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[54] **UNDERFIRED FORGING DIE HEATER**

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[52] **U.S. Cl.** **72/342**
[51] **Int. Cl.** **B21j 1/06**
[58] **Field of Search** .... 72/342; 100/93 P

[56] **References Cited**

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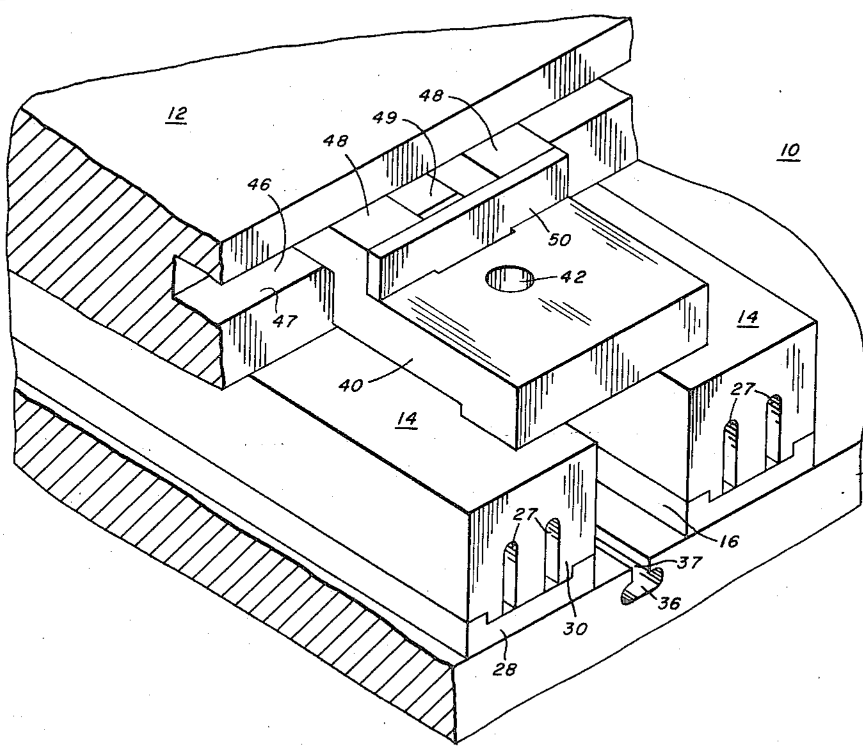
[57] **ABSTRACT**

A structure providing efficient gas heating of forging dies comprising a plurality of bearing bars made of a high strength metal located between the dies of a forging press and respective die supporting structures. The bars are spaced apart to accommodate gas fired burners and layers of heat insulation in such a manner that only the bearing bars receive forging loads, the layers of insulation and the burners, being accommodated in the spaces between the bearing bars, receive no forging loads. The bearing bars are provided with longitudinally extending openings for preheating and conducting the gas (or gas-air mixture) to the burners, and for limiting the conduction of heat from the dies to the die supporting structures. Each die supporting structure includes a plate or platen provided with slots adapted to receive and retain die clamping bolts, the bolts being located between adjacent bearing bars, and extending from the plate to and through respective clamps engaging the edges of the die and portions of at least two adjacent bearing bars extending beyond the edges of the die.

3 Claims, 4 Drawing Figures



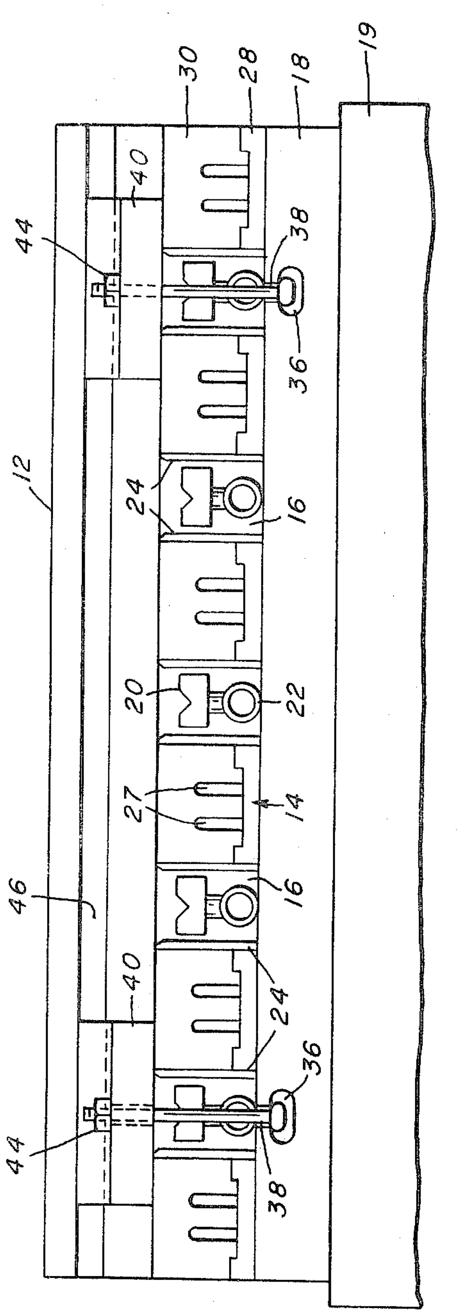


FIG. 1.

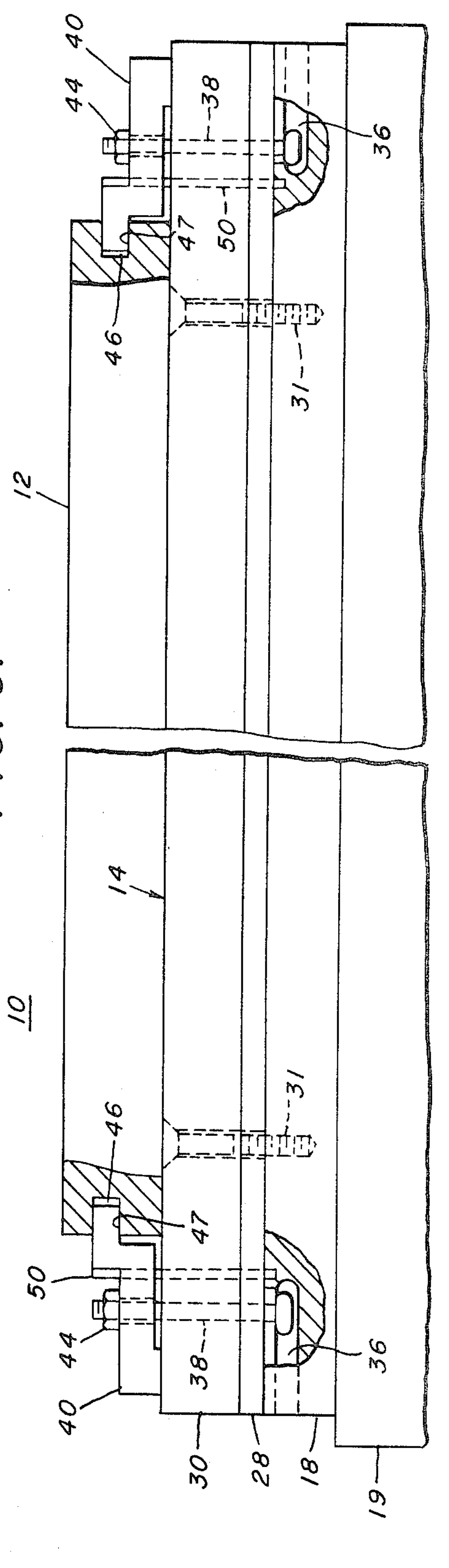


FIG. 3.

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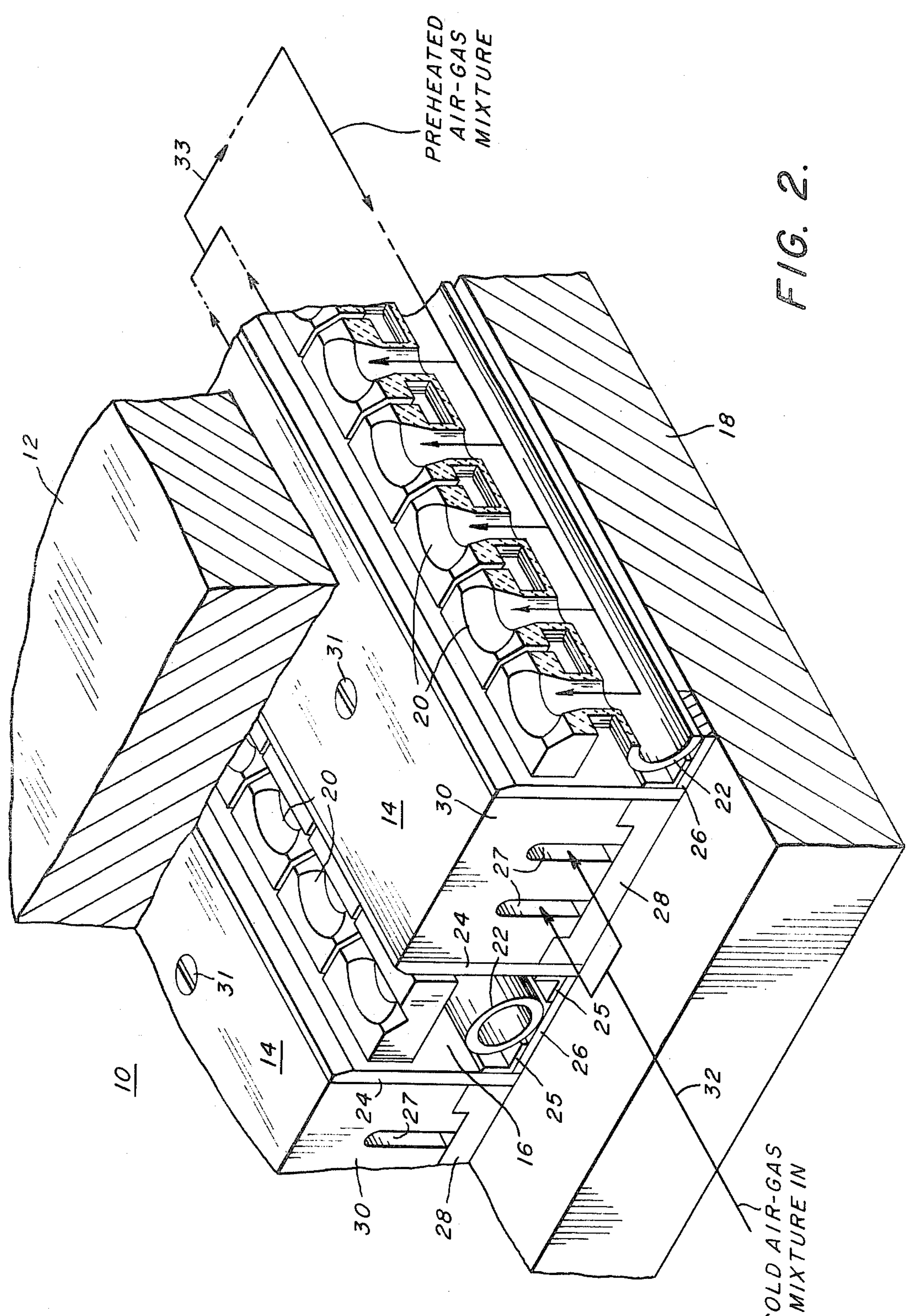

FIG. 2.

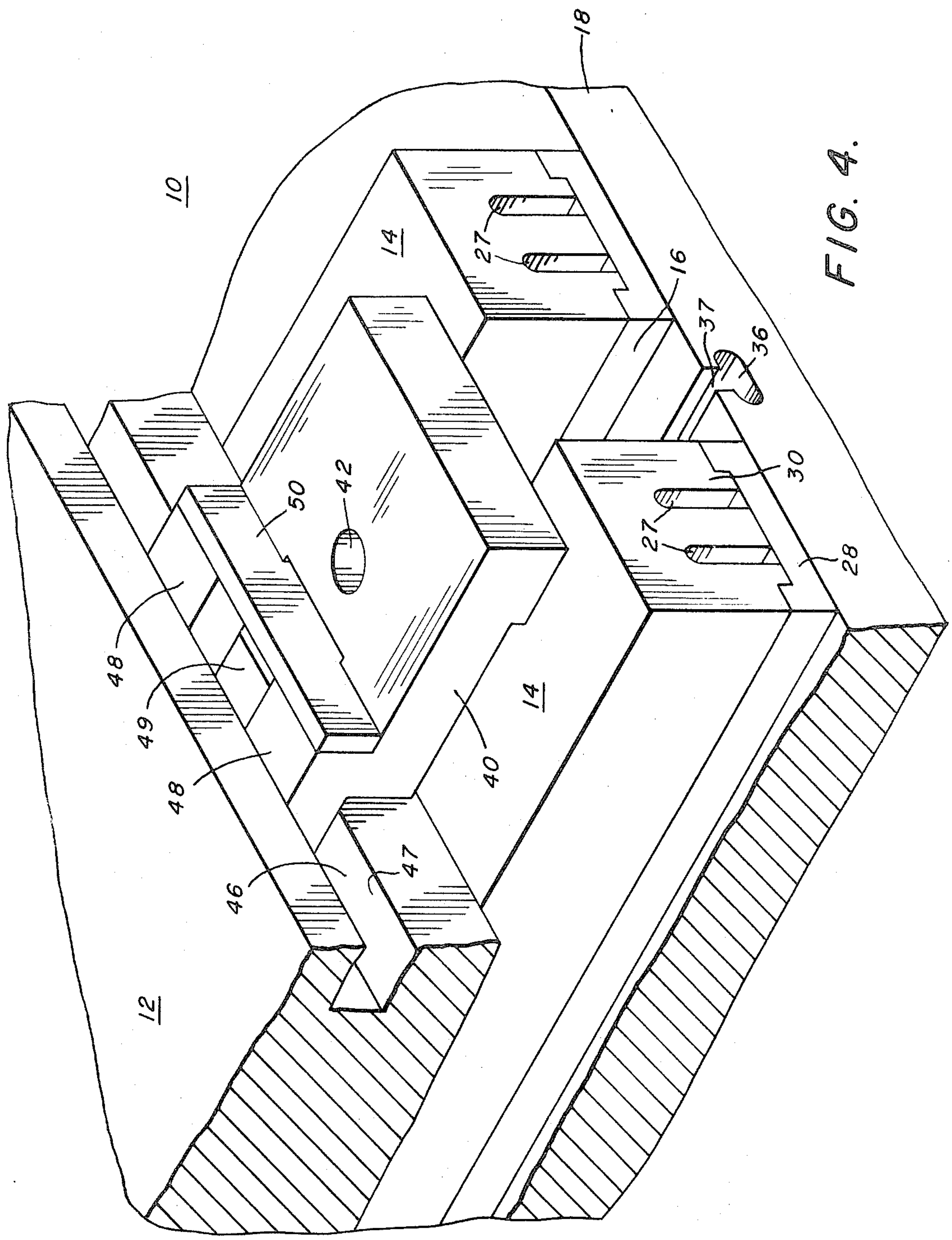

FIG. 4.

UNDERFIRED FORGING DIE HEATER

BACKGROUND OF THE INVENTION

The present invention relates generally to forging presses, and particularly to a die for forging presses that is heated by gas supplied burners located at the base of the die.

One of the problems in attempting to heat the dies of a forging press is the excessive heat loss to the die supporting structures and platens and to the press bed and ram. With large, massive presses, the heat conduction problem is increased in like proportions over the smaller, less massive presses.

Attempts to insulate forging dies from the die supporting structure and remainder of the press with the use of die heating systems, particularly for large presses, have been largely unsuccessful because there are no insulating materials that can withstand large forging press loads at the temperatures generally encountered in heated forging dies, i.e., loads of 5,000 to 80,000 psi and higher at temperatures on the order of 600 to 900°F.

Layers of insulation have been used to insulate heated sheet metal forming dies from their supporting structures but the pressures and temperatures involved are not near as large as those employed in forging presses. For example, forming pressures are generally in the range of 100 to 1,000 psi, the forming of relatively soft metals and alloys being in the lower portions of the above range while forming the harder metal and alloys requires pressures in the upper portion of the range. As can be readily seen, the highest of the forming pressures does not approach the forging pressures mentioned above.

Electrical resistance and induction heating of forging dies have been tried but even at moderate voltages (i.e., 120 and 240 volts) such systems create a safety problem for personnel working with and/or near the press. This is particularly so when metal tools and graphite-containing lubricants are used with the press. In addition, no scheme has been developed to protect the heating elements and their electrical connections with normal handling of the dies, and each die has to be equipped with the heaters, thereby adding to the construction cost of each die. Further, with electrical heaters, a major investment is required to equip the press with transformers and electrical controls to provide adequate power for the heaters.

Ideally, the requirements for heating forging dies are as follows. The heating system should (1) be adaptable to existing dies without alteration; (2) should provide a uniform temperature in the die cavity and thus a favorable temperature distribution throughout the mass of the die; (3) should have a low cost of construction; (4) should not substantially increase production set-up time; (5) should transfer a maximum percentage of the heat produced into the body of the die; (6) should permit the use of conventional die clamping systems; and (7) should avoid excessive thermal stresses in the die and its supporting plate.

In the prior art, these ideals have not been attained so that there is thus needed in the forging press art a die construction that permits the die to be readily heated throughout its width and breadth in an efficient, economical manner, and in a manner that effectively insulates the die from its supporting structures so that the heat conduction from the die is negligible.

BRIEF SUMMARY OF THE INVENTION

This is accomplished in the present invention by use of gas fired burners located between bearing blocks or bars separating a die from its supporting structure in a forging press, and between layers of insulation located along the sides of the bars facing the burners. The bars are effective to receive the full press load in a forging operation while the layers of insulation and burners remain protected from the forging loads by the bars. The burners are in close proximity to and face in the direction of the base of the die so the heat from the burner flames is directed onto the die while the layers of insulation limit the conduction of heat from the burner area into the bearing bars, and thus into the remaining supporting structure for the die.

Preferably, the bearing bars are not solid structures, but are, instead, provided with openings extending longitudinally therethrough. The openings are connected in fluid communication with manifolds that supply fuel gases or a fuel gas-air mixture to the burners. In this manner, the bars conduct and thereby preheat the gases supplied to the burners. The preheating of the gases cools, i.e., extracts heat from the blocks, the cooled blocks serving further to insulate the heated die from its supporting structure. In addition, the openings in the bars reduce the cross sectional area thereof thereby reducing the amount of metal available to transfer heat from the base of the die to the platen.

The die supporting plate, in the present invention, is preferably provided with slots located adjacent at least two opposed edges thereof for receiving and retaining the head of die clamping bolts. The slots permit rapid and easy attachment and removal of die to and from the plate (and press), as explained in detail hereinafter.

THE DRAWINGS

The invention, along with its advantages and objectives, will be best understood from consideration of the following detail description in connection with the accompanying drawings in which:

FIG. 1 is an end elevation view of a structure for heating a forging die in accordance with the principles of the present invention;

FIG. 2 is a partial perspective view of the structure of FIG. 1;

FIG. 3 is a side elevation view of the structure of FIG. 1; and

FIG. 4 is a partial perspective view of the structure of FIG. 1 showing a die clamp and the slotted die supporting plate of the invention.

PREFERRED EMBODIMENT OF THE INVENTION

Referring now to the drawings, FIG. 1 shows, in elevation, a structure **10** for heating a forging die **12** with gas fired burners. More particularly, the structure **10** comprises a plurality of spaced apart, elongated bearing blocks or bars **14** providing similarly spaced apart heating spaces **16** therebetween, and between the die **12** and a plate **18** supporting the die and bars on the bed **19** (only partially shown) of a forging press (represented only by the bed **19**). The spaces **16** accommodate gas burners **20** mounted on and in fluid communication with elongated, gas conducting manifolds **22** (FIG. 2) extending through the spaces. The burners, which may comprise a row of cups integral with and located over the manifold, face in the direction of and are located near the base surface of the die 12 in the distributed manner provided by the spaced bars. Such burner structures are commercially available, the Selas Duradiant burner, manufactured and sold by the Selas Corporation of America, Dresher, Pennsylvania, having been found to be a suitable burner for the purposes of the present invention.

In the figures of the drawings, only a lower die heating structure is shown since a substantially identical, upper die heating structure would be attached to the movable platen (not shown) of the press.

In the spaces 16 and adjacent the surfaces of the bars 14 facing the burners 20 are located layers of heat resistant insulation 24. The layers of insulation are thus located on each side of each row of burners and its associated manifold 22, and may be attached to the manifold and burners in the manner suggested in FIG. 2 though the invention is not limited thereto. In FIG. 2, the two layers of insulation (respectively located on each side of the manifold and burners) are respectively attached to two angle pieces 25 located in the corners formed by the insulating layers and a flat strip 26 resting on the plate 18 beneath the manifold 22. The angle pieces, in turn, may be attached to the flat strip 26, and the strip attached to the bottom side of the manifold. A suitable number of such strips are spaced apart along the length of the manifold. In this manner, each row of the burners and its manifold is provided with an insulating system that is properly located and installed when the burners are located in the spaces 16. The layers of insulation 24 extend throughout the length of the spaces 16 between the burners and the bearing bars to prevent substantial conduction of burner heat into the bars and thus into the die supporting plate and the bed (and movable platen) of the press as explained in greater detail hereinafter.

The bearing bars are preferably made with openings 27 extending longitudinally therethrough for the purpose of providing further cooling of the bars, as explained in detail hereinafter. To this end, each of the bars is preferably at least a two piece structure comprising an elongated hard metal piece 28 located against supporting plate 18, and a second elongated hard metal piece 30 provided with U-shaped openings 27 (inverted in the drawings). The open end of each U extends to one surface of the piece 30, and is closed by the surface of the piece 28 disposed in mutual engagement with the one surface of piece 30. The two piece structure of the bars is an expedient for providing the openings 27 therein. A unitary bar with a longitudinal opening or openings would function in the same manner as the two piece structure for the purposes of the invention. The mutually engaging surfaces of the bar pieces 28 and 30 may be stepped, as shown, to form mating, close fitting faces.

The bearing bars 14 may be a part of the press by being secured thereto by bolts 31 extending through appropriate openings located between the openings 27 in the bars, and threaded into the plate 18, as shown in dash outline in FIG. 3. Only two bolts are shown for purposes of illustration. The openings are countersunk at the die engaging surface of the bars to accommodate the bolt heads and thereby present an essentially smooth surface for proper seating of the die.

The openings 27 provided in the bearing bars 14 are serially connected between the manifolds 22 and a supply (not shown) of the gas of air and gas mixture for the burners 20, as indicated schematically in FIG. 2 by arrow lines 32 and 33. The connections can be made in any suitable manner, the actual construction thereof forming no part of the present invention.

In using the present invention, as thus far described, the bearing bars 14 are placed on the plate 18 of the press 19 (and on the moving platen portion of the press not shown) in the spaced apart manner shown in the drawings, and secured to the plate 18 by the bolts 31 just described. The die 12 is secured to the press and bars by a suitable clamping means, preferably by the die clamping means best depicted in FIGS. 3 and 4. More particularly, the surface of the die supporting plate 18 facing the die (and bearing bars) is provided with slots 36 (having a narrow neck portion 37 adjacent the surface) extending into the plate from outer edges thereof, as indicated in FIG. 3 in partial section.

As shown in FIGS. 1 and 4, the bearing bars 14 and slots 36 are positioned such that the spaces 16 between the bars are substantially centered over the slots. The purpose of this is to accommodate bolts 38 between the bars, the bolts extending from the slots to respective clamps 40 engaging two adjacent bearing bars and located astraddle respective spaces 16 therebetween. The bolts and clamps are effective to conveniently secure the die and bearing bars to the plate 18 in a manner presently to be explained.

As seen in FIGS. 3 and 4, the bearing bars 14 and the plate 18 extend beyond opposed ends or sides of the die 12 to accommodate the clamps 40 on the exposed surfaces of two adjacent bars and the bolts 38 therebetween. The head of each bolt is held within the slot 36 by the shoulder or ledge formed by the narrow neck portion 37 of the slot while the other end of the bolt extends through an opening 42 (FIG. 4) in the rear of the clamp to receive a nut 44.

The opposed ends or sides of the die 12 are slotted at 46 to receive the forward portion of each clamp 40, as best seen in FIG. 3. This requires the clamp to have a stepped configuration so it can extend over and engage the ledge 47 of the die (formed by the slot 46), as shown in FIGS. 3 and 4. In addition, the forward portion of the clamp is preferably bifurcated to provide two leg portions 48 separated by an opening 49 (FIG. 4) for purposes presently to be explained. Within the opening 48 is located the leg portion of a T-shaped, heat resistant, insulating board 50, the leg portion of board extending downwardly between the leg portions of the clamp to, and preferably into the upper surface of the plate 18, as indicated in FIG. 3. The upper, laterally extending arm portions of the insulating board 50 (i.e., of the T) rest on the upper rear surface of the clamp 40, as best seen in FIG. 4.

The clamping structure, as thus far described, provides a convenient and inexpensive means for clamping the die 12 to the press 19. It can be appreciated that with the bolts 38 held loosely in place in the clamps 40 by the nuts 44, the die is quickly and conveniently clamped to the press by slipping the heads of the clamping bolts into the slots 36 of the plate 18 from the sides thereof, while the clamps are disposed to rest on the two adjacent bars 14 above each slot, with the forward portion 48 of the clamp located in the slot 46 provided in the side of the die.

The nuts 44 are then tightened to complete the clamping process. In FIG. 1, only two of the clamps 40, with their associated bolts and slots 36, are shown on the side in view for purposes of illustration. On the opposite side two more such clamping means would be employed. However, the number of clamps and their locations depends upon such factors as the size of the die and press involved.

In a forging operation using the structure of the present invention, a combustible fluid, such as a fuel gas or air and gas mixture is simply supplied to the burners via the manifolds **22** and the openings **27** in the bearing bars, and the burners ignited using any suitable ignition means. The flame from the burners is directed to the base of the die **12** to heat the die. Since the flames of the burners is directed only to the die, and with the layers of insulation **24** located between the flame and the bearing bars, and major portion of the heat of the flames is directed to and into the die body, the layers of insulation preventing substantial conduction of heat into the bearing bars from the spaces **16.** Because the burners are distributed over the base area of the die in the present invention, the distribution of the heat provided by the burner flames is throughout the body of the die to provide an essentially uniform distribution of temperature in the working cavity of the die. With the bars insulated from the heat zone, i.e., from the burner flames, conduction of heat from the bars to the press bed and ram is negligible.

Conduction of heat from the bearing bars **14** to the press is further limited by the heat exchange function that takes place with the flow of fuel gas through the bars (through bar openings **27**) on its way to the burners. The gas, in passing through the bars, is heated, and the bars cooled to provide simultaneously two desirable functions, namely, preheating of the gas or gas-air mixture to increase flame temperature at the point of combustion **20** thereby increasing heat transfer to the die base, and the above-mentioned cooling of the bearing bars. The stepped configuration of the mating faces of bar pieces **28** and **30,** which are tightly secured together by the bolt **31,** serve to prevent substantial escape of gas between the mating faces.

It can be appreciated that the insulation **24** in the present invention is not subject to forging pressures and therefore are not subject of the destructive forces of such pressures. Rather, both the insulation **24** and the burners **20** are protected from forging pressures by the bearing bars **14,** which bars carry the full forging loads of the press. For reason, the bars are made of a high strength material, die steels for example.

As the flames from the burners heat the die, exhaust gases and products of combustion are directed from the ends of the spaces **16** (accommodating the burners). The escaping gases and products from the lower die heating construction rise upwardly along the exposed sides of the die to heat the same, thereby enhancing die heating and reducing thermal stresses in the die. From the lower die construction, the heat and gases rise upwardly to heat the outside surfaces of the upper die mounted on the ram of the press, thereby providing essentially the same beneficial thermal effects on the upper die as provided for the lower die.

At the location of the clamps **40** on the die sides, the spaces **16** are closed off by the T-shaped insulating boards **50,** which boards direct the exhaust gases through the openings **49** provided in the clamps. In this manner, the exhaust gases are directed along the sides of the die **12** to heat the same while the boards **50** simultaneously insulate and thereby protect the clamping bolts **38** from the heat of the burners within the spaces **16.** For this reason, it is preferred that the die supporting plate **18** be slotted to receive the lower end of the insulating board, as shown in FIG. **1,** to insure a negligible conduction of heat and gases to the bolts. The upper end of each bolt and each nut **44** is protected by the upper portion of the insulating board associated therewith.

The die heating structure of the invention meets the requirements for the ideal system outlined earlier. Existing dies can, with the present invention, be used without alternation since the heat source, in the present invention is not located in the die but rather at the base of the die. Favorable heat distribution and uniform die cavity temperature is also effected in the invention by virtue by the physical distribution of the burner structures at the base of the die. The initial cost of the structure of the invention is not substantial since the bearing blocks are not difficult to make, and the burner-manifold construction is commercially available. No costly transformers and electrical controls are involved since the present die heating system is not electrical. The production set-up time of a press using the invention is not substantially altered since die clamping and unclamping is involved when changing most dies, and existing die clamping slots are usable in the invention. The bearing bars in the present invention are made a part of the press, via bolts **31,** and the slotted support plate **18** (at **36**) allows die changes with maximum facility. With the burners **20** facing directly toward the base of the die and the bearing bars **14** insulated and cooled in manner described above, substantially all of the heat generated by the flames of the burners is directed toward the die. For this reason there is very little thermal stress placed upon the supporting plate **18,** and the thermal stresses upon the die are minimal because of the distribution of the burners over essentially the entire base surface of the die. The flow of exhaust gases along the sides of the dies reduces further thermal stressing of the dies.

While the invention has been described in terms of preferred embodiments, the claims appended hereto are intended to encompass all embodiments which fall within the spirit of the invention.

Having thus described my invention and certain embodiments thereof, I claim:

1. In combination with a forging press having opposed forging dies attached respectively to opposed die supporting structures, an arrangement for substantially uniformly heating at least one of said dies comprising,

a plurality of bearing bars made of a high strength metal located between and in contact with at least one of the forging dies and its supporting structure, and spaced apart to provide a plurality of spaced compartments between said die and supporting structure for accommodating heat resistant insulation and burners adapted to be supplied with a combustible fluid,

burners adapted to be supplied with the combustible fluid located in said compartments, and facing in the direction of said die, and

a layer of heat resistant insulation located on the opposed sides of said bearing bars to insulate said burner compartments from the bearing bars, the location of said layers of insulation being such that the layers receive substantially no forging loads.

2. The structure of claim 1 in which the bearing bars are provided with at least one opening extending longitudinally therethrough, and are connected in fluid communication with the burners for preheating combustible fluid directed to the burners while simultaneously limiting the conduction of heat from the die to the supporting structure.

3. The structure of claim 1 including means for clamping at least one of the forging dies to its die supporting structure, said clamping means comprising,

at least two slots provided in the supporting structure adjacent respectively opposed edges thereof,

a clamp structure located in substantial respective alignment with each of said slots, and engaging respectively opposed edges of the die and portions of at least two bearing bars extending beyond the edges of the die, and

at least two fasteners extending respectively between said clamp structures and said slots, with one end of each fastener being located respectively within said slots while the other end of each fastener extends respectively through openings provided in said clamp structures, with means securing said fasteners to said clamp structures and in said slots.

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