

Aug. 29, 1961

M. G. TIBERG ET AL

2,997,758

HOT TOPS FOR INGOT MOULDS AND METHOD OF MAKING THE SAME

Filed Jan. 13, 1958

3 Sheets-Sheet 1

Fig. 1.

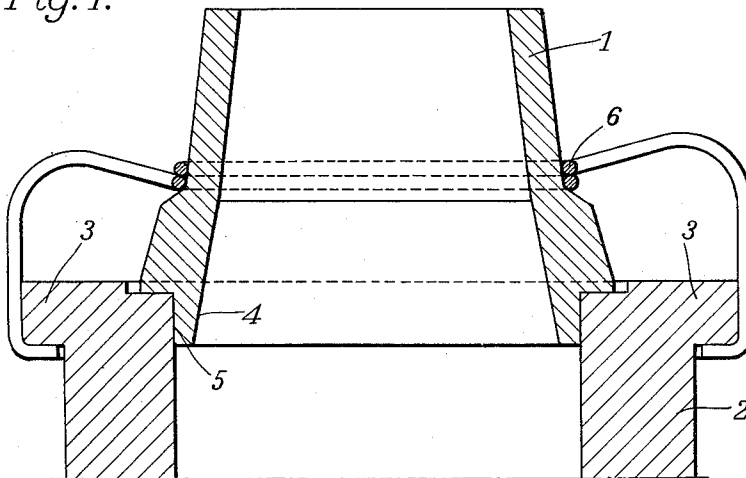
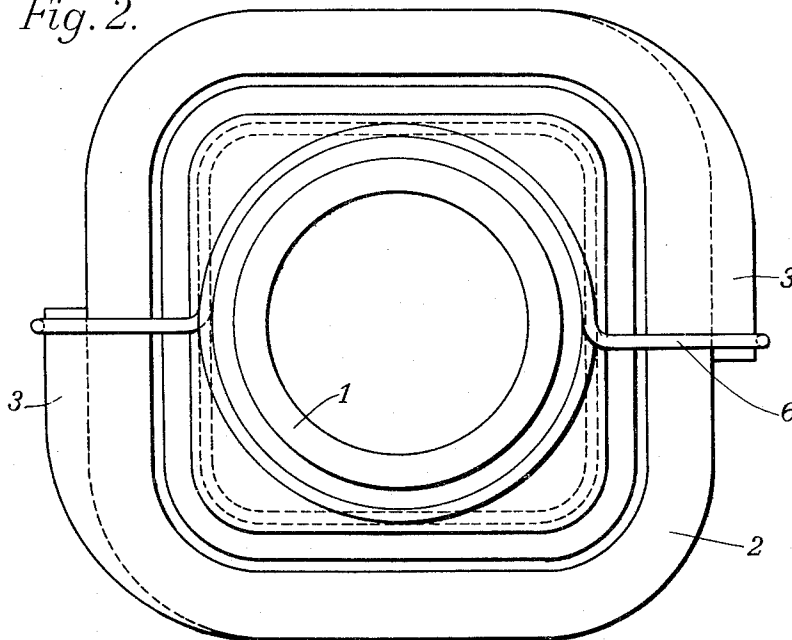


Fig. 2.



INVENTORS:
MAGNUS GEORG TIBERG
SVEN AXEL KJELLBERG
BY *Howson & Howson*
ATTYS.

Aug. 29, 1961

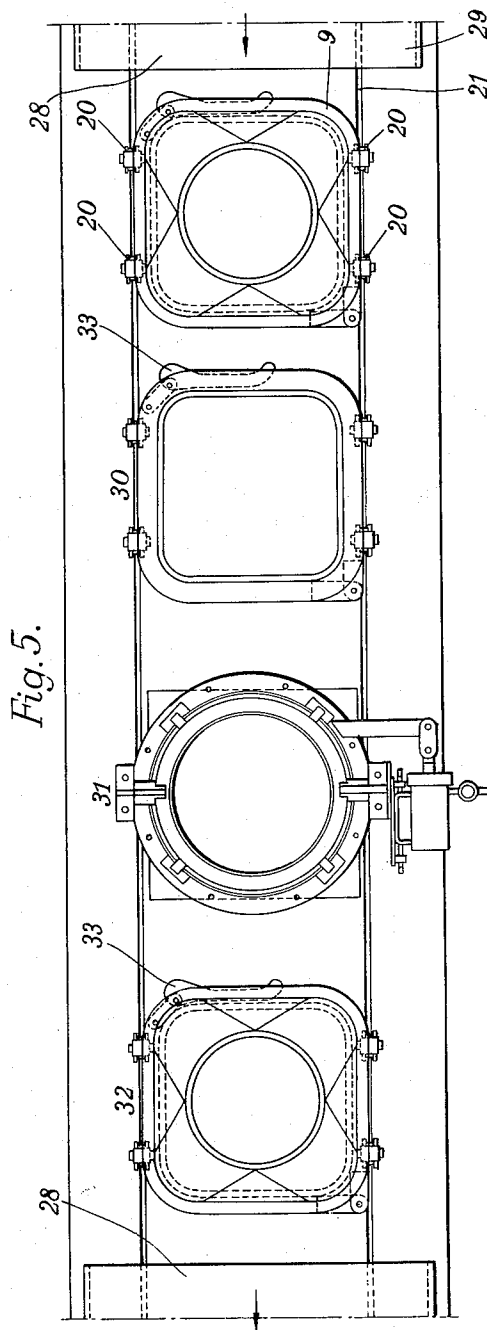
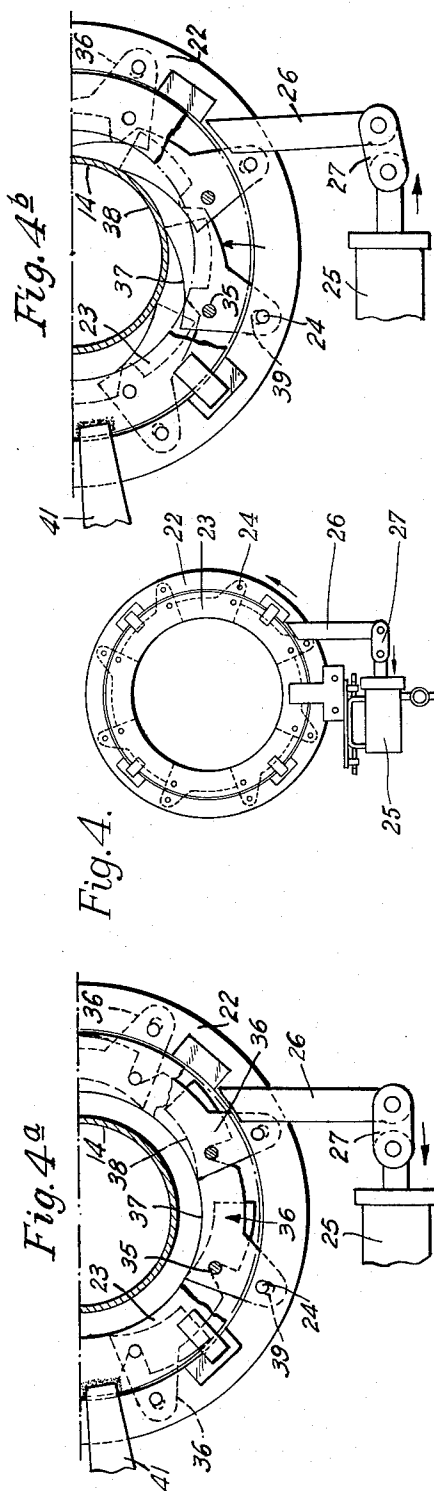
M. G. TIBERG ET AL

2,997,758

HOT TOPS FOR INGOT MOULDS AND METHOD OF MAKING THE SAME

Filed Jan. 13, 1958

3 Sheets-Sheet 3



INVENTORS:
MAGNUS GEORG TIBERG
SVEN AXEL KJELLBERG
BY *Howdon & Howdon*
ATTYS.

1

2,997,758

HOT TOPS FOR INGOT MOULDS AND METHOD OF MAKING THE SAME

Magnus Georg Tiberg and Sven Axel Kjellberg, Hällefors, Sweden, assignors to Aktiebolaget Svenska Kullagerfabriken, Göteborg, Sweden, a corporation of Sweden

Filed Jan. 13, 1958, Ser. No. 708,629

Claims priority, application Sweden Jan. 14, 1957

1 Claim. (Cl. 22—147)

The present invention relates to hot tops for ingot moulds for making killed steel ingots and a method of making the same.

There are many different kinds of hot tops in use on ingot moulds. In some types, the hot top is separate from the mould and is placed on or in the mould before the steel is poured. In other types the hot top is formed on the mould with the aid of a pattern. The separate hot tops are made in various forms, of which the oldest and most common comprises a hood of plate or cast iron which is lined with brick or is filled with a refractory material. This type of hot top is cheap and permits a high degree of utilization of the ingot, but because it is usually very heavy it is inconvenient to handle and requires much manual labour to use since it must be dried and recoated between pourings.

Brick has sufficient strength but in cases in which loose material is tamped to form a hot top, it is necessary to use a hood plate or cast iron to take most of the pressure which the steel exerts on the wall of the hot top.

It is known in foundries to make moulds from suitable materials containing core binding substances which either bind upon drying or after hardening with a suitable hardener. Form bodies are sometimes made of exothermic materials which are used as linings in feeders, in which case they are surrounded by a casing of suitable material and tamped since they are in themselves not strong enough to withstand the pressure of the steel without breaking.

The present invention has for its purpose to provide a hot top which permits a high degree of utilization of the ingots, is clean and dry, easily and quickly applied and which does not cause cracks in the ingot and which is cheap to make.

The hot top according to the invention is characterized mainly thereby that it comprises a chemically bound body consisting mainly of a refractory material, preferably sand, and a sodium silicate and/or a potassium silicate binder, the average grain size of said sand being 0.4 to 2 mm. to form a porous body capable of being formed by a vibratory process, the said body having a downwardly directed extension for projecting into the mould.

The method according to the invention is characterized mainly thereby that a mixture is prepared comprising mainly a refractory material and waterglass and that a hot top is moulded from this material while vibrating it, the volume of the wall of the said hot top being made less than 1½ times the volume enclosed by the said wall, the said hot top being provided with a downwardly projecting extension at its lower end, and then drying the hot top thus formed at a temperature of between 110° C. and 550° C., suitably higher than 140° C., the said refractory material consisting of grains of such size that they permit of forming the hot top by a vibratory process while providing a porous structure in said wall.

The size of the grains of the refractory material should be such that the biggest grains are not greater than 5 mm. and the average grain size is 0.4 to 2 mm. In other words they should all be able to pass through a sieve with 5 mm. mesh and the greater part (over 50%)

2

of the grains should be within the limits 0.4 to 2 mm. Further not more than 5% of the grains preferably should be less than 0.2 mm.

If the sand is too fine the hot top will crack when it has been filled with steel because its permeability to gases will not be sufficient to permit the steam formed from the water of crystallization in the waterglass used as a binder (about 1.8% by weight) to disperse. If the sand is too coarse the top may be too weak before being dried, whereby its manufacture will be unnecessarily complicated and material can loosen from the walls after drying and fall into the mould while the top is being applied to the mould. It is also difficult to pack coarse sand by vibrating it.

The body may also contain porous and/or fibrous material such as sawdust, bark chips, shavings or slag up to 40%, preferably 20%, by volume. If the fire-proof material used has a large percentage of grains less than 0.2 mm. this may be counteracted by increasing the proportion of porous material.

The amount of binder should be 2% to 15%, preferably about 10%, by volume of about 38 to 40 Bé. calculated on the volume of the dry material. In the dried top this corresponds to a sodium and/or potassium silicate content of 1.7 to 5.2% by weight calculated on the weight of the dry material. The binder content should be so great that all the material is wetted in an intimate or homogeneous mixture. If porous material is present it will be impregnated with waterglass and will thereby become practically fire-proof, if not already so as is the case with asbestos and certain kinds of slag. If the content of porous material is high it may be advisable to use a higher content of binder depending upon how porous and absorbent the material is. Part of the water disappears during the drying operation so that after drying the top contains a binder consisting of sodium and/or potassium silicate having three molecules of water of crystallization. The waterglass originally contains nine molecules of water and the drying takes place at a temperature at which six molecules are driven off. The remaining three molecules of water of crystallization are driven off only at a higher temperature as will be found when the hot top is used. Because the permeability of the walls to gas is high the water of crystallization is driven off through them and does not give rise to absorption of hydrogen into the steel.

By adding porous material the advantage is gained that the weight of the hot top will be lowered, since porous materials usually have a low specific weight. It is thus advantageous to choose porous materials having as low specific weights as possible, suitably less than 1.5 and preferably less than 1.0.

The volume of the wall of the hot top should be as small as possible in order to save material and make transportation and work as easy as possible. The volume of the wall may thus be less than the enclosed volume. Tests have shown that a volume of the wall of 46% of the volume enclosed by it is sufficient. Excellent results can be guaranteed if the volume of the wall is 50% of the enclosed volume. The thickness of the wall would in such case be about 20 to 22 mm. at the upper part and 35 to 40 mm. at the lower part for a 12" ingot. The reason that the thickness of the wall can be maintained at this low value is that the hot top is very tough, which is particularly apparent at the high temperatures which occur when afterpouring in the moulds. The top is thereby a monolithic self-supporting body which expands without cracking.

Before the hot top is applied to the mould it is provided externally on its lower projecting portion with a sealing material. This sealing material has for its purpose

to seal the joint between the top and the inner surface of the mould. A suitable sealing material comprises an intimate mixture of a non-drying binder such as Vaseline, grease or oil and at least one of the following components: a refractory finely divided material, preferably with good heat conducting qualities, for example clay or grinding swarf and a finely divided material which expands when heated, for example powdered slate.

The mixture should be of such consistency that it can be extruded in strips and be applied in that form about that part of the hot top which is to be sealed against the mould. This part of the top may suitably take the form of a flange extending down into the mould. The sealing strip is applied to the outside of the flange so that there will be no opening between the flange and the inside of the mould. The dimension of the strip is thus determined by the size of the opening between the mould and the flange.

By suitably proportioning the quantities of binder and finely divided material the mixture can be given suitable consistency. If the binder is a liquid, such as oil, it has been found suitable to use 25 to 50% thereof, and if it is semi-liquid or pasty 15 to 40%.

The material having good heat conducting qualities may be for example clay or grinding swarf. Grinding swarf is in this case intended to refer to such waste material as is obtained when grinding iron and steel with a grinding wheel containing, for example, Carborundum. The grinding swarf will thus consist mainly of a more or less intimate finely divided mixture of iron and Carborundum. Since the sealing material thus has a comparatively good heat conducting capacity it will cool the molten steel so that it solidifies at the joint.

The heat expansive material may consist for instance of pulverized slate which will expand to six times its original volume at a temperature of 1100° C., or some other available material which has the capacity of expanding at the temperature in question and which may be obtained in finely divided form.

It has been found especially suitable to use the following compositions:

- 30 to 35 percent by weight of clay
- 40 to 50 percent by weight of pulverized slate
- 20 to 25 percent by weight of Vaseline

In order to retain the top in contact with the mould it is provided with a clamp 6. This clamp may be suitably made of spring steel wire of 5 to 10 mm. diameter which is wound round the hot top 1½ turns at about half its height and the ends of which are intended to engage lugs or grooves in the mould so that the top will be fixed to the latter. If the walls of the top are as thin as possible the clamp should be double, the part surrounding the top comprising two springs at different heights at a distance of 5 to 10 mm. from each other and with portions common to both of them to fix the top in place. The double clamp can of course also be used even if much thicker walls are used than strictly necessary.

The hot top resembles a hood fixed over the mould. The lower part of the top fits the upper part of the mould so that there will be no openings. In order to obtain the greatest possible strength the upper part of the top is circular in section. The portion projecting into the mould has a somewhat smaller dimension than that of the mould in order to make sure that it can enter the mould. The interstice between the projection and the mould can be filled by the above mentioned sealing material which prevents the steel from penetrating up to the horizontal lower edge of the top.

The invention is illustrated in the accompanying drawings showing a form of hot top and a machine suitable for making it.

In the drawings, FIG. 1 shows a section through a hot top applied to a mould. FIG. 2 shows the same hot top seen from above. FIG. 3 shows a section of a machine

for making the hot top. FIG. 4 shows a device for cutting off the top at the upper edge according to the invention. FIG. 4a is a fragmentary enlarged plan view of the cut-off device shown in FIG. 4, showing the cut-off elements retracted. FIG. 4b is a fragmentary enlarged plan view of the cut-off device showing the cut-off elements advanced to cut-off position. FIG. 5 shows the sequence of operations in making a hot top.

FIGS. 1 and 2 show a hot top 1 applied to an ingot mould 2. The upper part of the mould is substantially square with rounded corners. At two opposed sides of the mould are lugs 3. The lower part of the top is shaped to fit the mould and is extended downwards so that an extended portion 4 projects into the mould. Between the inner surface of the mould and the outer surface of the portion 4 there will be a small interstice 5. This interstice is filled with a sealing substance. The top tapers off upwardly and its upper part is circular. A spring 6 is wound round the top at about half its height and encircles the top 1½ times and is extended to grip the lugs 3.

FIG. 3 is a section through a machine for making hot tops according to the invention. The top is formed between an outer pattern 7, an inner pattern 8 and a lower pattern 9.

The outer pattern 7 can be raised and lowered together with a feed hopper 10 by means of a bar 11 and a pneumatically operating piston in a cylinder 12. It is guided by rollers 13. A cone 14 is located within the feed hopper 10 and is supported on cross pieces 34 in the hopper. A discharge pipe 15 is arranged above the feed hopper 10 for filling material into the hopper. The lower end of the hopper can be closed by a cutting off device 16 which is shown more clearly in FIG. 4. The hopper may suitably be coated with polytetrafluoroethylene.

The inner pattern 8 is carried by a bar 17 and can be raised and lowered in a similar manner by means of a piston pneumatically operated in a cylinder 18. A vibrator 19 is located under the pattern 8. The pattern 8 is provided with a shoulder against which the cone 14 rests.

The lower pattern 9 comprises a frame member formed from a Z-shaped profile bar and having rollers 20 for rolling on a track 21.

FIG. 4 shows the cutting off device 16 which resembles the diaphragm of a camera. It cuts off the flow of material from the hopper and after completion of the moulding separates the hot top from the material remaining in the hopper.

The cutting off device comprises an outer ring 22 and an inner ring 23 which latter consists of a number of segments pivotted in the ring 22 and 24. The cutting off operation is accomplished with the aid of a pneumatic device which actuates the ring 22 through an arm 26 and a link 27. The ring is thus rotated thereby turning the segments and decreasing the diameter of the opening to cut off the flow of material.

The cut-off device is constructed and operates as best shown in FIGS. 4a and 4b. These figures show the overlapping segments 36 pivotted on pins 35 on the inner ring 23. The inner edges of the segments are formed on two arcs, 37 and 38. When the segments are in the retracted or inoperative positions, as shown in FIG. 4a, the arcs 37 of the segments jointly form a circle which corresponds to the inner peripheral surface of the hopper 10, as also shown in FIG. 3.

When the segments are advanced to the operative position as shown in FIG. 4b, the arcs 38 form a circle smaller than the aforesaid circle formed by the arcs 37 and conforming in size to the circumference of the upper end of the cone 8, again with reference to FIG. 3. Thus in a retracted position of the segments the top of the mould cavity is opened to the hopper, and in the advanced position, the segments act to close the opening and in the process of advancement to sever or to separate the material in the mould cavity from the material in the hopper.

5

As previously explained, the segments are advanced and retracted by rotating the outer ring 22 through the medium of the arm 26 by action of the pneumatic cylinder 25, which contains a plunger connected by link 27 to the arm. Each of the segments is connected to the ring 22 through the medium of a pin 24 on the ring, which is received in a slot 39 in the segment. The inner ring 23 is fixed through the medium of arm 41 extending inwardly from the fixed frame of the apparatus.

FIG. 5 shows the sequence of operations for making the hot top. A drying furnace is designated 28. The dried hot tops are transported from the end 29 of the furnace while resting on the lower pattern 9 which rolls on wheels 20 on a track 21.

The next operation takes place at 30 where the hot top is removed and the lower pattern is cleansed and may also be provided with a thin protective coating of gypsum. The removal is facilitated thereby that the lower pattern can be opened up by means of a handle 33. The empty lower pattern is then rolled in under the machine at 31. After a new hot top has been moulded the lower pattern is transported to the furnace 28 as shown at 32.

The moulding of the hot top is carried out as follows:

From an elevated container (not shown) material is led through the discharge pipe 15 to fill the hopper 10 which, together with the outer pattern 7, is then in upper position. The cutting off device 16 is closed and rests against the cone 14. At the same time the lower pattern 9 is centered over the inner pattern 8 which is at the time in its lower position. The inner pattern 8 is then raised and the hopper 10 and the outer pattern 7 are lowered. The inner pattern 8 continues its movement until its top enters the cone 14 after which the latter will rest on a shoulder on the inner pattern. At the end of its downward movement the outer pattern rests on the lower pattern. The lower pattern is positioned thereby that it is guided by the inner pattern and the latter in turn is guided by the cone which is fixed to the hopper and the outer pattern. The cutting off device is now opened and material falls quickly from the hopper into the space formed by the inner, outer and lower patterns and the vibrator is started. The vibrator is allowed to run for a suitable length of time after the moulding space has been filled. The cutting off device is now closed, the outer pattern raised and the inner pattern lowered, whereby the finished hot top remains resting on the lower pattern. This is transported away, preferably direct to the furnace. The cycle is repeated for the next hot top.

It has been found that the whole cycle takes about 20 seconds. The lower patterns move along a closed circular track about which furnaces are arranged. The furnace may have a capacity of for instance about 75 hot tops per hour and the operations of the machine are regulated to coincide therewith. About 25 lower patterns will then be required which circulate along the closed track through the machine and the furnaces.

The removal of hot tops from the lower pattern after they have been dried can also be accomplished automatically for instance by means of an arm with suitable gripping members, which lift the top from the pattern to a suitable transporting device and the machine and the furnaces can thus be made to operate wholly automatically without special attendance.

If greater capacity is required the machine may be made with several moulding units working at the same time.

The hot tops should be dried at a temperature exceeding 110° C., preferably over 140° C. and less than 550° C., in an atmosphere which does not contain a high content of carbon dioxide. No carbonic acid hardening will thus occur. The drying operation is done so that six

6

molecules of water of crystallization are driven off from the waterglass binder after which three molecules remain. The preferred drying temperature is 200° C. The permissible carbon dioxide content is 1 to 2% in the furnace. If the carbon dioxide content is too high carbonic acid hardening will occur and the hot top will be brittle. Instead the top should be tough whereby it can be easily handled after drying and strong enough to stand the pressure to which it is subjected.

When the hot tops have been dried they are removed from the lower pattern as has been described above. The patterns are then coated to prevent them from sticking to the hot top unless they have been coated with polytetrafluoroethylene. Gypsum is suitable for the purpose.

When making hot tops according to the invention good results have been obtained by the following procedure:

The sand in the mixture may be composed of grains of the following sizes in the quantities indicated

>3 mm. about 1%
>2 mm. about 6.5%
>1 mm. about 32%
>0.43 mm. about 46%
>0.20 mm. about 14%
Less than 0.15 mm. about 0.5%

This mixture is vibrated in a machine as described above and dried at 200° C. The amount of mixture is 6 litres per top and after drying the volume of the hot top was 5 litres and its weight 6.5 kgs. The volume enveloped by the wall of the hot top was 10 litres for a 12" ingot mould. After drying the top was firm, hard and porous to provide a lightweight, fluid-permeable, self-supported body. In order to test its permeability 66.5 litres of air was forced into the top per minute per square decimeter. When the wall thickness was 20 mm. the air pressure was 5 mm. of water. If the thickness of the wall was increased to 35 mm. under otherwise the same conditions the pressure was 12 mm. water and with a wall thickness of 60 mm. it was 22 mm. of water.

We claim:

A hot top for ingot molds for making killed steel ingots, comprising a lightweight, fluid-permeable, monolithic, homogeneous self-supporting body consisting substantially of a granular refractory material bound by a silicate binder selected from the group consisting of sodium silicate and potassium silicate, more than 50% of said refractory material being of a grain size within the limits of 0.4 to 2 mm., not more than 5% of said refractory material being of a grain size less than 0.2 mm., the remainder of said refractory material being of a grain size not greater than 5 mm.

References Cited in the file of this patent

UNITED STATES PATENTS

1,022,343	Turner	Apr. 2, 1912
1,135,381	Kenny	Apr. 13, 1915
1,650,700	Egler	Nov. 29, 1927
1,668,567	Messler	May 8, 1928
1,689,174	Perry	Oct. 23, 1928
1,804,205	Charman	May 5, 1931
2,513,212	Saives	June 27, 1950
2,652,609	Sudia	Sept. 22, 1953
2,846,741	Whitacre	Aug. 12, 1958

FOREIGN PATENTS

570,719	Great Britain	July 19, 1945
525,428	Canada	May 22, 1956

OTHER REFERENCES

Dietert: "Modern Core Practices and Theories," copyright 1942, pages 5 and 6.