Jan. 30, 1945. H. R. MAXON, JR 2,368,370

GAS BURNER

Filed May 26, 1943 3 Sheets-Sheet 1

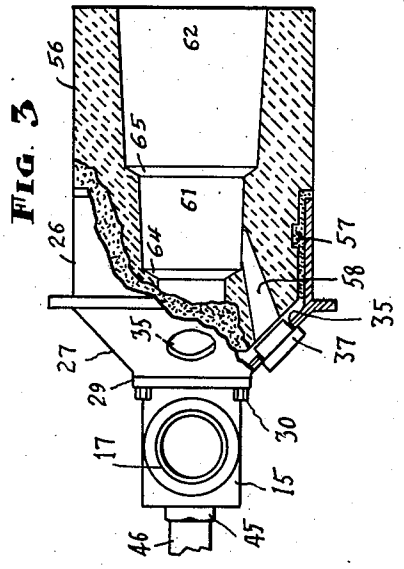


FIG. 3

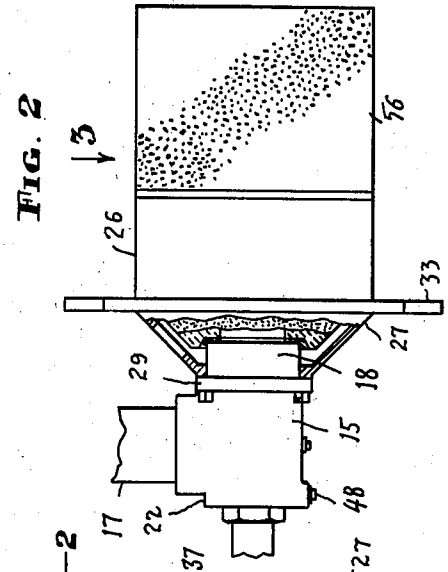


FIG. 2

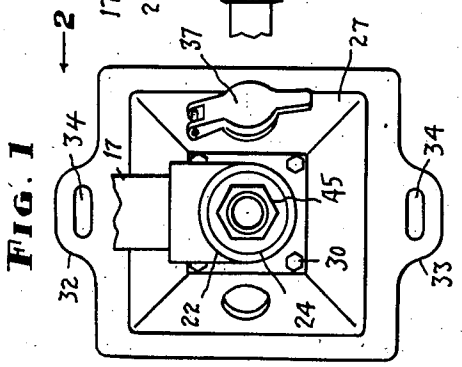


FIG. 1

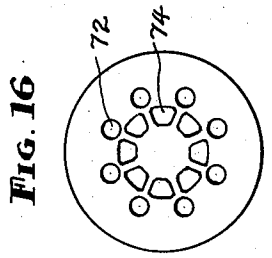


FIG. 16

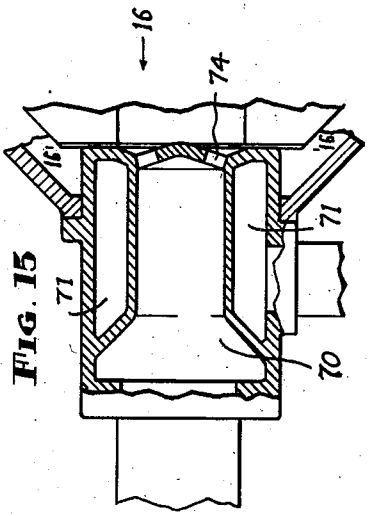


FIG. 15

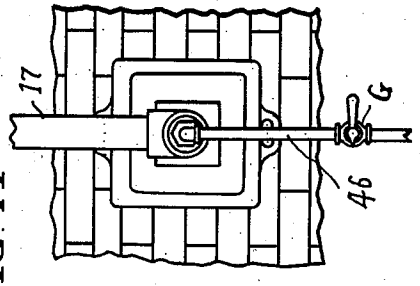


FIG. 14

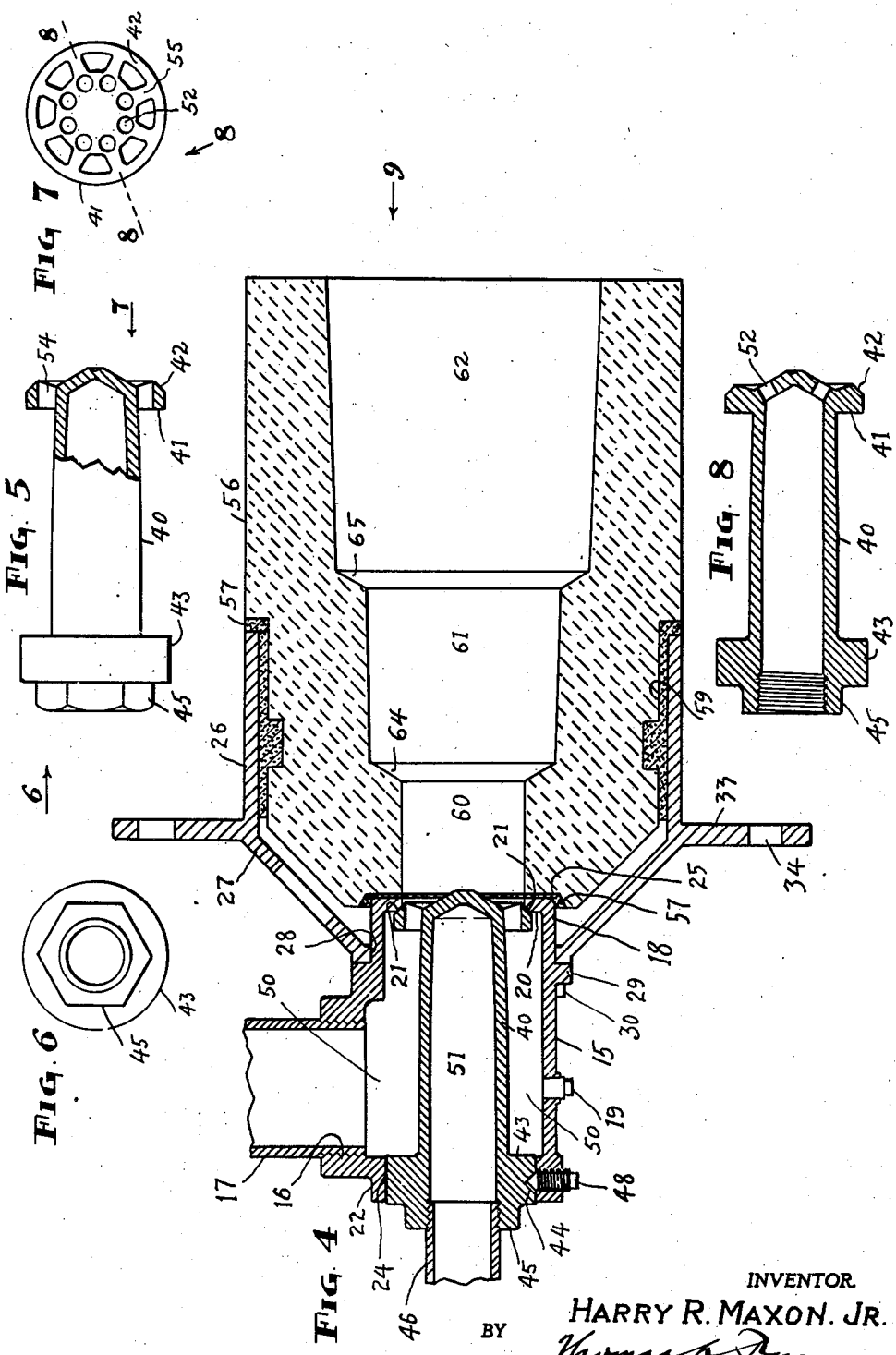
INVENTOR.
HARRY R. MAXON. JR

BY Thomas A. Ryan
ATTORNEY

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GAS BURNER

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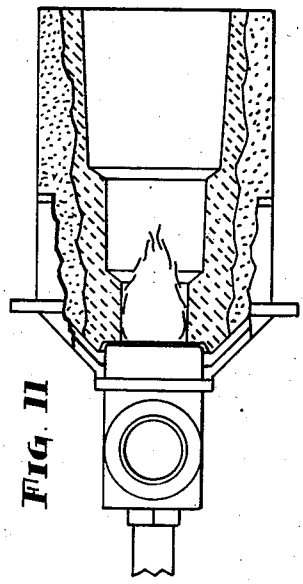


FIG. 11

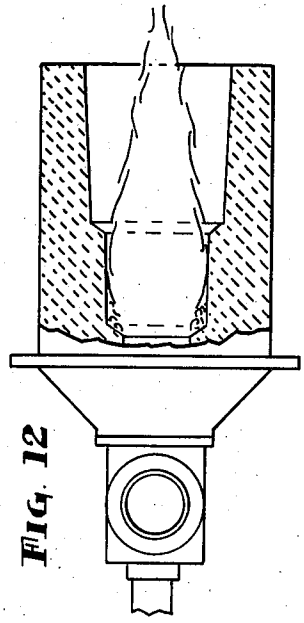


FIG. 12

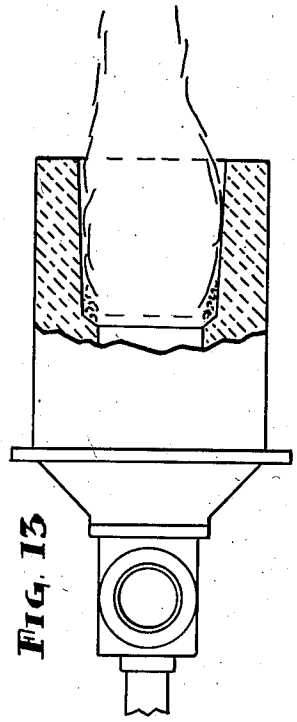


FIG. 13

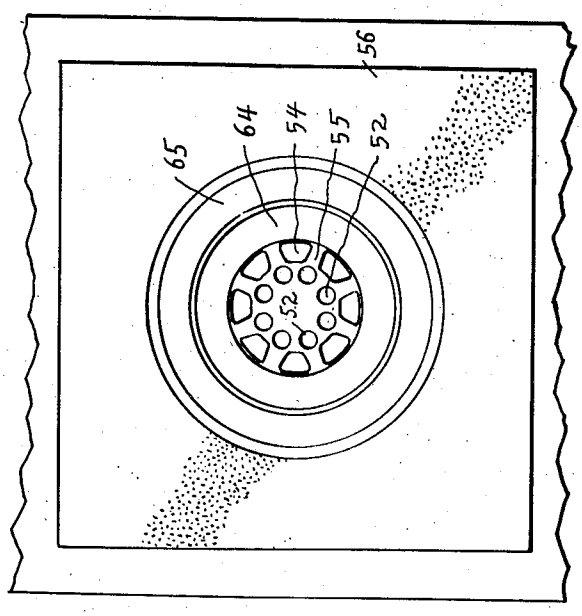


FIG. 9

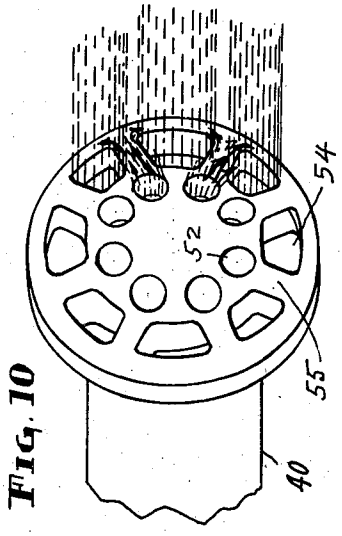


FIG. 10

INVENTOR.
HARRY R. MAXON, JR.

BY Thomas D. Ryan

ATTORNEY

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2,368,370

UNITED STATES PATENT OFFICE

2,368,370

GAS BURNER

Harry R. Maxon, Jr., Muncie, Ind., assignor to Maxon Premix Burner Company, Muncie, Ind., a corporation of Delaware

Application May 26, 1943, Serial No. 488,797

6 Claims. (Cl. 158—7)

In operations of heat treating wherein a wide range of furnace temperatures is required, there has long been the problem of how best to obtain, and of how best to control heat inputs.

One of the many problems which have confronted the designer of an installation for heat treating of metal, is the securing of adequate turn down range in the burner system. By "burner system" being meant, the burner or burners used in connection with a furnace, or furnaces. Such problem is especially present in the handling of a batch-type furnace, because of the following factors:

A. The burner system must have a sufficiently large maximum capacity to provide adequate speed of heat input for initially bringing the charge of metal pieces to be treated, up to desired control temperature.

B. The burner system must have a sufficiently low minimum capacity to prevent overheating after the control temperature will have been reached. Such conditions may require a minimum firing rate as low as one eighth of the maximum burner capacity (particularly when the charge of metal pieces is held in the furnace for a soaking period of several hours after the desired temperature will have been reached). Under conditions as above indicated, it is understood that the burner system must have a turn down range of 8 to 1. That is to say, there must be an 8 to 1 ratio between the maximum and the minimum firing rates.

C. The burner system must be sufficiently flexible to permit firing of the furnace or oven at more than one control temperature. For example, steel parts to be treated, are frequently heated to a temperature within the range of 1500 to 1700 degrees and then suddenly quenched in oil or water to impart characteristics of additional hardness to the metal. It is customary, after the steel will thus have been hardened, to reheat same to a temperature within a range of 800 to 1200 degrees, for the drawing out of undesirable stresses or strains which may have been set up during the quenching operation.

Hitherto it has been found impossible to obtain sufficient burner flexibility to permit of the handling of both of the above named operations (that is, to quench at 1500 to 1700 degrees, and to draw at 800 to 1200 degrees) in the same furnace without shutting off part of the burners, and thus impairing uniformity of heat distribution. There is needed, for operations at 1700 degrees, approximately five times as much heat as is required for re-processing the same material at 800 degrees, and two furnaces or ovens have usually been employed, one being equipped with small burners (for operating in the 800 to 1200 degree range), and the other being equipped with burners three to five times as large (for operating in the 1500 to 1700 degree range).

The situation above outlined has necessitated the installation of duplicate heat treating furnaces or ovens in thousands of plants, there having been no choice other than to install one furnace for such operations as fall in the 1500 to 1700 degree range, and also to install a different furnace for heat treating operations that fall within the 800 to 1200 degree range. Resultant, in many instances, has been a duplication of capital investment, especially undesirable in plants where finances are limited, and where heat treating operations are only occasional.

Many plants are out of balance in their heat treating facilities, having an excess of furnaces for high temperature operations, and at the same time, being inadequately equipped for operations wherein drawing, tempering, or stress relieving, in the 800 to 1200 degree range are involved. Conversely, numerous other plants may be possessed of large and costly facilities for the low temperature work, but are acutely bottle necked when confronted with operations of normalizing at 1700 degrees.

From the conditions above sketched, there has developed an urgent demand for a multiple purpose furnace; one that can be operated at any of the higher heat treating temperatures, or alternately, at any of the lower heat treating temperatures.

In endeavors to meet contingencies such as those above outlined, extensive efforts have been put forth to work out a burner system having a sufficient turn down range to make a multiple purpose furnace possible. Elaborate tests along this line have indicated that to assure any practicable degree of flexibility of furnace operation a burner system having a turn down range of at least 40 to 1, and preferably, 50 to 1, is required.

For illustration, the case of a certain type of annealing furnace operating at 1750 degrees, may be cited. As hereinbefore pointed out at "A," the burner system must be large enough whereby to bring the charge of metal pieces rapidly up to the desired 1750 degree control temperature, and which in this instance requires a maximum firing rate of 2,400,000 B. t. u. per hour. At the same time, as pointed out in "B" above, the burner system just mentioned must be capable of throttling low enough (usually a turn down of

8 to 1) to avoid overheating during the soaking period. That is to say, that while the charge in the car-type furnace cited above is being soaked at 1750 degrees control temperature, the actual heat input required, may drop so low that the burner firing rate is only 300,000 B. t. u. per hour, or one eighth of maximum.

Now let it be assumed that the above charge of metal (or an equivalent charge) be placed in the aforesaid furnace, for drawing or tempering at 800 degrees. At this lower temperature, the maximum burner firing rate required for bringing the charge quickly up to temperature may be (as outlined in "C" above) as little as one fourth, or even one fifth, of the previous maximum firing rate. That is to say, the actual heat input required for bringing the charge quickly up to the desired 800 degree temperature will be approximately 480,000 B. t. u. per hour. But of far greater importance, the minimum firing rate required of the burners, in order to prevent overheating the charge while soaking at 800 degrees, must be as low as 60,000 B. t. u. per hour (⅛ of the 480,000 B. t. u. per hour maximum firing rate).

It will thus be seen that the burner system for the furnace just cited, must have an overall maximum of 2,400,000 B. t. u. per hour (for plenty of speed of heat input at 1750 degrees), and it must have an overall minimum as low as 60,000 B. t. u. per hour (to avoid overheating when holding at 800 degrees), or a combined overall turn down range of 40 to 1.

The car-type furnace above mentioned is typical of a large variety of heat treating furnaces now being designed for multiple purpose service. In each of such cases, the burner system must have a turn down range of at least 40 to 1. If the furnace is to be equipped with automatic temperature control (as a very high percentage of recent installations are), a still wider turn-down range on the part of the burner system, is required.

Modern devices for automatic temperature control in industrial furnaces require, that in order to provide a margin of safety for the automatic control system, so that "over-shooting" or "under-shooting" of desired temperature may be quickly corrected, the burner system must be capable of turning slightly higher, or turning slightly lower than is actually necessary for supplying the heat input needed at any given moment. The effect of the above required margin of safety, is to increase the turn down requirements by an additional twenty five per cent, thus making the overall turn down range, for the above described furnace when automatically controlled, 50 to 1 (instead of 40 to 1).

I am aware that burners have heretofore been devised wherein the object has been to accomplish a turn down of wide range. However, in every instance of which I have knowledge, each of said devices has been limited in performance in conformity with the nature of and means for accomplishing the combustion of the fuel mixture used, and no known device of a single-burner type provides a turn down of scope necessarily demanded for a heat treating furnace intended for multiple purpose operations.

Among other things which contribute to the limitation of the turn down range of previously designed burners, are—

Tendency of the air-gas mixture to flash back into the supply pipe, thereby limiting minimum firing rate, such flash back damaging the burner and piping, and also preventing the burner from being throttled to extreme low firing rate.

Blowing away of the flame, and therefore the prevention of operation at high firing rates.

Failure to hold flame continuously throughout turn down.

Impossibility of throttling smoothly in cases where double burners are used (a larger burner being used for handling higher heat inputs, and a smaller burner being used for handling low and minimum heat inputs), there being either a sudden gap between the minimum of a large burner and the maximum of a small burner, or else a sudden step up or a sudden step down at that phase of the throttling range at which the two firing rates overlap.

To the end that above named disadvantages may be overcome, and that there may be rendered practicable the utilization of a single furnace for heat treating operations wherein wide ranges of temperatures are required, the object of my invention is to provide a burner device which will afford a scope of turn down sufficient to accomplish temperature control over a range of firing capacities as great as 100 to 1, a range of such scope being highly desirable if a single furnace is to be used in operations alternating between low temperature work and high temperature work.

Accordingly, in carrying out the purposes of my invention, further aims are to provide a burner which will lend itself especially to use in industrial heat treating furnaces and ovens, it being kept in mind that for such an apparatus, there must be, at all stages of firing rates (from low minimum to high maximum), combustion of such dependability and such constancy, that in throttling, the change in heat input from any intermediate capacity to another, may be smooth and even.

The above named objects, as well as other and more specific endeavors of my invention, and which have to do with improved structural features leading to economy of manufacture, facility of installation and use, and to efficiency and durability, are accomplished by, and my invention is embodied in, the new construction, combination, and arrangement of parts illustrated in the accompanying drawings, described in the following specification, and defined in the claims.

The several parts of the invention are identified in the different views in the drawings, by suitable characters of reference applied to them.

In the drawings:

Figure 1 is a front view of my improved gas burner.

Figure 2 is a side view in the direction of arrow 2 in Figure 1, a portion of the mount frame being broken away, and the mouth or inlet portion of the burner block being shown in cross section.

Figure 3 is a top plan view in the direction of arrow 3 in Figure 2, a portion of the mount frame, and a portion of the burner block being broken away, and the latter being shown in cross section.

Figure 4 is an enlarged vertical central longitudinal sectional view of Figure 2.

Figure 5 is a side view of the burner-insert, removed, the head portion thereof being shown in cross section.

Figure 6 is an end view in the direction of arrow 6 in Figure 5.

Figure 7 is an end view in the direction of arrow 7 in Figure 5.

Figure 8 is a central longitudinal sectional view

of said burner-insert, taken on the broken line 8—8, in the direction of arrow 8 in Figure 7.

Figure 9 is an end view of the burner block, taken in the direction of arrow 9 in Figure 4.

Figure 10 is an enlarged perspective view of the head portion of the said burner-insert.

Figure 11 is a diagrammatic view showing the location of the flame at a low firing rate.

Figure 12 is a diagrammatic view showing the location of the flame at an intermediate firing rate.

Figure 13 is a diagrammatic view showing the location of the flame at a high firing rate, and its full length being not shown.

Figure 14 diagrammatically illustrates the appearance of the invention in a typical installation.

Figure 15 illustrates a modification.

Figure 16 is an end view of Figure 15.

The embodiment of my invention as it is described herein and depicted in the drawings, is typical. It will be understood of course, that the details of construction and arrangement of parts are capable of minor changes, alterations and modifications, such as may occur to those persons skilled in the art to which the invention appertains, without departing from the spirit or principle of the invention or sacrificing any of its advantages.

A metal casing 15 is provided with lateral opening 16 in which is received the air inlet feed pipe 17. Forward end 18 of said casing has inturned wall portion 20 provided with machined annular beveled seat 21. The rearward end portion 22 of said casing is provided with circular opening 24. A hole in a side of said casing, and which is closed by a removable plug 19, affords facility for making tests of the air pressure within the casing.

A metal mount frame 26, box-like in formation, embodies bulged breast portion 27 having a circular opening 28 within which the forward end 18 of said casing is received, and at its annular flange 29 is secured as by the cap screws 30. In each of the flanges 32 and 33 of said mount frame, is an elongated aperture 34 for the reception of fastener bolts (not shown) and by which the said frame is secured in its installed position, as indicated in Figure 14.

A hinged cover plate 37 provided at that one of the pilot holes 35 which is in registration with the lighter and observation port of the burner block (presently to be referred to), constitutes a suitable closure for the prevention of infiltration of excess air thereat.

A structure which I designate as a burner-insert, constitutes an inner portion of said casing, and it consists of a tubular conduit 40 the forward end of which embodies a circular head plate 41 having annular machined beveled edge 42. The rear portion of said structure embodies an annular shoulder 43 which is of diameter to fit within the said opening 24 of the casing. In the peripheral face of said shoulder is a conical recess 44. Castellated rear end 45 of said burner-insert permits holding by a wrench when connecting the gas inlet pipe 46 at the threaded opening therefor. A pointed set screw 48 is so positioned, that when tightened, the burner-insert will have been tightened to and made fast in the position indicated in Figure 4, the annular face 42 being secured to the seat 21 of the inturned wall portion 20 of the aforesaid casing 15. The head portion 41 of said burner-insert, and the wall portion 20 of said casing, in the united relation as shown, constitute and end wall which is common to the outer casing 15 and to the conduit 40, and common to the chambers thus formed, namely, the air chamber 50, and the gas chamber 51.

Provided in the head portion of said burner-insert and in circular alignment coincident with the internal marginal portion of the chamber 51, is a series of uniformly spaced ports or orifices 52. Provided in the outward or marginal area of said head portion of plate 41 of the said burner-insert in close proximity to, and concentric with the said ports 52, is a series of uniformly spaced ports 54 and which are in staggered relation to said ports 52. The ports 54 are of larger area than the ports 52 and their corners are of filleted formation. The radial partitions 55 between said ports 54 are in alignment with the transverse axes of said ports 52, as indicated in Figure 10. Each of said partitions is of a minimum width, and all are of the minimum widths with relation to the widths of the said ports 54, substantially as shown in Figure 10.

For reasons that are incident to convenience and economy in processing, the central mass of the head portion of said burner-insert is of bulged formation. For the same reasons, and for the further reason, that the anterior rims of the ports 52 may be in close proximity with the planes of the ports 54, the said ports 52 are inclined at an angle toward the longitudinal axis of the burner insert. Also the structural formation just mentioned simplifies the operation of drilling the ports 52 so that they open from the gas chamber directly at the forward internal marginal portion thereof.

A burner block 56 made of suitable refractory material such as fire brick, and which is of formation in cross section to fit into the said mount frame 26, is provided with a tunnel formed in circular subdivisions or stages which are concentric and which at their proximal edges are joined by annular offsets. For brevity these subdivisions may be referred to as zones, and hence, the tunnel, as zonate in longitudinal formation. The said block is united with the said mount frame, as by the application of high temperature cement 57 at the lateral recesses 59, and at the end recess 25, the latter constituting a seal at the forward wall of the casing 15. The mouth zone or inlet 60 of said tunnel is of diameter to closely encircle the area defined by a line bounding the outer series of ports 54. Each of the succeeding zones 61 and 62 is of progressively larger diameter to the discharge end of the block, and they are joined by the annular offsets 64 and 65. An aperture 58 which is in registration with the pilot hole 35 hereinbefore mentioned in connection with the mount frame, extends into the zone 61 of the said tunnel, and it affords access thereinto for applying a lighter torch, or for observation purposes. In case the block may be set so that its aperture 58 is at a reverse position, or is at a position at a right angle to that shown in Figure 3, the hinged cover plate 37 would be fitted to a different one of the pilot holes accordingly.

My improved burner is capable of being installed with the casing so poised that the air feed line 17 may be either in a vertical alignment, or at an angular alignment, thus accommodating itself to local conditions affecting the pipe lines. Illustrative of a typical installation, is Figure 14. Air supply is through pipe 17, and gas supply is through pipe 46 which is fitted with

a shut-off cock G. The said pipes are connected with throttling devices and regulators (not shown) usual to industrial furnace installations and equipment.

In operation of my new burner, the air fed into the chamber 50 flows through the air ports 54; and the gas fed into the chamber 51 flows through the gas ports 52. Incident to the relatively high velocity of the air flow, there are produced along the side edges and in the space between said edges and at the gas ports 52 and ahead of the partitions 55, low pressure areas, there being such an area immediately at the front of and extending forwardly of each of said partitions. In each of these low pressure areas there is set up a partial vacuum. The gas streams issuing from the gas ports 52, being sucked into said low pressure areas, collapsing, and coming into contact with the highly agitated and broken-surfaced streams of air, are caused to fill the space between and around the air streams, the effect being that the gas becomes infused in and completely co-mingled with the air streams, hence the volume composed of all of the air-gas streams will have become merged into an intensively and intimately mixed homogenized mass. The mass so formed constitutes a mixture which is thorough and complete.

It is considered that the accomplishment of this thorough mixture in the zone of the tunnel mouth and closely adjacent to the front of said ports is of the essence of this invention, the degree of thoroughness of said mixture distinguishing my improved burner from all prior nozzle type mixers.

The air and gas having not been combined until they have entered the inlet or mouth of the tunnel of the burner block, there is no possibility of flash back such as exists with burners of the premix type. By reason of the thorough and effective mixture so obtained, immediately at the said mouth 60, flame retention at minimum air pressure (that is to say, low firing rate) is assured, the tiny flames, at low pressure, burning quietly and steadily in the first small stage or inlet zone of the tunnel of the burner block, as indicated in Figure 11.

As the firing rate of the burner is increased (incident to increase of air pressure entering the air chamber) and the velocity of the air-gas mixture in the mouth zone 60 becomes too great for the continuation of self-ignition thereat, the said mixture is discharged, unignited, beyond the offset 64 and into the second zone 61 of the tunnel. Tiny eddy currents (see Figure 12) in the air-gas mixture, and which are automatically created at the said offset 64, whip small portions of said mixture into the dead area immediately at the lee of the edge of said offset, and where they burn continuously and ignite the mass volume of air-gas mixture issuing from the said mouth zone into the next or second zone 61 of the tunnel, thus combustion is had in the remaining zones of the tunnel, or in the area or space immediately beyond the outlet end of same, as indicated in Figure 12.

Similarly, when the firing rate is still further increased, and the velocity of the mixture is increased to such degree that ignition ceases in the said second zone 61 of the tunnel, then, at the protected space at the lee of the edge of the next offset 65 (see Figure 12) combustion occurs in the manner as above described, as indicated diagrammatically in Figure 13.

Whereas in most cases, a tunnel or duct having three zones or stages as depicted in the drawings, has been found adequate for the maintenance of ignition of the air-gas mixture throughout all of the stages of a turn down having a range of 100 to 1; it will be understood that unusual or extremely difficult conditions may be met by providing a block having a tunnel comprising four or more zones.

My improved burner lends itself to smooth and gradual throttling, thereby facilitating controls of furnace temperatures. The flame being constant and dependable at every stage of throttling, the burner accordingly is responsive at every stage of and throughout the full turn down range. The thorough and intimate mixture accomplished by my invention, occurring as it does, immediately in the mouth of the tunnel; and ignited, as it is, at the offsets of the progressive stages of the tunnel leading to the outlet of the block, the combustion is of such dependability and constancy that the wide range turn down so long sought for, is at last accomplished.

Continuous ignition and constant flame is had at all firing rates from low minimum to high maximum, and without any interruption when throttling from one firing rate to the other. Because of the flexibility and the easiness of control of my improved burner its use is not limited to any one type of industrial furnace or oven, and it provides advantages in a wide variety of heat applications. A field in which it is especially distinguished is the heat treating of metals in those furnaces used for the processing of steel, aluminum or brass. In any of said applications, the ratio between the maximum and the minimum firing rates may be as great as 100 to 1, if desired, and the extremely wide range of turn down is accomplished without the use of any secondary or auxiliary burners or appliances, and same is without interruption when throttling from one firing rate to another.

Whereas in the preferred form of embodiment of my invention as it is illustrated and described herein, the casing which constitutes the two chambers is of structural formation so arranged that the air is introduced into the outer chamber, I wish it to be understood that the invention is capable of such modification that when special or unusual conditions affecting processing of the parts, or affecting installation of the invention, might suggest a change from said embodiment, the air feed may be provided for in the inner chamber, and the gas in the outer chamber. Such a modification is illustrated in Figures 15 and 16, wherein 70 designates the air chamber, and 71 the gas chamber. 72 and 74 designate the closely adjacent and staggered gas ports and air ports respectively.

What I claim as my invention is:

1. In combination with a refractory burner block having a multiple stage tunnel therethrough, each stage of progressively larger diameter from its inlet to its outlet, and each joining the next by an offset shoulder, a casing embodying two conduits, one within the other, said casing having an end wall that terminates each of the conduits, is abutted against said block to span the inlet of said tunnel, is provided with a series of ports circularly arranged and which open directly from one of the conduits into the tunnel inlet, and is provided with a series of ports circularly arranged in close adjacency to and alternated with the ports of the first named series, and which said last named ports open from

the other of said conduits into the said tunnel inlet.

2. In combination with a refractory burner block having a multiple stage tunnel therethrough, each stage of progressively larger diameter from its inlet to its outlet, a casing embodying a gas conduit and an air conduit, one within the other, said casing having a wall that terminates each of said conduits, is abutted against said block to span the inlet of said tunnel, is provided with a series of ports circularly arranged, equally and closely spaced, and which open directly from the gas conduit into the tunnel inlet, and is provided with a series of ports circularly arranged, equally and closely spaced, in close adjacency to and alternated with the ports of said gas conduit, and which said last named ports open from the air conduit into the said tunnel inlet.

3. The combination of a refractory burner structure having a multiple stage tunnel therethrough, each stage of progressively larger diameter from its inlet to its outlet and each joining the next by an offset shoulder, a casing embodying two conduits, one within the other, said casing having a wall that terminates each of the conduits, is abutted against said burner structure to span the inlet of said tunnel, is provided with a series of ports circularly arranged, equally and closely spaced, and which open directly from one of said conduits into the tunnel inlet, and is provided with a series of ports equally and closely spaced in close adjacency to and alternated with the ports of the first named series, and which said last named ports open from the other of said conduits directly into said tunnel inlet, the webs between the ports of one series being of predetermined form with relation to the forms of the ports of that series.

4. A burner apparatus of the kind described, consisting of a burner block having a tunnel therethrough, zonate in formation and provided with a lighter aperture, a mount frame in which said block is received and secured, said frame having a bulged breast portion and provided with an opening in axial alignment with said tunnel, a casing retained at its forward portion within the opening of said mount frame and abutted against the inlet end of said block, said casing having an air inlet in the side thereof, and having a central opening in its rear portion, and an internal annular seat at its forward end, a gas conduit which embodies at its rear portion an annular shoulder which is fastened in the opening of said casing, and at its forward end a circular head plate that engages the annular seat of said casing thereby spanning the inlet of said tunnel, the said head plate having a series of equally spaced circularly arranged ports interiorly of said conduit, and a series of equally spaced circularly arranged ports exteriorly of said conduit, the ports of one series being alternated with and in close adjacency to the ports of the other series, and means to supply said gas conduit.

5. A mixer, ignition, and combustion apparatus consisting of a casing provided with an air inlet, and having an inturned forward end provided with an annular seat, said casing at its rear portion having a circular opening, a conduit extended into said casing and embodying at its forward end a circular transverse head plate to engage said annular seat, said head plate having a series of circularly arranged radially partitioned ports therethrough exteriorly of said conduit, and having a series of circularly arranged ports therethrough interiorly of said conduit, the ports of one series being alternated with and in close adjacency to the ports of the other series, a closure interconnecting the said gas conduit with the rear portion of said casing, inlet means for said gas conduit, and a burner block united with the forward end of said casing, said block having a tunnel therethrough of zonate formation, the zones thereof being of progressively larger diameter from the inlet to the outlet of said tunnel, and the inlet zone being of diameter coincident with that of the head plate of said conduit.

6. A gas burner of the kind described, consisting of a casing having an open forward end provided with an internal annular seat, and being provided at its rearward end with a circular opening, an air inlet into said casing, a conduit having at its forward end a transverse circular head plate to engage said annular seat, and embodying at its rearward portion a shoulder to close the said circular opening of said casing, the said head plate having a series of circularly arranged equally spaced ports that open therethrough exteriorly of said conduit, and having a series of circularly arranged equally spaced ports that open therethrough interiorly of said conduit, the ports of one series being alternated with the ports of the other series and the webs between the ports of one of the series being radial and of predetermined width with relation to the diameters of the ports of that series, a gas inlet means for said conduit, and a burner block united with the forward end of said casing and having a zonate tunnel therethrough, the inlet of which is in axial alignment and registration with the head plate of said conduit.

HARRY R. MAXON, JR.