparatus according to claim 1 and including control means connected to said power cylinder means for regulating the pressure applied and the length of time pressure is applied to said mass of molding sand for simu-

lating the effect upon said frictional characteristics of operating conditions of sand molds being applied to patterns having the surface characteristics of said plate.

4. An apparatus of the character described for testing the frictional characteristics of various parting layer surfaces of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds comprising a test plate of the material from which the patterns are to be made, a parting layer applied to the parting surface of said test plate, means for mounting said test plate for vertical swinging from a horizontal position through successive inclined positions, said mounting means including a shaft disposed at one end of said plate for supporting a plate for swinging movement about the shaft axis, means for measuring the angle between said horizontal position and said successive inclined positions, a container disposed over said plate and having an open top and bottom for receiving a mass of molding sand from which said molds are to be made and disposed so that the lower surface of said mass of molding sand in said container is in contact with the surface of said plate, said container being spaced from said plate so that sand contained therein will slide relative to said plate as said plate reaches a certain inclined position, and means disposed above said container for compacting said mass of molding sand in said container for simulating the pressure applied to molding sand under varying conditions when it is pressed against the surface of a parting layer surface having the characteristics of said plate.

5. An apparatus of the character described for testing the frictional characteristics of various parting layer surfaces of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds comprising a test plate of the material from which the patterns are to be made, a parting layer applied to the parting surfaces of said test plate, means for mounting said test plate for vertical swinging from a horizontal position through successive inclined positions, said mounting means including a shaft disposed at one end of said plate for supporting said plate for swinging movement about the shaft axis, means for measuring the angle between said horizontal position and said successive inclined positions, a container disposed over said plate and having an open top and bottom for receiving a mass of molding sand from which said molds are to be made and disposed so that the lower surface of said mass of molding sand in said container is in contact with the surface of said plate, the container being spaced from said plate so that sand contained therein will slide relative to said plate as said plate reaches a certain inclined position, means disposed above said container for compacting said mass of molding sand in said container for simulating the pressure applied to molding sand under varying conditions when it is pressed against a parting layer surface having the characteristics of said plate, and power means for revolving said shaft and raising said plate to various vertical positions above said horizontal position, and manual means for revolving said shaft and lowering said plate back to said horizontal position.

6. An apparatus of the character described for testing the frictional characteristics of various parting layer surfaces of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds comprising a test plate of the material from which the patterns are to be made, a parting layer applied to the parting surface of said test plate, means for mounting said test plate for vertical swinging from a horizontal position through successive inclined positions, said mounting means including a shaft disposed at one end of said plate for supporting said plate for swinging movement about the shaft axis, means for measuring the angle between said horizontal position and said successive inclined positions, a container disposed over said plate having an open top and bottom for receiving a mass of molding sand from which said molds are to be made and disposed so that the lower surface of said mass of molding sand in said container is in contact with the surface of said plate, the container being spaced from said plate so that sand contained therein will slide relative to said plate as said plate reaches a certain inclined position, means disposed above said container for compacting said mass of molding sand in said container for simulating the pressure applied to molding sand under varying conditions when it is pressed against a parting layer surface having the characteristics of said plate, and heating means in said test plate for simulating the effect of differences in temperature between foundry sand molds and patterns upon the frictional characteristics of the parting surfaces thereof.

7. An apparatus according to claim 4 and including a vibrator attached to said test plate at the end opposite said shaft for facilitating the separation of the surfaces of said mass of molding sand and said test plate as said test plate assumes a particular level of inclination.

8. In a method for testing the frictional characteristics of surfaces of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds the steps which comprise compacting a mass of molding sand against the surface of a test plate of the material from which a pattern will be made, raising said test plate from a substantially horizontal position to an angle of inclination at which said mass of sand begins to slide on the surface of said test plate, and measuring the angle of inclination.

9. In a method for testing the frictional characteristics of the parting layer surface of patterns to assure the obtaining of clean withdrawal thereof from foundry sand molds the steps which comprise applying a parting layer of the material to be tested to a plate, compacting a mass of molding sand against the surface of said parting layer, measuring the pressure applied and the length of time pressure is applied to said mass of sand for simulating varying conditions of pressure in actual sand molds upon said frictional characteristics of a parting layer surface having the characteristics of said parting layer, raising the test plate from a substantially horizontal position to an angle of inclination at which said mass of sand begins to slide on said parting layer surface, and measuring the angle of inclination.

10. In a method for testing the frictional characteristics of surfaces of patterns to assure the obtaining of a clean withdrawal thereof from foundry sand molds the steps which comprise compacting a mass of molding sand against the surface of a test plate of the material from which a pattern will be made, heating the test plate to a selected temperature to simulate the effect of differences in temperature between foundry sand molds and patterns upon the frictional characteristics of the parting surfaces thereof, measuring the pressure applied and the length of time pressure is applied to said mass of sand for simulating the varying conditions of pressure in actual sand molds upon the frictional characteristics of the parting surfaces thereof having the characteristics of said plate, raising said test plate from a substantially horizontal position to an angle of inclination at which said mass of sand begins to slide on said surface of said test plate, and measuring the angle of the inclination.

11. In a method for testing the frictional characteristics of surfaces of patterns to assure the obtaining of a clean withdrawal thereof from foundry sand molds the steps which comprise compacting a mass of molding sand against the surface of a test plate of the material from which a pattern will be made, heating said test plate to a selected temperature to simulate the effect of differences in temperature between foundry sand molds and patterns upon the frictional characteristics of the parting surfaces thereof having the characteristics of said plate, raising said test plate from a substantially horizontal position to an angle of inclination at which said mass of sand begins to slide on said surface of said test plate, and measuring the angle of inclination.

12. In a method for testing the frictional characteristics of surfaces of patterns to assure the obtaining of a clean withdrawal thereof from foundry sand molds the steps which comprise compacting a mass of molding sand against the surface of a test plate of the material from which a pattern will be made, vibrating said test plate to simulate the effect of vibration on the said frictional characteristics of said parting surfaces of patterns having the characteristics of said plate, raising the test plate from a

substantially horizontal position to an angle of inclination at which said mass of sand begins to slide on said surface of said test plate, and measuring the angle of inclination.

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