

Dec. 9, 1958

I. E. COX

2,863,656

INJECTORS FOR FURNACES

Filed Sept. 20, 1955

2 Sheets-Sheet 1

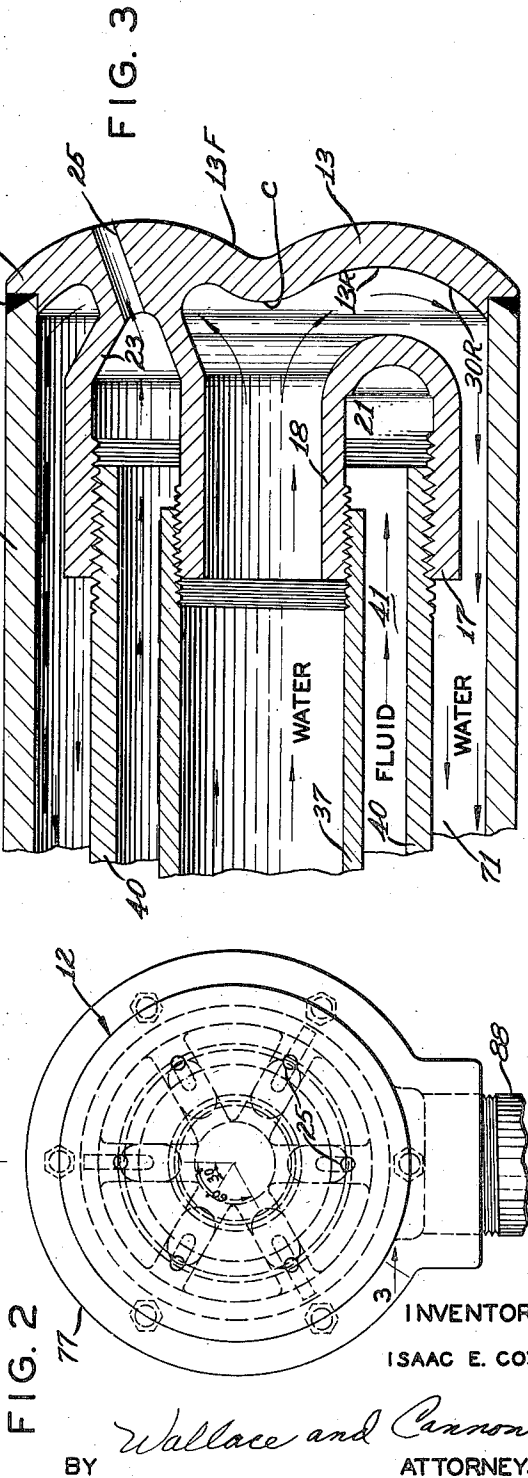
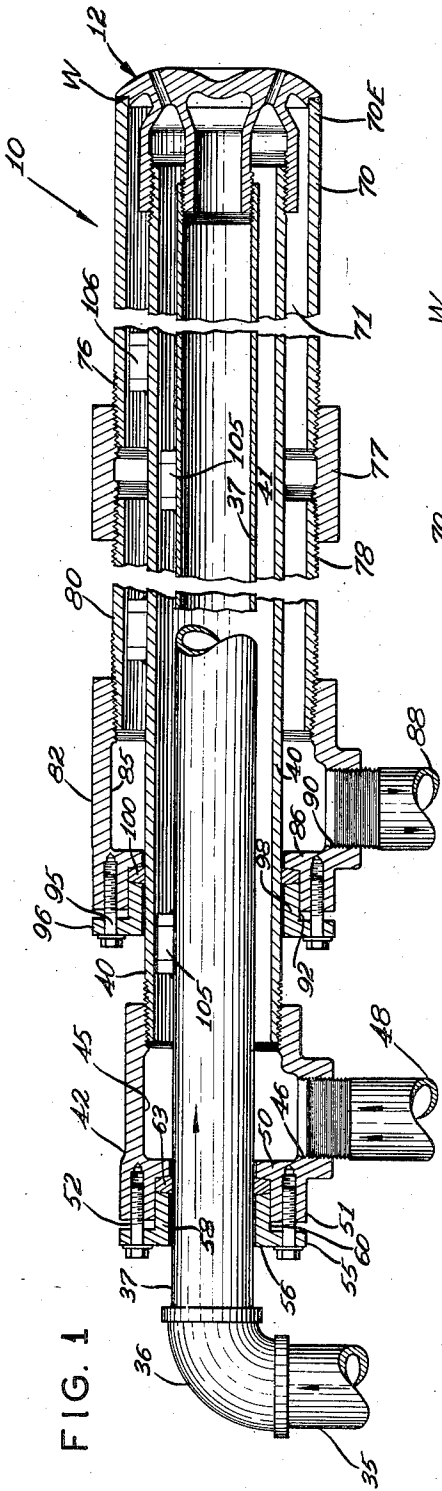
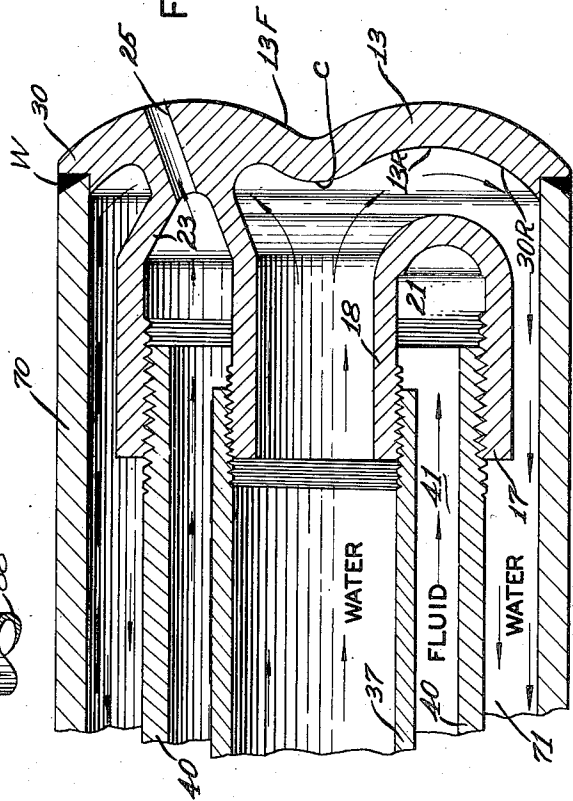


FIG. 3



INVENTOR
ISAAC E. COX

BY *Wallace and Cannon*
ATTORNEYS

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FIG. 5

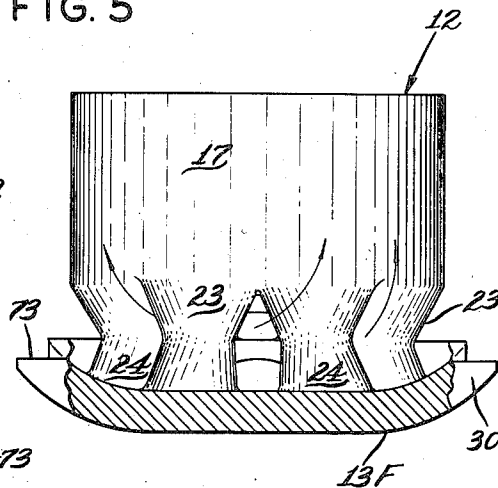


FIG. 4

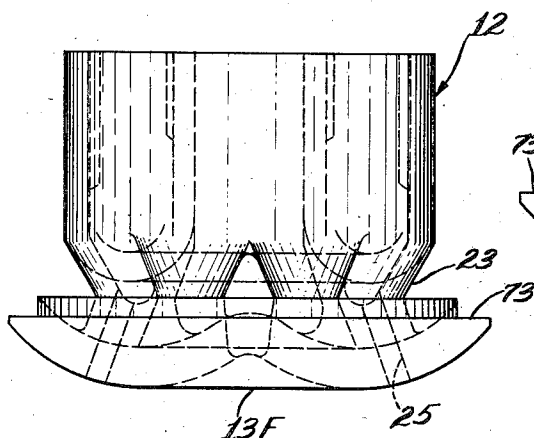


FIG. 7

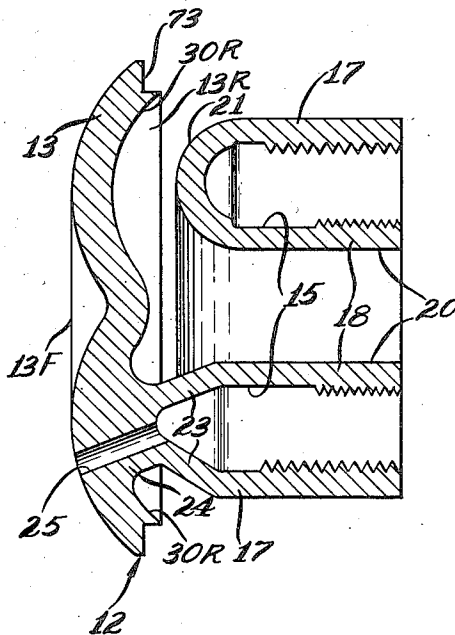
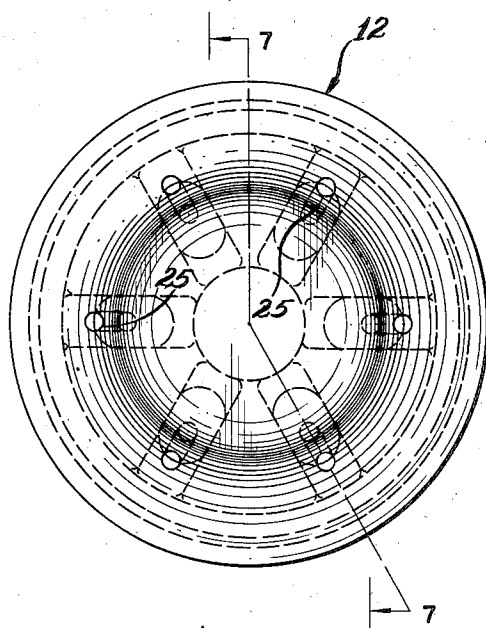


FIG. 6



INVENTOR

ISAAC E. COX

BY *Wallace and Cannon*

ATTORNEYS

1

2,863,656

INJECTORS FOR FURNACES

Isaac Eugene Cox, Kirkwood, Mo., assignor to American Brake Shoe Company, New York, N. Y., a corporation of Delaware

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6 Claims. (Cl. 266—41)

This invention relates to an injector for fluids, and in particular to a water cooled injector for introducing oxygen into an open hearth furnace to enhance combustion required for the melt.

In the production of steel by the open hearth process, it has been proposed that pure oxygen be introduced into the furnace to assist in supporting the flame over the melt. This has been accomplished in one way by an injector for pure oxygen having the discharge end or head thereof extending into the furnace at a point above the melt, and because of the extremely high temperatures encountered such injectors are arranged for water cooling. In spite of the cooling precautions used, however, the head of the injector that is exposed to the heat of the furnace has had an objectionably short life, and the primary object of the present invention is to remedy this objection by materially enhancing cooling of the injector head.

Open hearth oxygen injectors as heretofore constructed have conducted the stream of oxygen down the center of the injector so as to discharge the oxygen through narrow discharge passages about the center point of the head which account for a divergent stream of entrant oxygen into the combustion area. Surrounding the oxygen conduit in the injector are water inlet and return means, but this construction has not accounted for any direct cooling of the center of the head where the need for cooling is most critical.

Specifically, it is the object of the present invention to construct an injector of the foregoing kind with a cap having a discharge head and a chamber for cooling water that opens at the center of the rear face of the head. The cap includes fluid discharge means arranged concentrically in a set about the cooling chamber, and the construction is such that a constantly replenished supply of cooling water passes from the center of the head outwardly at right angles among the fuel discharge means to the outer extremities of the head and then rearwardly in a quick return past the fuel discharge means. Such construction accounts for an effective turbulent sweep or heat scavenging action of cooling water at the center of the head where the temperature is critical.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a vertical sectional view through the longitudinal center of the injector;

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Fig. 2 is an end elevation at the discharge end of the injector;

Fig. 3 is a detail sectional view on an enlarged scale taken on the line 3—3 of Fig. 2;

Fig. 4 is a side elevation of the cap at the discharge end of the injector;

Fig. 5 is a view similar to Fig. 4 broken away in part;

Fig. 6 is an end elevation at the front face of the injector cap; and

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 6.

The present invention is illustrated as embodied in an injector 10, Fig. 1, which is adapted to be inserted into the opening provided therefor in an open hearth furnace so that oxygen, in a way to be described, is injected into the furnace from the cap 12 of the injector. The cap 12 includes a head 13, Figs. 3, 5 and 7 having a rear face 13R and a front face 13F, the front face 13F being the face of the cap that is exposed to the heat of the combustion area.

In the present instance, the cap 12 is of cast copper and the head thereof is chilled. Extending rearwardly from the rear face of the head 13 are means affording an annular chamber 15, Fig. 7, and this chamber is to be supplied with gaseous fluid in the form of oxygen as will be described. Thus, the gas or fluid chamber 15 is defined by a sleeve-like outer wall 17, Fig. 7, and a sleeve-like inner wall 18 spaced radially inwardly from the outer wall 17. It will be observed that the inner wall 18 is of substantial diameter, and this affords an inner chamber 20 adapted to be supplied with a liquid coolant in the form of water as will be described below.

It will be observed from Figs. 1, 3 and 7 that the outer or gas chamber 15 terminates in an end wall 21 spaced from the rear face 13R of the head 13, so that the chamber 20 for cooling water opens just rearwardly of the center portion C of the rear face of the head of the injector cap. The center portion C of the head 13 is concavely bowed or recessed rearwardly as will be observed. At spaced circumferential intervals, the supply chamber 15 for oxygen is formed with reduced neck portions affording discharge nozzles 23 which communicate with a set of annularly spaced discharge passages 25 that are extended through the head of the cap in a forwardly diverging relation so as to open at spaced intervals at the front face thereof. The nozzles 23 are integral with relatively short stems 24, Figs. 5 and 7, that project rearwardly from the head of the cap where the passages 25 are provided, and these stems serve to connect integrally the fluid discharge supply means to the cap 12. The nozzles are progressively narrowed from the diameter of the outer chamber 21 to the greatly reduced diameter of the discharge passages 25. It will be further observed in Figs. 2 and 6 that the discharge passages 25 and the nozzles 23 are arranged in a cluster or set in regularly spaced intervals about the center portion C of the head which receives cooling water directly from the chamber 20.

Cooling water at a high velocity and in a constantly replenished stream, as will be described below, is directed from the chamber 20 against the center portion C at the rear face of the head of the cap. Striking the portion C of the head, this cooling water is diverted at right angles outwardly in a turbulent manner around the nozzles 23 and the stems 24 in the spaces therebetween as shown in Fig. 5. It has been found that this turbulence or sweeping action of the cooling water relative to the center of the head is most effective in extracting heat from this critical area of the injector, and suppresses the tendency for steam to form or collect.

Beyond the stems 24, the head of the cap is provided

with a flange 30 that is dished or convexed forwardly at 30R, Figs. 3 and 7, so as to assist in deflecting the cooling water directed outwardly to the extremities of the head rearwardly in a return direction past the outer wall of the gas chamber 15. In the manner thus described, all portions of the head of the cap about the gas supply and discharge means 23, 24, and 25 are exposed uniformly to an effective sweep of a constantly replenished supply of cooling water.

Under the present invention, the cooling water inlet and return means are in the form of conduits that are concentrically related, and the arrangement is such that the inlet conduit for cooling water communicates with the water cooling chamber 20, the gas inlet conduit communicates with the gas chamber 15, and the return conduit for water communicates with a passage surrounding the outer wall 17 of the gas chamber so as to receive cooling water deflected rearwardly from the outer portion 30R of the head of the injector cap.

Thus as will be observed in Fig. 1, an inlet pipe 35 for cooling water at a rate of about 400-500 gallons per minute is connected by an elbow 36 to an elongated water inlet pipe 37 serving as a conduit which extends from the cold end of the injector forwardly to the water chamber 20 of the injector cap, being threadedly connected thereto. The inner face of the outer wall 17 is likewise threaded to receive an end of a pipe 40 serving as a conduit for gas in the form of oxygen supplied to the chamber 15. Thus, the pipe 40 is of materially larger diameter than the pipe 37 so that oxygen may flow along the passageway 41, Figs. 1 and 3, between the pipes 37 and 40. The pipe 40 extends from the injector cap rearwardly in a concentric relation about the pipe 37 to a stuffing box 42, Fig. 1, and is threadedly connected thereto. As shown in Fig. 1, the stuffing box 42 affords a chamber 45 that surrounds a portion of the water inlet conduit 37, and the chamber 45 is provided with a threaded opening 46 in which is threadedly mounted an end of a pipe 48 connected at the opposite end to the oxygen supply source.

The chamber 45 is defined at one end by an annular lip 50 of slightly larger diameter than the pipe 37. Projecting beyond the lip 50 is a collar 51 tapped to receive fastening screws 52. The fastening screws 52 are extended through corresponding openings in the annular flange 55 of a packing gland clamp 56 which includes a stub sleeve 58 adapted to be telescoped on to the pipe 37. The stuffing box 42 rearwardly of the flange 50 is recessed at 60 to receive the stub sleeve 58, and interposed between the flange 50 of the stuffing box and the end of the stub sleeve 58 is a packing gland 63 which is adapted to be compressed by tightening the screws 52 to thereby seal the oxygen inlet chamber 45.

The return means for cooling water deflected rearwardly from the head of the injector cap is afforded by a short pipe 70 of such diameter as to afford a passage 71 between the pipe 70 and pipe 40 sufficient to handle the turbulent return flow of coolant at the required rate. In affording the return passage 71 for cooling water, the outer edge of the injector cap is provided with a peripheral rabbet 73, Figs. 4, 5 and 6, so as to be complementary to the inner or hot end 70E, Fig. 1, of the conduit 70, and the cap 12 is welded at W, Figs. 1 and 3, thereto. To enable the pipe 70 and the attached head 12 to be readily disassembled, the conduit 70 at the end opposite the weld W is threaded at 76 to receive a coupling 77, and the coupling 77 is likewise threaded on to the threaded portion 78 of a pipe 80 affording a return conduit for cooling water. Thus, the pipe 80, as shown in Fig. 1, is concentrically spaced relative to the pipe 40 to extend the return passageway for cooling water, and at the end opposite the coupling 77 is threaded into one end of a stuffing box 82.

The stuffing box 82 is provided with a chamber 85 for cooling water, and this chamber 85 is defined at one end by a flange 86 of slightly larger diameter than the

pipe 40. A return pipe 88 cooling water is threadedly connected to an opening 90 in the stuffing box 82 and communicates with the chamber 85 to receive cooling water from the passageway 71.

A portion of the stuffing box 82 extends rearwardly beyond the flange 86 and is recessed at 92 and is tapped to receive fastening screws 95. The fastening screws 95 are mounted in openings in the vertical flange 96 of a packing gland clamp having a stub sleeve 98 adapted to mate with the recessed portion 92 of the stuffing box 82. A packing gland 100 is interposed between the flange 86 and the end of the stub sleeve 98, and is adapted to be compressed by tightening the screws 95 to thereby seal off the water return chamber 85.

It is advantageous to utilize centering spacers between the pipes, and such may take the form of spacer blocks 105 and 106, Fig. 1, welded to the outer walls of the pipes 37 and 40 respectively. Under conditions of normal use, the several pipes included in the injector 10 tend to expand, and the particular construction of the stuffing boxes enables this to occur freely.

It will be seen from the foregoing that under the present invention, the head included in the cap at the hot end of the fuel injector is subjected to cooling in substantially all portions thereof including the central portion where the need for cooling is critical, the outer extremities beyond the fluid discharge means, and as well the portions of the head where the discharge nozzles 23 communicate with passages 25. Such cooling is attained by a constantly replenished supply of cooling water supplied at a relatively high rate of flow, and the desired cooling at the critical area of the injector head is accomplished by a construction that enables the stream of liquid coolant to break or turn turbulently at substantially 90° in an effective heat exchange relation.

Hence, while I have illustrated and described the preferred embodiment of my invention, it is to be understood that this is capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims:

I claim:

1. An injector for discharging fluid into a combustion area comprising, means affording an inlet conduit for coolant, means affording an inlet conduit for said fluid outwardly concentric to said inlet means for coolant, means affording a return conduit for coolant outwardly concentric to said fluid inlet means, and a cap on the end of the injector that is to be disposed toward the combustion area, said cap including a head having a front face that is to be exposed to the combustion area and having spaced fluid discharge passages therein, means affording a central coolant chamber in said cap in communication with the coolant inlet conduit and for directing coolant forwardly against the center portion of the head of the cap, a chamber for said fluid in said cap surrounding the coolant chamber and adapted to receive fluid from said fluid inlet conduit, means affording spaced apart nozzles for supplying fluid from said fluid chamber to the spaced passages in the head of the cap, means on the cap for causing coolant directed centrally against said head as aforesaid to flow toward the outer portions of said head and then rearwardly past said nozzles to the return conduit means for the coolant, a stuffing box tightly coupled to said return conduit and slideably mounted concentrically on said fluid inlet conduit and affording an outlet chamber for return coolant concentric to said fluid inlet conduit, and another stuffing box tightly coupled to said fluid inlet conduit and slideably mounted concentrically on said coolant inlet conduit and affording an inlet chamber for said fluid.

2. An injector having a head for discharging fluid into a combustion area comprising, means affording a water inlet for cooling the head of the injector, means af-

fording an inlet for fluid to be discharged from the head of the injector, means affording a return for water that has been used for cooling the head of the injector, and a cap on the end of the injector that is to be disposed toward the combustion area, said cap including a head as aforesaid having a front face that is to be exposed to the combustion area, means at the rear of the head affording a chamber in communication with the water inlet means and for directing cooling water against a portion of the rear face of said head, fluid discharge means formed in said head so as to receive fluid from said fluid inlet means and to discharge fluid through said head as aforesaid, means to enable the cooling water to flow in a constantly replenished supply from said portion of the head to other portions of the head and then rearwardly to the return means for water so that substantially the entire area of the head about the fluid discharge means is subjected to a sweeping action of the cooling water, a stuffing box tightly coupled to the water return means and slideably mounted concentrically on said fluid inlet means to provide a discharge chamber for return cooling water, and a stuffing box tightly coupled to said fluid inlet means and slideably mounted concentrically on said water inlet means to provide an inlet chamber for said fluid, said slideable mountings for the stuffing boxes enabling differential expansion of said inlet and return means to occur.

3. In an injector for directing fluid under pressure into the combustion area of a furnace for supporting combustion, a cap having a head to be exposed at the front face thereof to the heat of the combustion area, a pair of substantially parallel solid concentric sleeve-like walls at the rear face of said head having front and rear ends, said walls being radially spaced to afford between them an annular outer chamber for reception of said fluid, the inner one of said walls being substantially centered relative to the rear face of said head and said inner wall enclosing an inner chamber having a forward end directly in communication with the center portion of said rear face whereby coolant supplied under pressure in a constantly replenished supply to said inner chamber is forcefully directed against said center portion of the rear face of the said head to cool the head, said head having relatively narrow discharge passages formed therein and extended from openings at said rear face of said head, said discharge passages surrounding said center portion of the rear face of the cap head, said concentric walls being joined at their front ends adjacent the rear face of the head by an end wall spaced from the rear face of said head and said end wall having a plurality

of spaced nozzle means formed thereon which are connected to the rear face of said head and which establish communication between said outer annular chamber and the openings of the discharge passages at the rear face of said head whereby fluid under pressure in said outer annular chamber will be directed from said outer chamber and through said nozzle means and discharge passages for emission into said combustion area at the front face of said head and whereby coolant supplied under pressure to said inner chamber and first directed against the center portion of the rear face of said head will be directed radially outwardly in a turbulent manner among said nozzles and in sweeping contact with remaining portions of the rear face of said head, the outer one of said concentric walls being spaced inwardly of the outer edges of said head to enable said head to be joined at said outer edges to a return conduit for coolant collected in the area between the outside of said outer wall and the outer edges of said head, and the rear face of said cap being rearwardly convexed at the center portion thereof and being concaved forwardly at portions adjacent said outer edges thereof to encourage turbulence and impart a sharp radial outward turn to coolant first directed against said center portion and to assure quick return of said coolant rearwardly past said nozzle means.

4. An injector cap according to claim 3 wherein said concentric walls are threaded at their rear ends for union to inlet conduits for fluid and coolant respectively.

5. An injector cap according to claim 3 wherein said discharge passages are of greatly reduced diameter in comparison to the diameter of said outer annular chamber and wherein said nozzles are progressively narrowed from the diameter of said outer annular chamber substantially to the diameter of said discharge passages.

6. An injector cap according to claim 5 which is a one-piece casting.

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