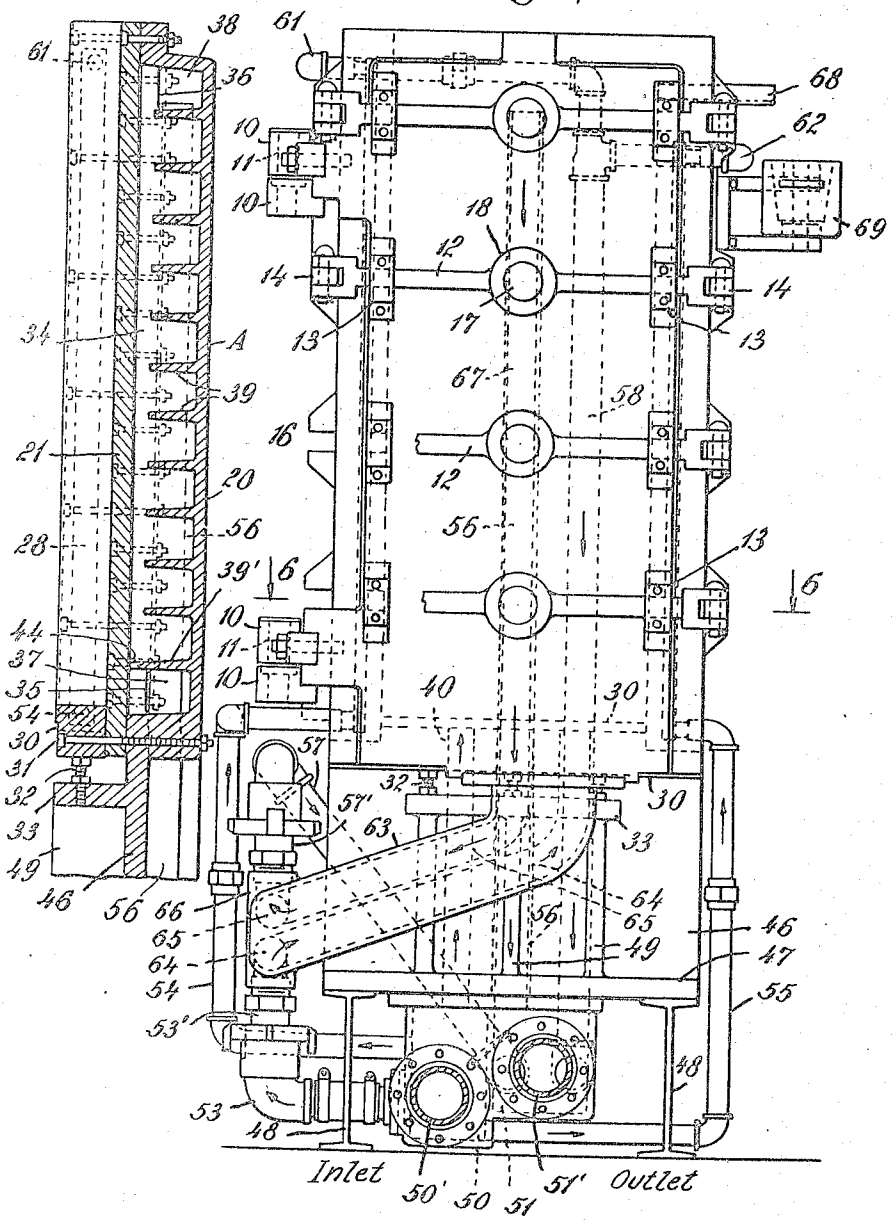
Oct. 7, 1947. E. C. FALK ET AL 2,428,657

WATER-COOLED SLAB MOLD

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Fig. 8,

Fig. 1,



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Fig. 2.

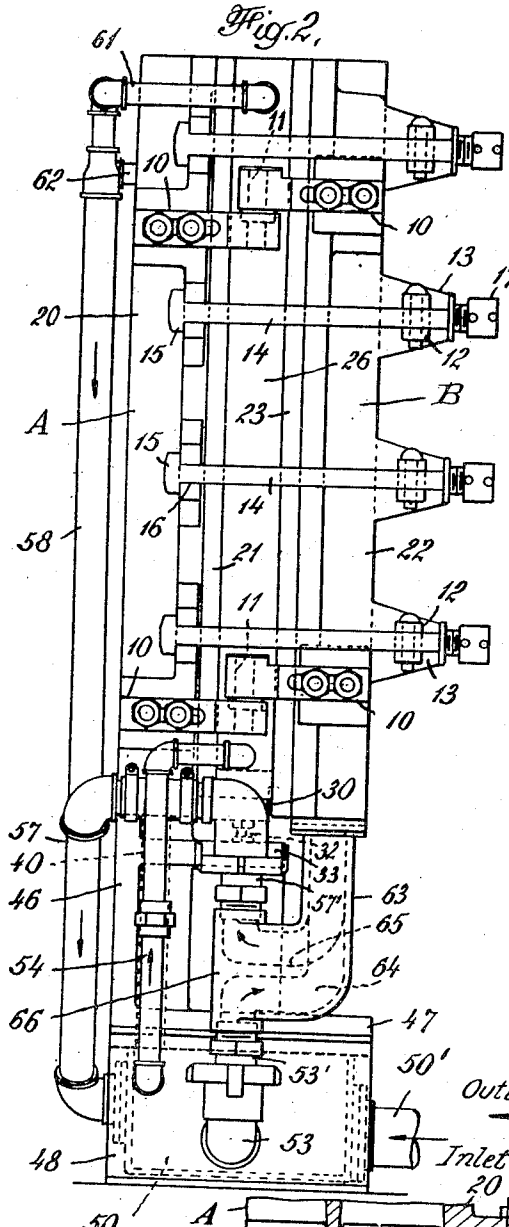


Fig. 3.

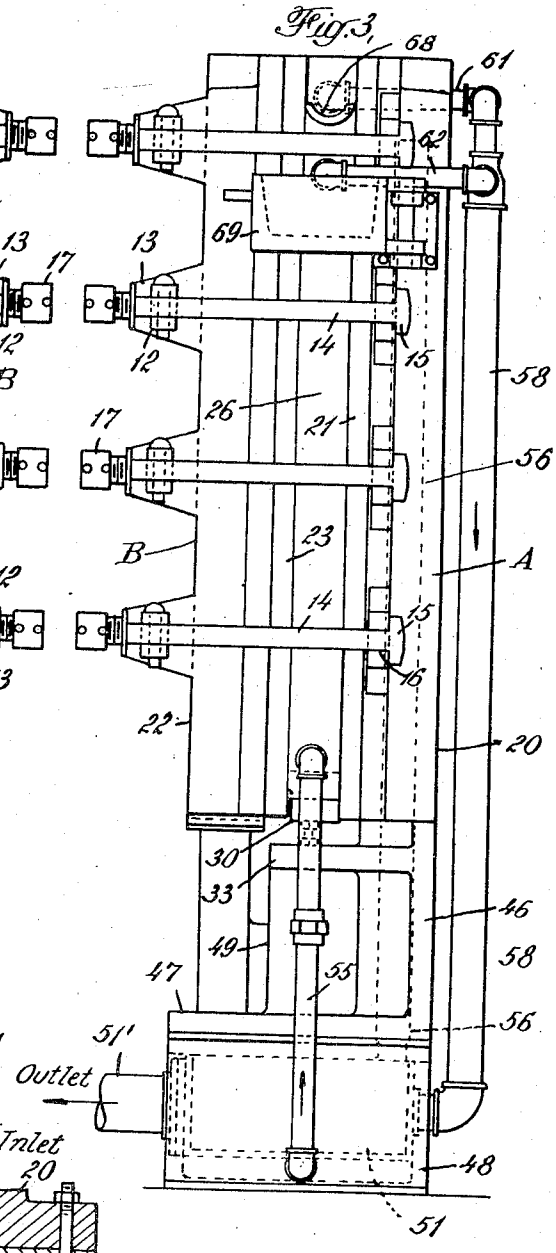
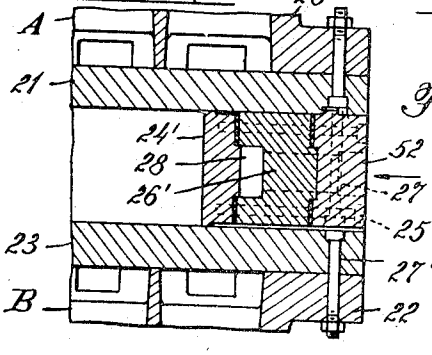


Fig. 9



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Fig. 4.

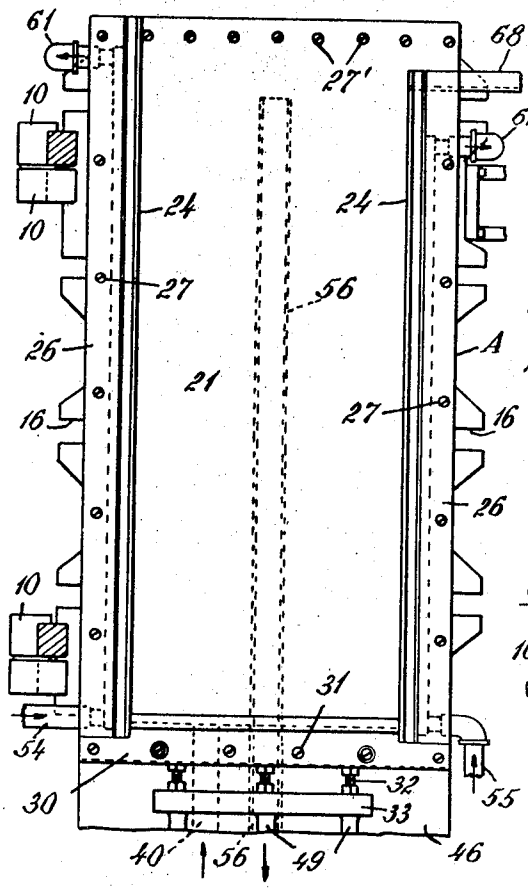


Fig. 5.

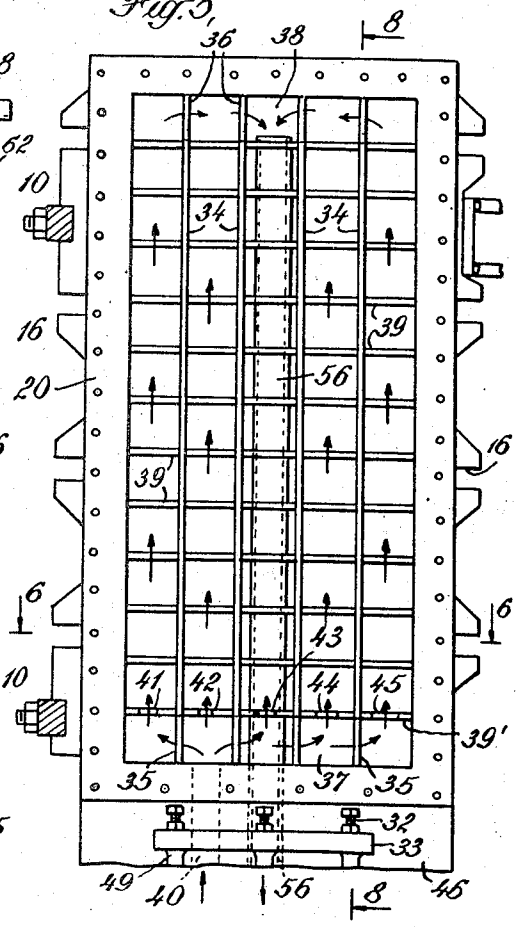


Fig. 6.

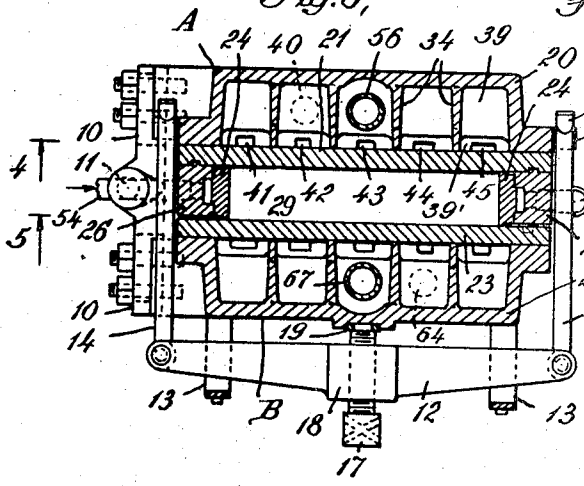
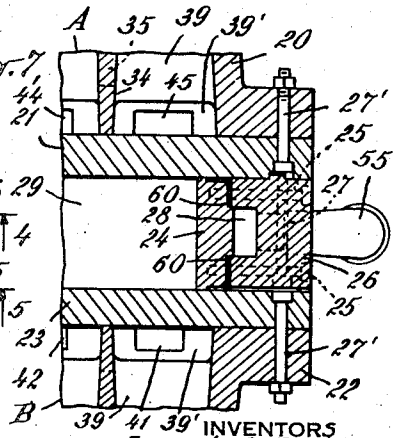


Fig. 7.



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WATER-COOLED SLAB MOLD

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Application February 15, 1944, Serial No. 522,459

5 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. The supply and withdrawal of the cooling medium to these compartments has heretofore been accomplished by a system of piping including several lengths of flexible hose or the like, particularly for the movable mold front.

The aim of our present invention is to provide a cooled slab mold of improved construction and appearance; and particularly to simplify the piping for delivering and withdrawing the cooling medium. A further aim of the invention is to provide for more uniform application of the cooling medium to the entire surface of the mold faces, and mold sides when cooled, and thus to more uniformly equalize the heat absorbed by the cooling medium. These and other objects of the invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a front elevation of the improved mold of the invention,

Fig. 2 is an elevation of the left side of the mold as viewed in Fig. 1,

Fig. 3 is an elevation of the right side of the mold as viewed in Fig. 1,

Fig. 4 is a front elevation of the mold back, with the mold front removed,

Fig. 5 is a front elevation of the frame and cooling compartment of the mold back, with the copper mold face removed,

Fig. 6 is a transverse section of the mold, on the section line 6—6 of Fig. 1,

Fig. 7 is an enlarged detail of the right end of the transverse section of Fig. 6,

Fig. 8 is a longitudinal side section of the mold back, on the section line 8—8 of Fig. 5, and

Fig. 9 is a transverse sectional detail of a modified form of mold side construction.

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The mold 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 member 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 movable mold member 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 member 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 or locked together by turning the bolts 17, screw-threaded in central bosses 18 of each yoke and pressing against aligning seats 19 on the outer face of the mold member B.

The stationary mold member A comprises a rectangular cast metal (e. g. iron) frame 20 and a rolled copper plate or mold face 21 appropriately secured thereto. The frame 20 is recessed or hollow to provide with the plate 21 a cooling compartment. The movable mold member B similarly comprises a rectangular cast metal frame 22 and rolled copper plate or mold face 23. The two mold sides are secured to the stationary mold member A and each comprises a copper plate or mold face 24 secured by bolts 25 to a backing bar or spacing block 26. The blocks 26 are secured to the member A by bolts 27 extending through registering holes in the intermediate copper plate. The inner face of each backing bar 26 is recessed to provide with its adjacent mold face 24 a longitudinal cooling compartment 28. Service packing 60 is included between the contacting surfaces of the mold face 24 and the backing bar 26 to provide a water-tight joint. In the accompanying drawings the copper plate is shown secured to its frame by round head bolts 27' fitting in counter bored holes in the plate and registering drilled holes in the frame. However, the plates may be attached to their respective frames by the construction described and claimed in our copending application for Letters Patent Ser. No. 522,460, filed February 15, 1944, whereby expansion and contraction of the plates during the casting cycle set up no undue stresses.

The copper face plates 22 and 23 and side plates 24 form a rectangular mold cavity 29. The bottom of the mold cavity is closed by a bottom bar 30, preferably of iron, chrome nickel iron, or the

like, secured by bolts 31 to the mold back A. Adjustable bolts 32 mounted in a bracket 33 on the depending foot of the mold back A help support the bottom bar 30 and prevent its sagging.

The frames 20 and 22 are substantial counter parts. Each has a series of spaced longitudinal or vertical ribs 34 dividing the recessed frame into a plurality of vertical channels. The frames of the mold illustrated in the drawings have five such vertical channels. The width or depth of the ribs 34 is the same as the depth of the recess in the frame. Each rib 34 has a transverse opening 35 at its bottom and a transverse opening 36 at its top. The bottom openings 35 register to provide an inlet manifold 37 for the five vertical channels, and the top openings 36 register to provide an outlet manifold 38 for all the channels. Each of the five channels has a series of spaced transverse ribs or baffles 39 of a width or depth somewhat shorter than the depth of the recess in the frame. While we have illustrated and described a mold with five vertical channels, it is to be understood that this is merely by way of example, since the mold may have fewer or more such channels.

A cooling medium, such as water, is admitted to the inlet manifold 37 of the mold back A through an inlet pipe 40 and to the inlet manifold 37 of the mold front B through an inlet pipe 64. The bottom or lowermost rib 39' in each vertical channel is positioned just above the bottom openings 35 of the longitudinal ribs, and differs from the other ribs above it in that it is of the same depth as the recess in the frame and has a vertical opening of predetermined size. These vertical openings 41, 42, 43, 44 and 45 are best shown in Figs. 5 and 6 and increase in size as their distance from the inlet pipe (40 and 64) increases in order to equalize the pressure and flow of cooling medium in each of the five vertical channels. Thus, the inlet pipe 40 is positioned directly below the smallest opening 42. The two adjacent openings 41 and 43 are equally distant from the inlet pipe 40 and are hence of the same size, but larger than the opening 42. The openings 44 and 45 are progressively larger being progressively farther from the inlet pipe 40. The openings are thus so graduated in size that equal distribution or flow of cooling medium takes place in the five channels.

The mold back A has a depending foot 46 preferably cast integrally with the frame 20. The foot has a base 47 resting on supports 48. Integral vertical ribs 49 extend between the base 47 and the bracket 33. The space between the base 47 and the floor accommodates a distributing chamber 50 for inflowing cooling medium, and a similar collecting chamber 51 for the out-flowing or exhaust cooling medium. Inlet and outlet pipes 50' and 51' communicate with the chambers 50 and 51, respectively.

The distributing chamber 50 has appropriate outlets for cooling medium, namely the substantially vertical pipe 40 communicating with the inlet manifold 37 of the mold back A, a pipe 53 communicating with the inlet manifold 37 of the movable mold front B, a pipe 54 communicating with the compartment 28 in the spacing block 26 of one of the mold sides (the left side as viewed from the front, Fig. 1), and a pipe 55 communicating with the compartment 28 in the other mold side. The collecting chamber 51 has appropriate inlets for returning cooling medium, namely the substantially vertical pipe 56 for cooling medium from the mold back A, a pipe 57 for cooling medium from the mold front B, and a pipe 58 for cooling medium from the two mold sides. The pipe 56 is a vertical standpipe or enclosed discharge conduit positioned in the middle vertical channel of the mold back A (Figs. 5 and 6), and extends upwardly to near the top of the recess in the frame 20 of the mold back A, and downwardly to its connection with the collecting chamber 51. The discharge conduit 56 may, of course, be positioned in any one of the vertical channels, and may in fact be a cast cored opening extending from near the top of the recess in the frame through the mold foot 46 to approximate its point of connection to the collecting chamber 51. In any event it is a cooling medium discharge conduit enclosed within the frame 20. The openings 36 near the upper ends of the vertical ribs 34 permit flow of the cooling medium from the tops of the vertical channels to the top inlet end of the conduit or pipe 56.

The inlet pipes 54 and 55 conduct the cooling medium to the bottom of the compartments 28 of the mold sides. Return cooling medium is conducted from the top of the left mold side (Fig. 1) by a pipe 61 connected to the pipe 58. Return cooling medium is conducted from the top of the other mold side to the pipe 58 through a pipe 62.

The inlet pipe 53 turns upwardly and terminates in a vertical nipple or section 53' in alignment with the axis of the pivot pins 11 (Figs. 1 and 2). The outlet or exhaust pipe 57 turns downwardly and terminates in a vertical nipple or section 57' in alignment with the axis of the pivot pins 11; the lower end of the section 57' terminating a short distance above the upper end of the aligning section 53'. A unitary cast metal manifold 63 having two separate cored holes or conduits 64 and 65 is secured at one end to the bottom of the mold front B and is mounted at the other end (66) to turn or swing about the axis of the pivot pins 11. The other end 66 of the manifold 63 is positioned between the ends of the aligning sections 53' and 57' and has a liquid-tight swivel connection with each section, permitting the manifold to be swung with the mold front about the axis of the pivot pins 11. One end of the cored hole 64 communicates with the vertical section 53' of pipe 53 and the other end of the cored hole communicates with the inlet manifold of the movable mold front B. Similarly, the cored hole 65 communicates at its ends with the vertical section 57' of the pipe 57 and an enclosed discharge conduit or standpipe 67 positioned in the middle vertical channel of the mold front B. The discharge conduit or standpipe 67, like the discharge conduit 56, extends upwardly from its connection with the cored hole 65 to near the top of the recess in the frame 22 of the mold front, and may be a cast cored opening in the frame 22 as hereinbefore mentioned in connection with the discharge conduit 56. The vertical ribs 34 of the frame 22 have openings (like the opening 36) permitting flow of the cooling medium from the tops of the vertical channels to the top inlet end of the discharge conduit 67.

Assuming the mold closed and locked, molten metal from a runner box or distributor (not shown) is poured into the top of the mold cavity 29 until metal flows from the spout 68 into the overflow box 69 pivotally supported from near the top of the mold back A. Cooling medium, such as water, circulates continuously through the vertical channels of the frames 20 and 22 and the compartments 28 of the mold sides. The circu-

lating medium rapidly carries away heat from the adjacent copper mold faces 21, 23 and 24. When the cast metal has set, the bolts 17 are turned to release the links 14, and the mold front B is then swung on its pivots through an arc of approximately 90°. The casting is removed, and the mold is ready to be closed and locked for another casting operation. Only two cooling medium connections are made to the mold, namely the inlet pipe 50' and the outlet pipe 51'.

In cooled slab molds of the heretofore customary construction, the cooling medium adjacent the copper mold faces flows upwardly, freely and unhindered, to the discharge outlet at the upper end of the water compartment. Our investigations have demonstrated that this construction does not afford a uniform distribution of the cooling medium to all parts of the copper mold faces, and hence does not uniformly cool the cast slabs. Our improved construction of the cooling compartments assures uniform distribution of the cooling medium. Thus, the cooling medium enters the manifold 37, formed by the lowermost transverse rib 39' and the openings 35, and flows into the five vertical channels through the graduated or metering slots 41—45. The transverse ribs 39 provide a series of deep pockets (see Fig. 8) 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 faces, and thereby effects a rapid and uniform equalization of the absorbed heat, since the cooling medium in contact with the copper mold faces is constantly changed by the turbulent and lively swirling action.

The flow of the cooling medium into each of the five vertical channels (of the mold back A and the mold front B) is regulated to give uniform distribution of the medium by the slots or openings 41—45. These slots are of predetermined graduated size to effect uniform distribution of the cooling medium to each of the five vertical channels, irrespective of the point of connection of the inlet manifold 37 to the inlet pipe 40 (or 64 in the case of the mold front B). Thus, the size of these slots increases as the distance of the slot from the inlet pipe 40 (or 64) increases.

The longitudinal ribs 34, in addition to forming the vertical channels, provide supports for the copper mold faces, and furthermore, in conjunction with the transverse ribs 39, reinforce the frames to withstand the clamping or locking of the mold members and the strains imposed by casting the slabs. The longitudinal and transverse ribbing is preferably cast integral with the metal frame. All of the ribbing is within the water compartments, so that the exterior of the mold is smooth, thereby avoiding the collection of spills, dirt etc.

Our invention provides a simple, neat and effective means for conducting the cooling medium to the movable mold front and withdrawing it therefrom. Since the mold front swings on its pivots or hinges through an arc of 90° or more, the cooling medium connections are made through swivel pipe connections, which heretofore have been troublesome and unsightly. According to our invention, the unitary cast manifold 63, with its two cored holes, is a permanent and rigid part of the mold. It provides a path of low friction loss for the flow of the cooling medium and materially improves the general appearance of the mold.

The distributing and collecting chambers or boxes 50 and 51 for the cooling medium are attached to the base or foot of the mold back, and permit convenient connection to the cooling medium inlet 50' and outlet 51', thereby saving time in initial installation, and when exchanging molds from time to time. All inter-connecting piping between the chambers 50 and 51 and the various cooling compartments of the mold are built into the mold and form a permanent part thereof, thus dispensing with the several flexible pipe connections heretofore used with molds of this type.

It has heretofore been usual to form the cooling compartment of the mold sides (where such cooling is necessary, as for example in casting slabs over about 2'' thick) in the copper mold face (i. e. 24). This involves machining the copper mold face to form the compartment, and requires an initial copper bar of sufficient thickness for the compartment, and involves an excess use of copper as well as the loss in machining. According to our invention, the backing bar 26 is made of cast iron or the like, and the water compartment 28 may be advantageously formed in it by a cast cored opening, although it may be formed by machining if desired. This permits the use of a rolled copper plate 24, of substantially uniform thickness as well as of less thickness than required when the cooling compartment is machined therein.

In order to cast slabs of varying widths in the same mold, it has heretofore been the usual practice to change the copper mold face (24) or backing bar (26) at one or both sides. Different mold faces or backing bars are used for each change, thus requiring a stock of different size mold faces or backing bars for each mold width.

We have found that changes in mold width can be more readily effected, with fewer stock parts of different size, by making the mold side of three members, namely (1) a copper mold face 24', an intermediate backing bar 26' and an outside backing bar 52 (Fig. 9), the backing bars being of cast iron or the like. The bar 52 is secured by bolts 27 to the mold back A, and the three members 24', 26' and 52 are secured together by bolts 25. Changes in mold width are obtained by using intermediate backing bars 26' of different widths, while retaining the same mold face 24' and outside backing bar 52. In Fig. 9, the cooling compartment 28 is shown as incorporated in the intermediate backing bar 26', but it will be understood that this feature of our improved mold construction may be equally well, and even more advantageously, applied where the cooling compartment is incorporated (by machining) in the copper mold face.

The improved mold of our invention provides for better and more uniform cooling of the cast metal than in the heretofore commonly constructed molds of this type. All of the pipes for the cooling compartments of the mold are rigid and connected as permanent parts of the mold. The location of the cooling medium supply and exhaust chambers beneath the mold simplifies the piping system and makes possible the short length of vertical pipe for the mold back. The permanent pipe connections insure tight coupling and connections, and eliminate the use of flexible hose with its attendant disadvantages of springing leaks and obstructing the normal operation of the mold. The mold and its piping is a unitary apparatus requiring only two outside

connections (50' and 51') for the supply and exhaust of the cooling medium.

In cooled slab molds, the mold faces and sides (when cooled) must have good heat conductivity for efficient transfer of heat from the cast metal to the adjacent cooling compartments. Rolled copper plate is now generally used for the mold faces and sides (when cooled), but it is to be understood that the mold faces and sides (when cooled) may be made of any other metal or material of equivalently good heat conductivity and not deleteriously affected by the molten casting metal. When not cooled, the mold sides may advantageously be made of chrome-nickel-iron. The backing bars, and intermediate backing bars when used, may be made of cast iron, cast or rolled steel, and the like. While it is advantageous to form the cooling compartment in the backing (or intermediate) bar as a cast cored opening, it may be machined if desired.

We claim:

1. In a mold for casting elongated metal slabs having a mold back and a complementary mold front pivotally mounted at one side of the mold back, the mold back comprising a recessed metal frame having a plurality of longitudinal ribs dividing the recess into a plurality of vertical channels, cooling medium supply and exhaust chambers positioned beneath the mold back, a mold foot directly beneath the mold back between the mold back and the supply and discharge chambers, a substantially vertical pipe connecting said supply chamber to the bottom of one of said vertical channels, and a discharge conduit positioned within said recess and extending upwardly to near the top of the recess and connected at its lower end to said exhaust chamber, both said pipe and said discharge conduit being disposed wholly within the mold foot over that portion of their lengths that connects the mold back with the supply and exhaust chambers.

2. 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 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, 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, cooling medium supply and exhaust chambers positioned beneath the mold back, a substantially vertical pipe connecting said supply chamber to the bottom of one of said vertical channels, and a discharge conduit positioned within said recess and extending upwardly to near the top of the recess and having a substantially vertical lower portion connected to said exhaust chamber.

3. 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 front comprising a recessed metal frame having a cooling medium inlet and a cooling medium outlet, a cooling medium supply pipe having a vertical section in alignment with the axis of the mold front's pivotal mounting, a cooling medium exhaust pipe having a vertical section in alignment with the axis of the mold front's pivotal mounting, and a unitary manifold having separate inlet and outlet conduits therethrough, one end of said manifold being secured to the bottom of the mold front with the inlet conduit registering with the cooling medium inlet of said recess and the outlet conduit registering with the cooling medium outlet of said recess, the other end of said manifold being positioned between the ends of the vertical sections of said supply and exhaust pipes and having swivel connections with those sections, the inlet conduit of the manifold communicating with said cooling medium supply pipe and the outlet conduit of the manifold communicating with said cooling medium exhaust pipe.

4. 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 front 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, 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, a discharge conduit positioned within said recess and extending from the bottom to near the top thereof, a cooling medium supply pipe having a vertical section in alignment with the axis of the mold front's pivotal mounting, a cooling medium exhaust pipe having a vertical section in alignment with the axis of the mold front's pivotal mounting, and a unitary manifold having separate inlet and outlet conduits therethrough, one end of said manifold being secured to the bottom of the mold front with the inlet conduit communicating with the bottom of one of said vertical channels and the outlet conduit communicating with the bottom of said discharge conduit, the other end of said manifold being positioned between the ends of the vertical sections of said supply and exhaust pipes and having swivel connections with those sections, the inlet conduit of the manifold communicating with said cooling medium supply pipe and the outlet conduit of the manifold communicating with said cooling medium exhaust pipe.

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 having a compartment with an inlet and outlet for cooling medium, a distributing chamber for cooling medium and a collecting chamber for exhaust cooling medium positioned beneath the mold, substantially vertical pipes connecting the cooling medium inlet and outlet of the mold back to said distributing and collecting chambers respectively, a cooling medium supply pipe and a cooling medium exhaust pipe terminating in spaced vertical sections in alignment with the axis of the mold front's pivotal mounting and communicating respectively with said distributing and collecting

chambers, and a unitary manifold having separate inlet and outlet conduits therethrough, one end of said manifold being secured to the bottom of the mold front with the inlet and outlet conduits communicating respectively with the cooling medium inlet and outlet of the mold front, the other end of said manifold being positioned between the spaced ends of the vertical sections of said supply and exhaust pipes and having swivel connections with those sections, the inlet and outlet conduits of the manifold communicating respectively with said supply and exhaust pipes.

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