Oct. 7, 1947. E. C. FALK ET AL 2,428,659

WATER-COOLED SLAB MOLD

Filed March 24, 1945 3 Sheets-Sheet 1

Fig. 1.

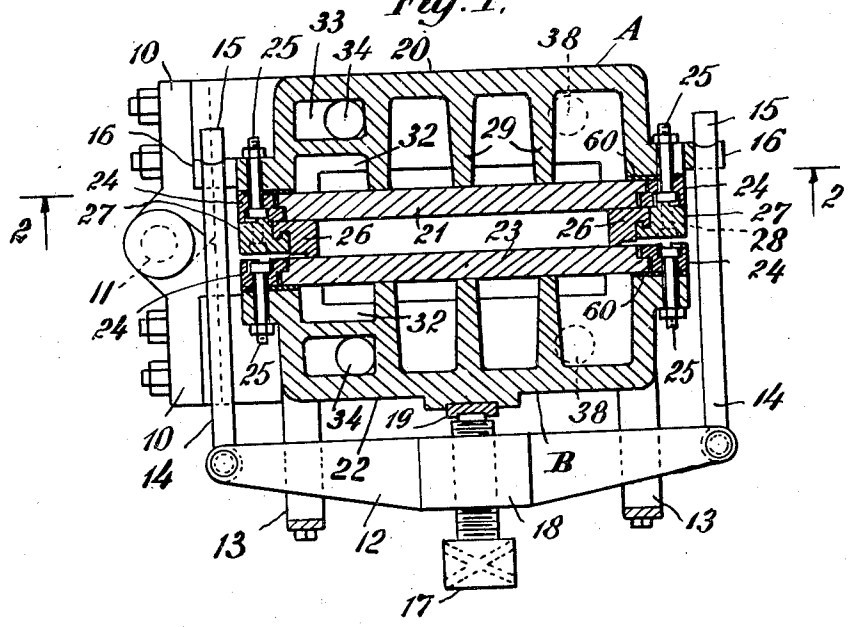


Fig. 6,

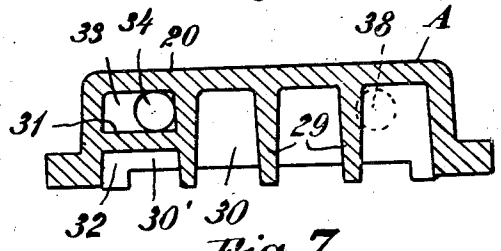
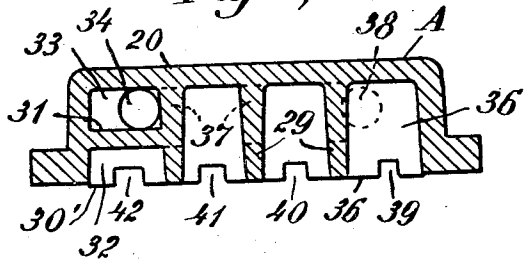


Fig. 7,

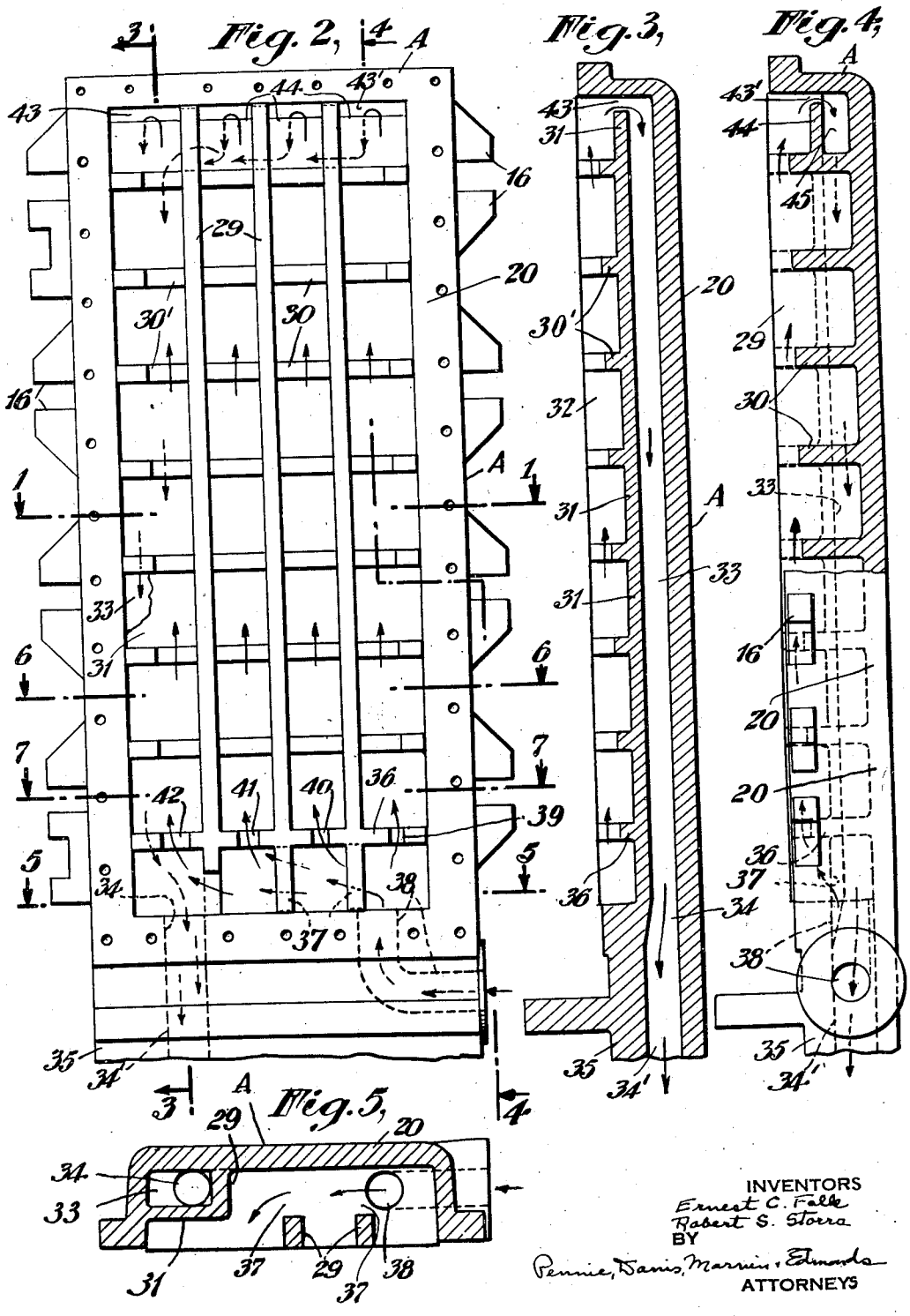


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WATER-COOLED SLAB MOLD

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Fig. 8

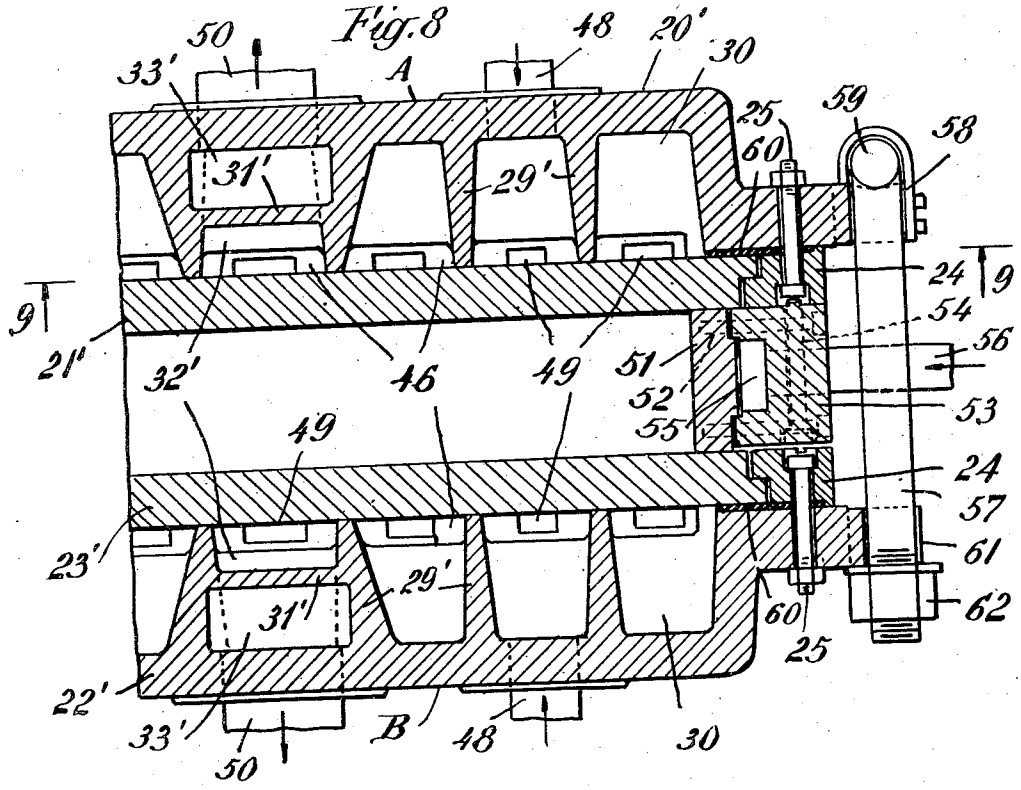


Fig. 9.

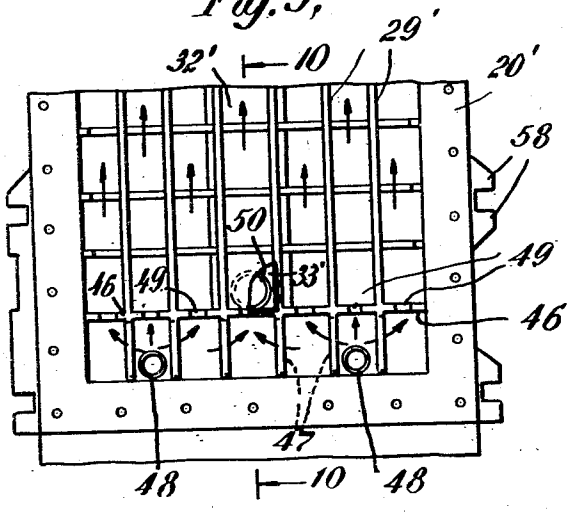
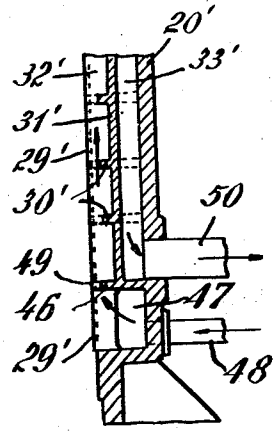


Fig. 10.



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Patented Oct. 7, 1947

2,428,659

UNITED STATES PATENT OFFICE

2,428,659

WATER-COOLED SLAB MOLD

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Application March 24, 1945, Serial No. 584,613

6 Claims. (Cl. 22—144)

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This invention relates to water-cooled or chill slab molds, and more particularly to molds of the type described in Junker U. S. Patent No. 1,615,086. Molds of this type are extensively used for casting slabs of metal, such as copper-bearing alloys, which are subsequently reduced to sheets by rolling.

In general, water-cooled slab molds of this type comprise a stationary mold back and a complementary or mating mold front hinged to the mold back and capable of being swung through an arc of 90° or more. When closed, the mold back and front provide a rectangular mold cavity having faces and sides of good heat conductivity, usually plates of copper. The mold faces and usually the mold sides are in contact with circulating water, or other suitable cooling medium, flowing through appropriately provided compartments.

As described in our copending patent application Ser. No. 522,459, filed February 15, 1944, of which this application is a continuation-in-part, we have devised an improved construction of cooling compartment, for the metal frames of cooled slab molds, comprising longitudinal and transverse ribbing forming a plurality of vertical channels with a series of vertically spaced pockets, which impart a very active swirling action to the upwardly flowing cooling medium. Briefly, our improved mold construction comprises a mold back and a complementary mold front pivotally mounted at one side of the mold back, the mold back and mold front each comprising a recessed metal frame having a plurality of longitudinal ribs dividing the recess into a plurality of vertical channels. The longitudinal ribs are each of substantially the same depth as the recess in the frame. A series of vertically spaced transverse ribs is provided in each of the vertical channels formed by the longitudinal ribs. The lowermost transverse rib in each vertical channel is, like the longitudinal ribs, of substantially the same depth as the frame recess, while the other transverse ribs are of less depth. The transverse ribs are all in substantially liquid tight engagement with the longitudinal ribs and the frame itself so as to form a series of relatively deep pockets communicating with each other only over the upper edges of the transverse ribs. Each of the lowermost transverse ribs has an opening therein, and each of the longitudinal ribs has an opening near its top and a bottom opening beneath the lowermost transverse rib. Means are provided for delivering cooling medium to the bottom of one of the vertical channels beneath its

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lowermost transverse rib, and further means are provided for withdrawing cooling medium from near the top of one of the vertical channels.

The present invention further provides an improvement upon the cooling compartment structure disclosed in our aforesaid application. Thus, according to the present invention, one or more of the vertical channels, in the recessed metal frame, is divided by a transverse vertical partition into a front cooling channel and a rear discharge channel in communication with one another at the tops thereof. The cross sectional area of the discharge channel (or channels) is greater than the cross sectional area of the inlet (or inlets) for the cooling medium. Where the mold back has a depending foot, as in the mold of our aforesaid application, the discharge channel may advantageously communicate with a registering opening in the foot itself.

The vertical channels formed by the longitudinal ribs are divided into a plurality of superposed pockets by a series of vertically spaced transverse ribs in the front cooling channel and in each of the other vertical channels. A transverse vertical partition above the uppermost transverse ribs forms a dam dividing each channel into a front pocket and a rear pocket in communication with one another at the tops thereof (i. e. over the dam). Behind the dams, the longitudinal ribs have openings (or are omitted or cut away) so that the rear pockets communicate with one another to form a transverse outlet manifold communicating with the aforementioned rear discharge channel. The longitudinal ribs also have openings near their bottoms to provide a transverse inlet manifold in communication with each vertical channel. An inlet and an outlet for cooling medium communicate with the transverse inlet manifold and the bottom of the rear discharge channel, respectively.

The foregoing and other novel features of the invention will be best understood from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a transverse section of a four-channel mold embodying the invention taken on the section line 1—1 of the mold back of Fig. 2,

Fig. 2 is a front elevation of the mold back (section 2—2 of Fig. 1),

Fig. 3 is a longitudinal section of the mold back on the section line 3—3 of Fig. 2,

Fig. 4 is a side elevation, partly in section (on the section line 4—4 of Fig. 2), of the mold back,

Figs. 5, 6 and 7 are transverse sections of the

mold back on the section lines 5—5, 6—6 and 7—7, respectively, of Fig. 2,

Fig. 8 is a partial transverse section of a seven-channel mold embodying the invention,

Fig. 9 is a front elevation of the mold back (section 9—9 of Fig. 8), and

Fig. 10 is a longitudinal section of the mold back on the section line 10—10 of Fig. 9.

The mold illustrated in Figs. 1 to 7 comprises a stationary mold member A (mold back) and a complementary mold member B (mold front) pivotally connected together by links 10 and pins 11 so that the mold front B can be swung to and fro to close and open the mold. Thus, the mold front is pivotally mounted at one side of the mold back. Transverse spaced yokes 12 are mounted in brackets 13 on the outer face of the mold front B. A link 14 is pivoted to each end of each yoke. The outer or free end of each link 14 has a head 15 adapted to operatively engage slotted lugs 16 on the sides of the stationary mold back A. When the mold is closed and the heads 15 operatively engage their respective slotted lugs 16, the mold members A and B are clamped together by turning the bolts 17, screw-threaded in central bosses 18 of each yoke and pressing against aligning wear plates 19 on the outer face of the mold front B.

The stationary mold back A comprises a rectangular metal frame 20 and a rolled copper plate or mold face 21 appropriately secured thereto. The frame 20 is recessed or hollow to provide when covered by the plate 21 a channelled compartment for the cooling medium, such as water. The movable mold front B similarly comprises a rectangular metal frame 22 and a rolled copper plate or mold face 23. While it is now our preferred practice to cast the frames of iron, they may be made of welded steel or in any other appropriate manner or of other suitable metal. The mold faces 21 and 23 are operatively secured to their mating frames 20 and 22, respectively, by longitudinal clamp bars 24, as particularly described and claimed in our copending patent application Serial No. 522,460, filed February 15, 1944. The clamp bars 24 are secured to the sides of their respective frames (20 and 22) by round headed bolts 25 fitting in counter bored holes in the clamp bars and registering holes in the frames. The mold sides are formed in two sections consisting of a mold side bar 26 having a tongue and groove connection with a backing bar 27, as particularly described and claimed in our aforementioned patent application. Each backing bar 27 is securely held against the adjacent clamp bar 24 by round headed bolts 28 fitting in counter bored holes in the backing bar and extending through registering holes in the clamp bar into registering holes in the frame 20. The joint between the rectangular end walls of the frame and the adjacent mold face and clamp bar is advantageously sealed by a heat resistant packing 60, as more particularly described and claimed in our copending application Ser. No. 584,614, filed Mar. 24, 1945. It is to be understood that the mold faces 21 and 23 may be secured to their mating frames in any other appropriate manner, as for example by the heretofore customary bolts as described in our aforementioned application Ser. No. 522,459, and similarly the mold sides may be bolted to the frames as described in that application.

The recessed compartments for the cooling medium in the frames 20 and 22 are provided with the characteristic longitudinal and transverse ribbing disclosed in our aforementioned application Ser. No. 522,459. Further, as hereinbefore stated, the invention involves an improved construction of that ribbing. Thus, each frame 20 and 22 has a series of spaced longitudinal or vertical ribs 29 dividing the recess in the frame into a plurality of vertical channels. The mold illustrated in Figs. 1 to 7 of the accompanying drawings has three such longitudinal ribs dividing the recess into four vertical channels. Each of the four vertical channels has a series of vertically spaced transverse horizontal ribs 30 (designated 30' in one vertical channel as hereinafter explained). The transverse ribs 30 form pockets, for the most part relatively deep, in the vertical channels formed by the longitudinal ribs 29. The depth of the longitudinal ribs 29 is substantially the same as the depth of the recess in the frame, while the depth of the transverse ribs 30 is less than the depth of the recess in the frame (Fig. 1), except as hereinafter particularly specified. In other words, the longitudinal ribs 29 extend from the back wall of the frame 20 (and 22) into contact with the adjacent mold face, while the transverse ribs 30 extend from the back wall of the frame to within a short distance of the mold face and thereby permit upward flow of the cooling medium through the spaces (passages) between the transverse ribs and the mold face.

In accordance with the present invention, one, or more if desired, of the vertical channels is divided by a transverse vertical partition 31 into a front cooling channel 32 and a rear discharge channel 33. Hence, the cooling channel 32 is only about half the depth of the other three vertical cooling channels, and the pockets formed in the channel 32 by the consequently narrower transverse ribs 30' are only about half as deep as the pockets formed in the other three vertical channels by the full depth transverse ribs 30. The cross sectional area of the discharge channel 33 is greater than the cross-sectional area of the inlet (38) for the cooling medium, to eliminate any possibility of back pressure in the cooling compartment. The discharge channel 33 communicates at its lower end with an outlet opening 34 in the lower end wall of the recessed frame. In the case of the stationary mold back A, where the frame 20 has a depending foot 35 integral with the frame, the outlet opening may advantageously be extended through the foot as a hole 34' in the foot.

As more particularly explained in our aforementioned application Ser. No. 584,614, the longitudinal ribs 29 extend a distance corresponding to the thickness of the packing 60 (say about 0.045 inch) beyond the rectangular end walls of the recessed frame, in order to give adequate support to the adjacent mold face and thus to insure casting slabs of uniform thickness. To the same end and additionally to form restraining elements for the packing, the transverse ribs of the two outer vertical channels are of the same depth as the longitudinal ribs for a short portion of their width adjacent the side wall of the recessed frame. Thus, in the mold of Figs. 1 to 7, the transverse ribs 30' as well as the transverse ribs 30 in the opposite outside vertical channel terminate short of the adjacent mold face for a greater part of their width and extend into contact with the mold face for the remainder of their width (see Figs. 1 and 6).

Below the series of transverse ribs 30 and 30', of less depth than the depth of the vertical channels in which they are respectively positioned, is

a transverse horizontal rib 36 suitably spaced from the lower end wall of the recess in the frame and of the same depth as the recess. Between these lowermost transverse ribs 36 and the lower end wall of the recess, the longitudinal ribs 29 have transverse openings 37 which place the bottoms of all four vertical cooling channels in communication to provide a transverse inlet manifold. Cooling medium is delivered to the inlet manifold through an inlet opening 38 in the lower end wall of the recessed frame. In the case of the stationary mold back A, where the frame 20 has the depending foot 35, the inlet opening may advantageously be laterally extended through the upper part of the foot to one side of the frame and there suitably connected to the source of cooling medium. Each lowermost transverse rib 36 has a vertical slot or opening 39, 40, 41 and 42 respectively, providing passages for the cooling medium from the transverse inlet manifold (formed between those ribs and the bottom wall of the recessed frame) to the four cooling channels there above. These vertical openings 39, 40, 41 and 42 increase progressively in size as their distance from the inlet opening 38 increases in order to equalize the pressure and flow of cooling medium to each of the four vertical cooling channels.

The transverse vertical partition 31 terminates short of the upper end wall of the recessed frame 20 (and 22), thus providing a dam with an opening or slot 43 permitting unrestricted flow of cooling medium from the front cooling channel 32 over the top of the dam into the rear discharge channel 33 (Fig. 3). Each of the other three vertical channels has a corresponding transverse vertical partition or dam 44 above the uppermost transverse ribs 30 (Fig. 4). The dams 44 terminate short of the upper end wall of the recessed frame 20 (and 22), thus providing openings or slots 43' permitting unrestricted flow of cooling medium from each vertical channel over the top of its dam 44. Behind the partition 31 and dams 44 and above the uppermost transverse ribs 30, the longitudinal ribs 29 extend through only the front half of the depth of the recess, or in other words there are no vertical ribs behind the dams. Thus, the space behind the dams (i. e. between the dams and the back wall of the frame 20) serves as a transverse outlet manifold 45 for the cooling medium flowing over the tops of the dams, and from this manifold the cooling medium flows into the discharge channel 33.

Cooling medium, such as water, is delivered to each mold member A and B through the inlet opening 38, and is distributed to the four vertical cooling channels through the graduated or metering slots 39—42. The transverse ribs 30 and 30' provide a series of pockets in the vertical channels, which impart a very active swirling action to the upwardly flowing medium. This swirling action causes turbulence in the cooling medium as it flows upwardly past the copper mold face 21 (and 23), and thereby effects a rapid and uniform equalization of the absorbed heat, since the cooling medium in contact with the copper mold face is constantly changed by the turbulent and lively swirling action. The pockets in three of the vertical channels are of the full depth of the recess in the frame 20 (and 22), while the pockets in the fourth vertical channel are of approximately half the depth of the recess, the discharge channel 33 taking up the remaining half of the depth of the recess behind this fourth vertical cooling channel. The top pockets in each

of the vertical channels are of approximately half the depth of the recess in the frame 20 (and 22), the discharge manifold 45 taking up the remaining half of the depth of the recess behind these top pockets.

The frames 20 and 22 may advantageously be made of iron, steel or the like with the ribbing and partitions integral parts of the frame. The inlet and outlet openings for the cooling medium, as well as the graduated openings 39—42 may be formed in the frame itself, so that the frame requires a minimum of machining to provide its characteristically novel system of cooling and discharge channels, and transverse inlet and outlet manifolds.

The recessed cooling compartment of the frame may be divided by longitudinal ribs into any desired number of vertical cooling channels, and the transverse vertical partition 31 may be positioned in any one or more of the vertical channels. Similarly the inlet and outlet for the cooling medium may be variously positioned. Thus, in Figs. 8, 9 and 10 of the drawings, the metal frames 20' and 22' of the mold back and front, respectively, have their recessed cooling compartments divided by the longitudinal ribs 29' into seven vertical channels. The middle channel of each frame is divided by a transverse vertical partition 31' into a front cooling channel 32' and a rear discharge channel 33'. Spaced from the lower end wall of the frame, each vertical channel has a lowermost transverse rib 46 of substantially the same depth as the recess. Beneath the transverse ribs 46, the longitudinal ribs 29' have openings 47 to provide a transverse inlet manifold. Two inlet pipes 48 communicate with the inlet manifold. The inlet pipes 48 are positioned near the bottoms of the second and sixth vertical channels, and the opening 49 in the transverse ribs 46 are metered or graduated in size according to their distance from one or the other inlet, for the purposes hereinbefore explained. Directly above the lowermost transverse rib 46 of the center vertical channel, an outlet pipe 50 communicates with the discharge channel 33'. The inlet pipes 48 and outlet pipe 50 extend from the back of the frame, as clearly shown in Fig. 10.

The mold of Figs. 8, 9 and 10 has water-cooled sides. Each mold side comprises a copper plate or mold face 51 secured by bolts 52 to a backing bar 53. Each backing bar 53 is securely held against its adjacent clamp bar 24 by round headed bolts 54 fitting in counter bored holes in the backing bar and extending through registering holes in the clamp bar into registering holes in the frame 20'. The inner face of each backing bar 53 is recessed to provide with its adjacent mold face 51 a longitudinal cooling compartment 55 having an inlet 56 near its bottom and a corresponding outlet near its top.

So far as the features of the present invention are involved, the mold of Figs. 8, 9 and 10 is otherwise of substantially the same construction as the mold of the other figures, and such other corresponding elements are indicated by the same reference characters. The mold of Figs. 8, 9 and 10 is adopted to cast slabs 40 by 62 inches and 7 inches thick, weighing approximately 5000 pounds. The swinging mold front B is clamped to the stationary mold back A, on each side, by T-headed bolts 57, having their T-heads held in bifurcated lugs 58 on the sides of the mold back by yokes 59. The bolts 57 may be swung horizontally to engage and disengage bifurcated lugs 61 on the sides of the mold front. When the mold

is closed and the bolts 57 engage the lugs 61, the mold members are clamped together by tightening the nuts 62.

We claim:

1. A recessed metal frame for a cooled slab mold having a plurality of longitudinal ribs of substantially the same depth as the depth of the recess dividing the recess into a plurality of vertical channels and having a series of vertically spaced transverse ribs forming communicating pockets in the vertical channels, a transverse vertical partition in one of said vertical channels dividing that channel into a front cooling channel and a rear discharge channel, said longitudinal ribs having openings near their bottoms to provide a transverse inlet manifold, a dam in each of said vertical channels above the uppermost transverse rib dividing the channel into a front pocket and a rear pocket in communication with one another at the tops thereof, said longitudinal ribs having openings behind said dam to provide a transverse outlet manifold in communication with said rear discharge channel, an inlet for cooling medium communicating with said transverse inlet manifold, and an outlet for cooling medium communicating with said rear discharge channel.

2. A mold member for a cooled slab mold comprising a recessed metal frame having a plurality of longitudinal ribs of substantially the same depth as the depth of the recess and dividing the recess into a plurality of vertical channels, a mold face secured to said frame and covering said recess, a transverse vertical partition dividing one of said vertical channels into a front cooling channel and a rear discharge channel in communication with one another at the tops thereof, a series of vertically spaced transverse ribs in said front cooling channel and in each of the other vertical channels formed by the longitudinal ribs, the lowermost transverse rib in each of said channels contacting the adjacent mold face and the other transverse ribs being spaced from the adjacent mold face to permit upward flow of cooling medium, each of the lowermost transverse ribs having an opening therein, each of said longitudinal ribs having an opening above the uppermost transverse rib and an opening beneath the lowermost transverse rib, an inlet for cooling medium beneath said lowermost transverse ribs, and an outlet for cooling medium communicating with the bottom of said rear discharge channel.

3. A mold member for a cooled slab mold comprising a recessed metal frame having a plurality of longitudinal ribs of substantially the same depth as the depth of the recess and dividing the recess into a plurality of vertical channels, a mold face secured to said frame and covering said recess, a transverse vertical partition dividing one of said vertical channels into a front cooling channel and a rear discharge channel in communication with one another at the tops thereof, a series of vertically spaced transverse ribs in said front cooling channel and in each of the other vertical channels formed by the longitudinal ribs, the lowermost transverse rib in each of said channels contacting the adjacent mold face and the other transverse ribs being spaced from the adjacent mold face to permit upward flow of cooling medium, each of the lowermost transverse ribs having an opening therein, each of said longitudinal ribs having a transverse opening beneath the lowermost transverse rib, the portion of each of said longitudinal ribs above the uppermost transverse ribs extending inwardly from the adjacent mold face for only about half the depth of the recess in said frame, a dam above the uppermost transverse rib in each of said vertical channels between the inner edges of the portions of the longitudinal ribs of decreased depth and extending upwardly towards but spaced from the upper end wall of the frame, an inlet for cooling medium beneath said lowermost transverse ribs, and an outlet for cooling medium communicating with the bottom of said rear discharge channel.

4. A mold back member for a cooled slab mold comprising a metal frame having a recess and a plurality of longitudinal ribs of substantially the same depth as the depth of the recess and dividing the recess into a plurality of vertical channels, a mold face secured to said frame and covering said recess, a transverse vertical partition dividing one of said vertical channels into a front cooling channel and a rear discharge channel in communication with one another at the tops thereof, an integral foot depending from said frame and having a hole therethrough communicating at its top with said discharge channel, a series of vertically spaced transverse ribs in said front cooling channel and in each of the other vertical channels formed by the longitudinal ribs, the lowermost transverse rib in each of said channels contacting the adjacent mold face and the other transverse ribs being spaced from the adjacent mold face to permit upward flow of cooling medium, each of the lowermost transverse ribs having an opening therein, each of said longitudinal ribs having a transverse opening beneath the lowermost transverse rib, a dam above the uppermost transverse rib in each of said vertical channels dividing the channel into a front pocket and a rear pocket in communication with one another at the tops thereof, the tops of said longitudinal ribs having openings providing free communication between said rear pockets and the top of the aforesaid rear discharge channel, and an inlet for cooling medium beneath said lowermost transverse ribs.

5. In a mold for casting metal slabs having a mold back and a complementary mold front pivotally mounted at one side of the mold back, the mold back and mold front each comprising a recessed metal frame having a plurality of longitudinal ribs dividing the recess into a plurality of vertical channels, said longitudinal ribs being of substantially the same depth as the depth of the recess, a series of vertically spaced transverse ribs in each of the vertical channels formed by the longitudinal ribs, the lowermost transverse rib in each vertical channel being of substantially the same depth as the recess and the other transverse ribs being of less depth, said transverse ribs all being in substantially liquid tight engagement with the longitudinal ribs and the frame itself so as to form a series of relatively deep pockets communicating with each other only over the upper edges of the transverse ribs, each of the lowermost transverse ribs having an opening therein, each of said longitudinal ribs having an opening near its top and a bottom opening beneath the lowermost transverse rib, means for delivering cooling medium to the bottom of one of said vertical channels beneath its lowermost transverse rib, and means for withdrawing cooling medium from near the top of one of said vertical channels.

6. In a mold for casting metal slabs having a mold back and a complementary mold front pivotally mounted at one side of the mold back, the mold back and mold front each comprising a re-

cessed metal frame having a plurality of longitudinal ribs dividing the recess into a plurality of vertical channels, said longitudinal ribs being of substantially the same depth as the depth of the recess, a series of vertically spaced transverse ribs in each of the vertical channels formed by the longitudinal ribs, the lowermost transverse rib in each vertical channel being of substantially the same depth as the recess and the other transverse ribs being of less depth, each of the lowermost transverse ribs having a vertical opening therein, each of said longitudinal ribs having a transverse opening near its top and a transverse opening beneath the lowermost transverse rib, means for delivering cooling medium to the bottom of one of said vertical channels beneath its lowermost transverse rib, the size of the vertical openings in the transverse ribs progressively increasing the farther the opening is positioned from the channel to which cooling medium is delivered, and

means for withdrawing cooling medium from near the top of one of said vertical channels.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,973,550	Todt	Sept. 11, 1934
2,316,180	Mueller	Apr. 13, 1943
972,429	Baird	Oct. 11, 1910
1,796,853	McMullan	Mar. 17, 1931
1,895,135	Rohn	Jan. 24, 1933
1,218,367	Bruggeman	Mar. 6, 1917
1,373,660	Iverson	Apr. 5, 1921
1,987,962	Leupold	Jan. 15, 1935