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Mathew et al.

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(54) **FUEL WITH AUDIO AND VISUAL EFFECTS**

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(73) Assignee: **Fire Design LLC**

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Related U.S. Application Data

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(51) **Int. Cl.**[7] **C10L 7/04**

(52) **U.S. Cl.** **44/265**; 44/266

(58) **Field of Search** 44/265, 266

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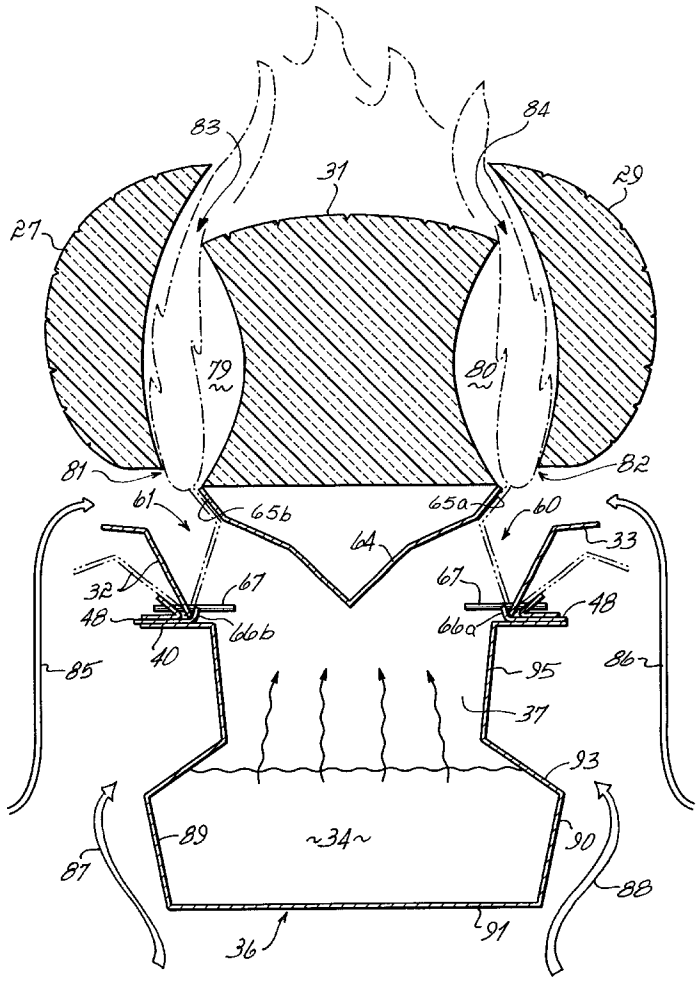
(57) **ABSTRACT**

A fuel for producing attractive audio and visual burning results is disclosed.

10 Claims, 13 Drawing Sheets



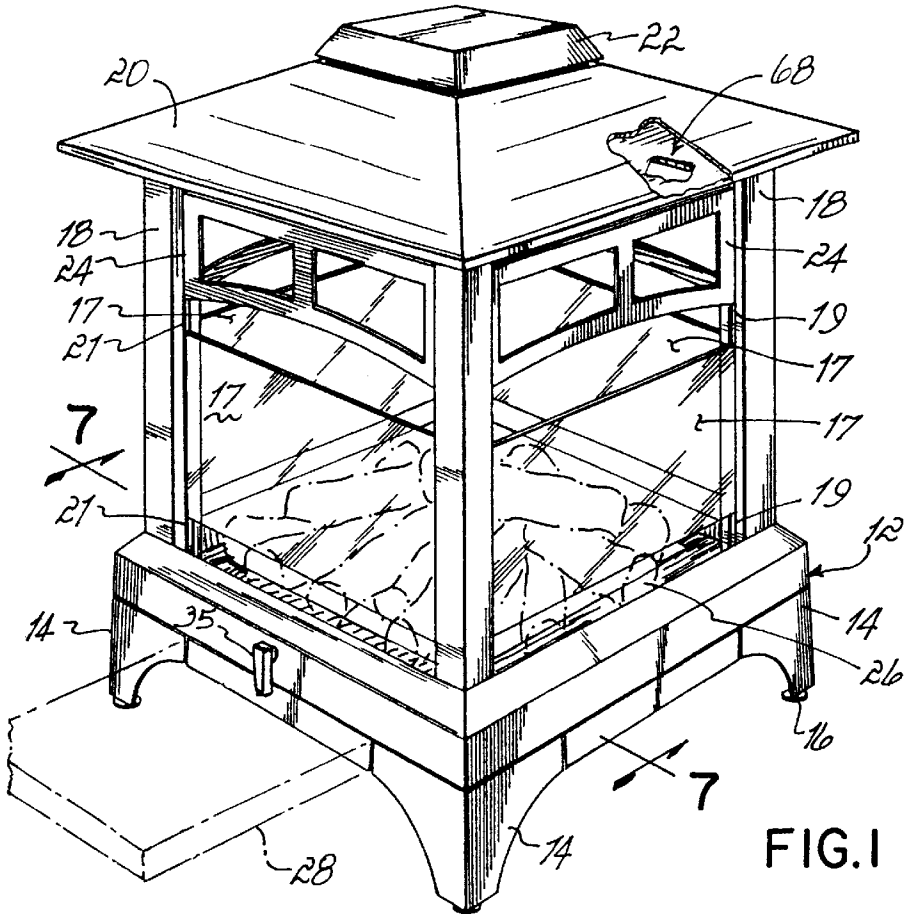


FIG.1

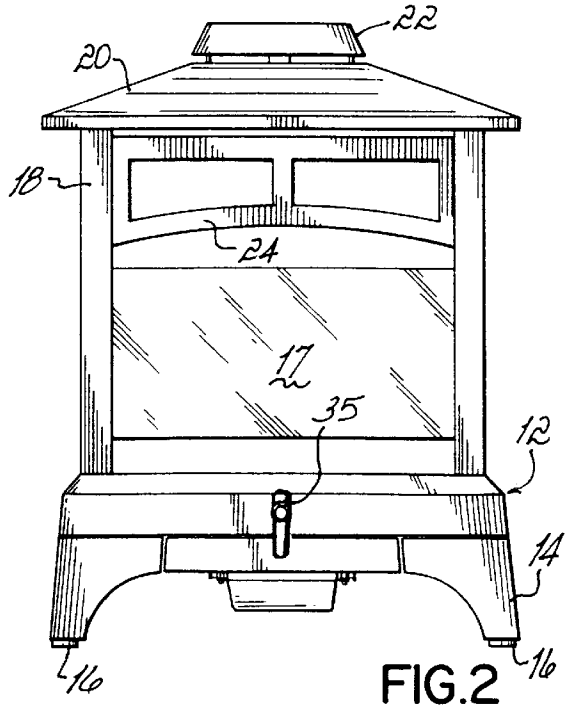


FIG.2

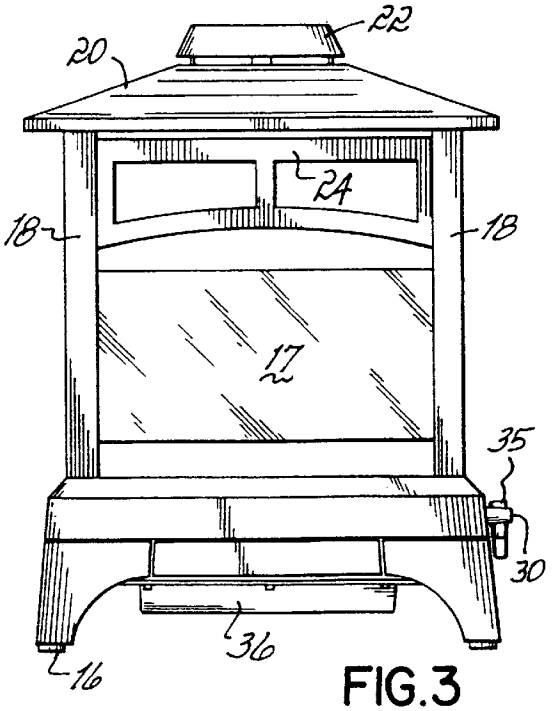


FIG.3

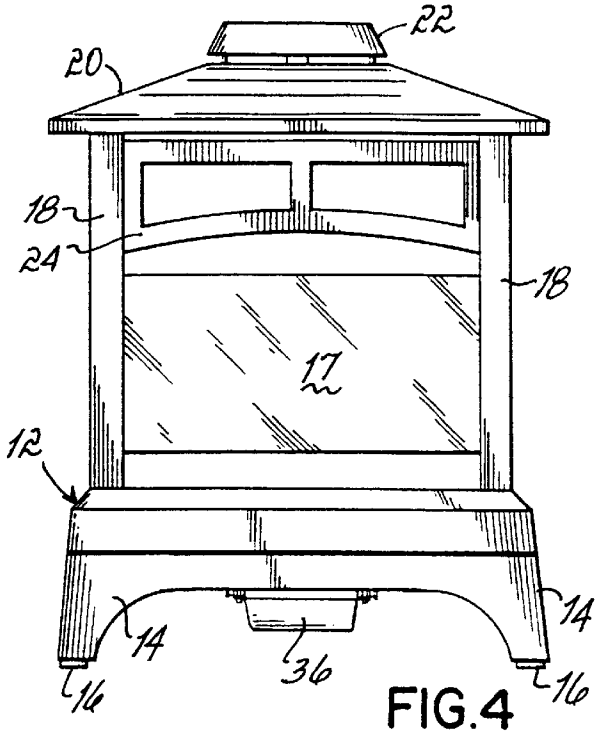
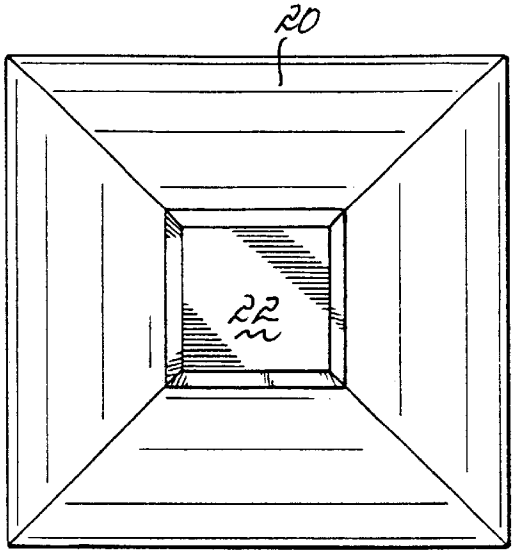


FIG.4



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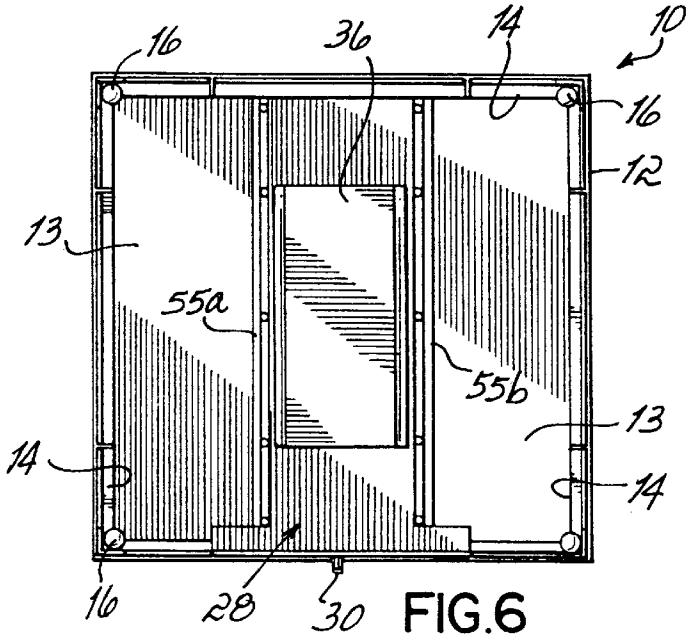

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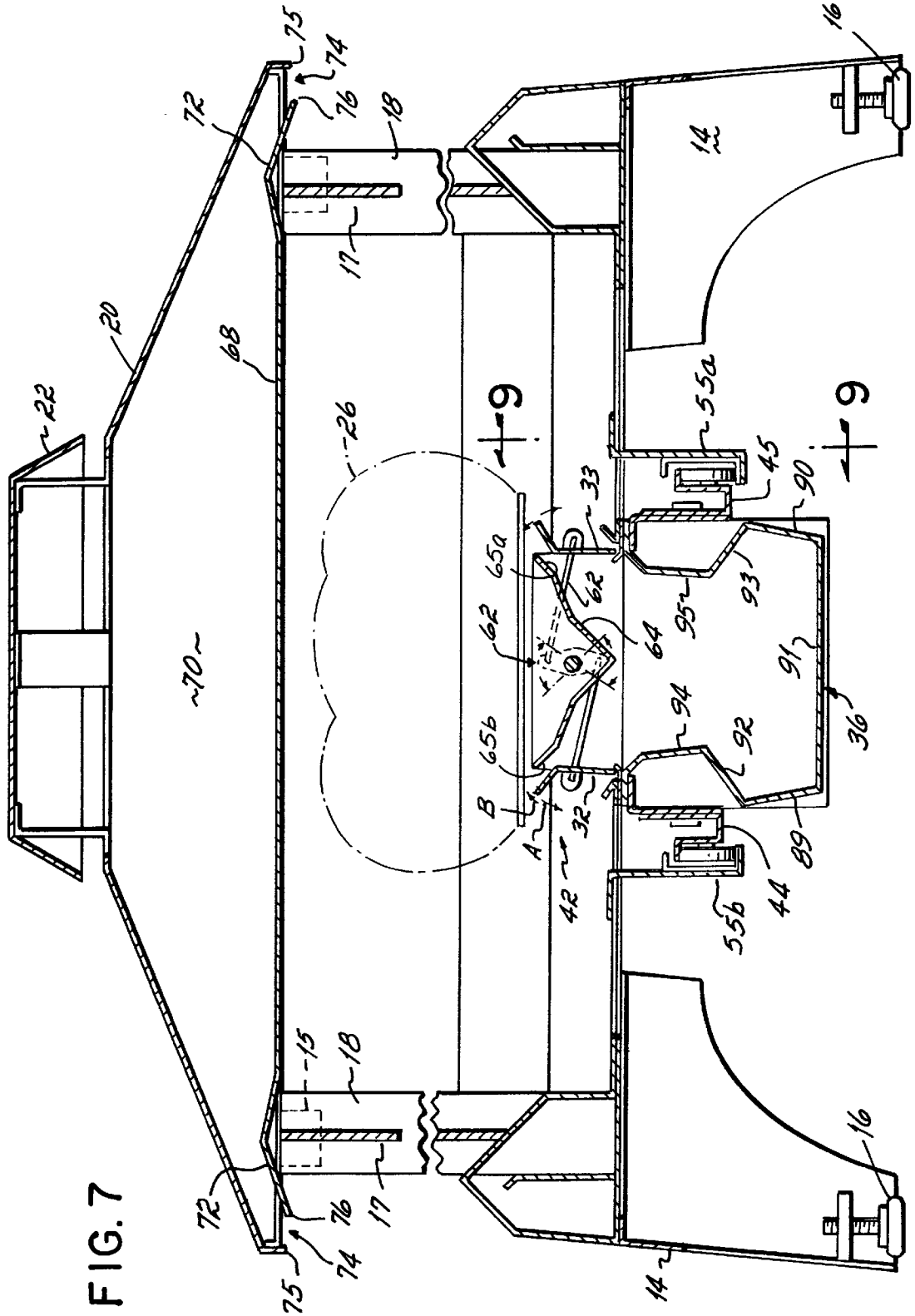
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FIG. 7

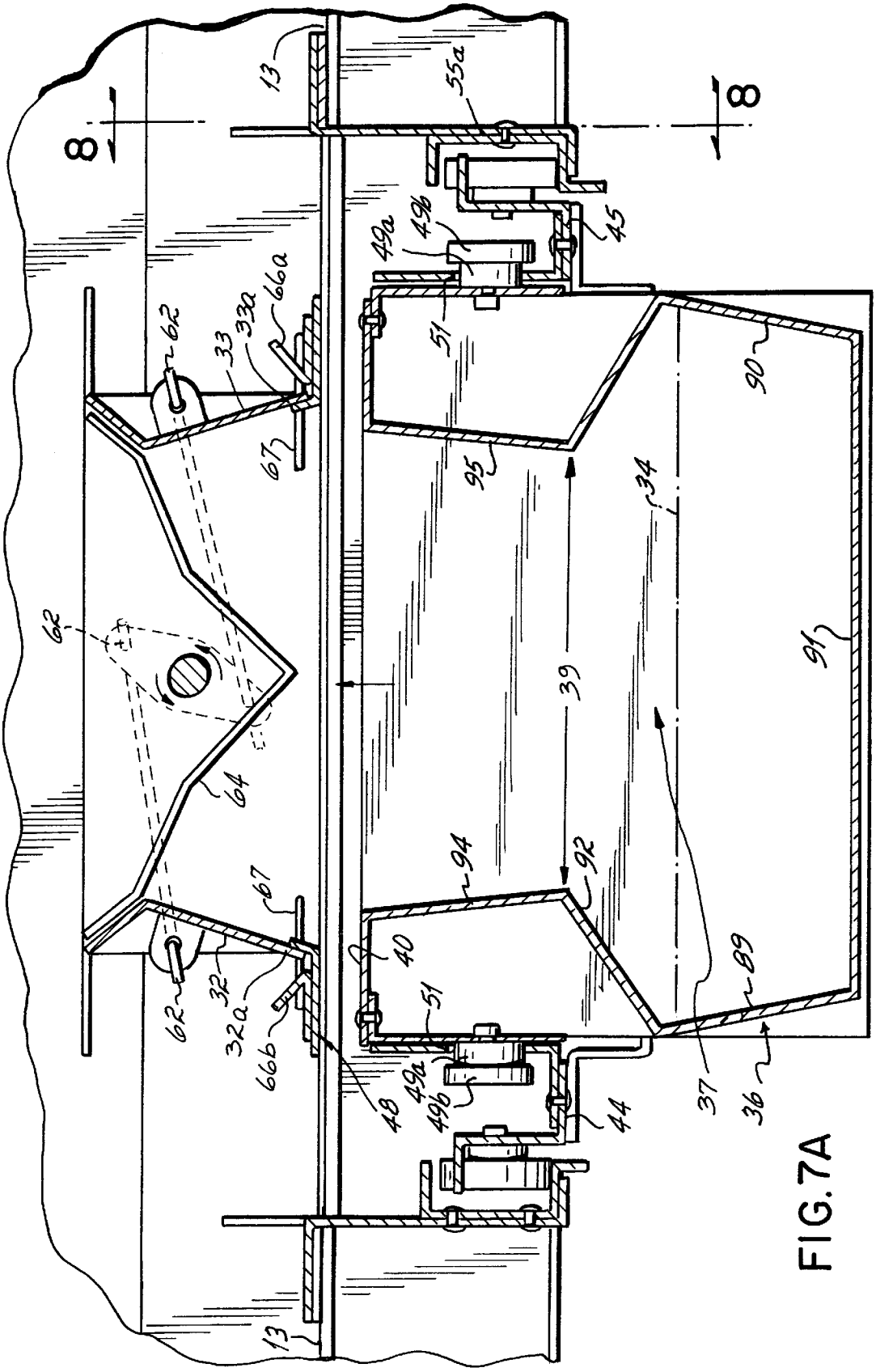
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FIG. 7A

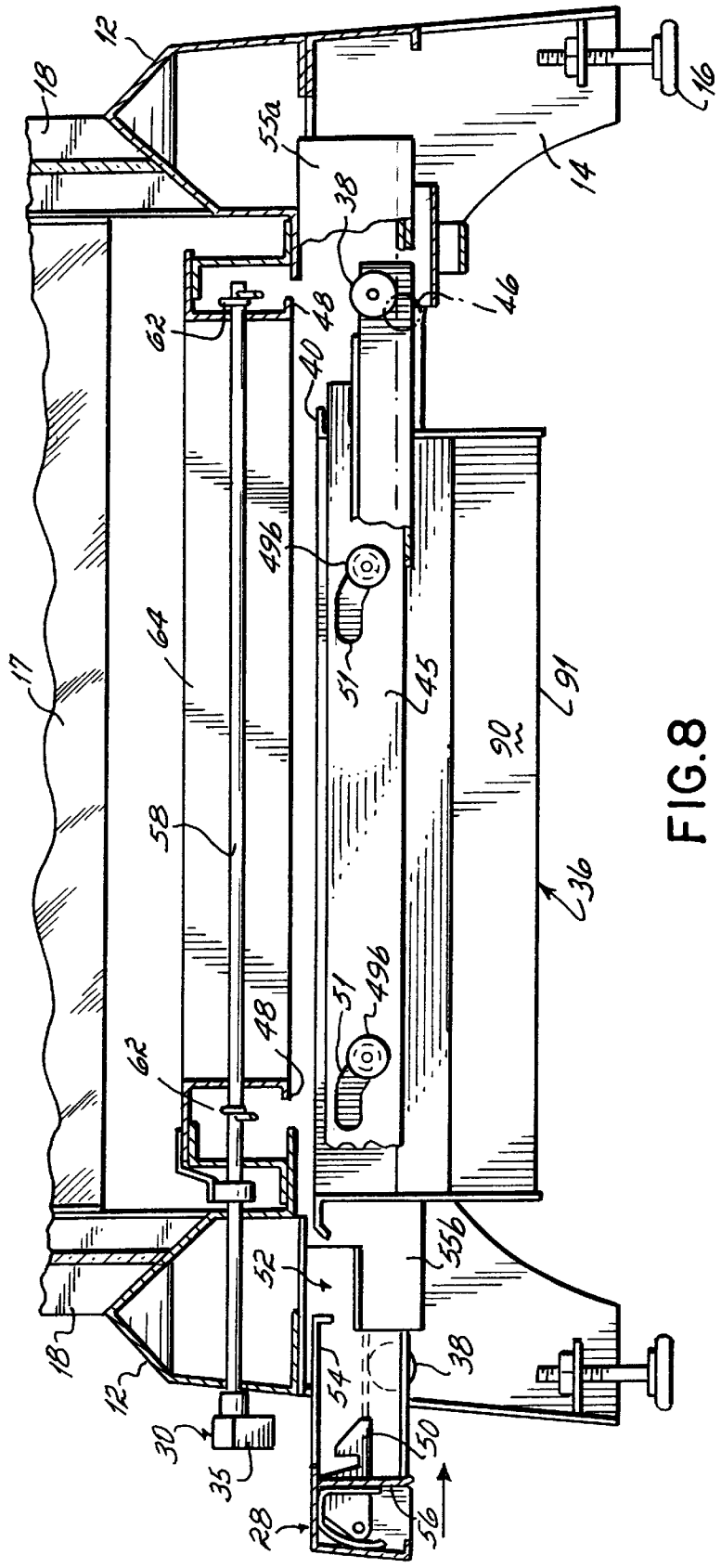
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FIG.8

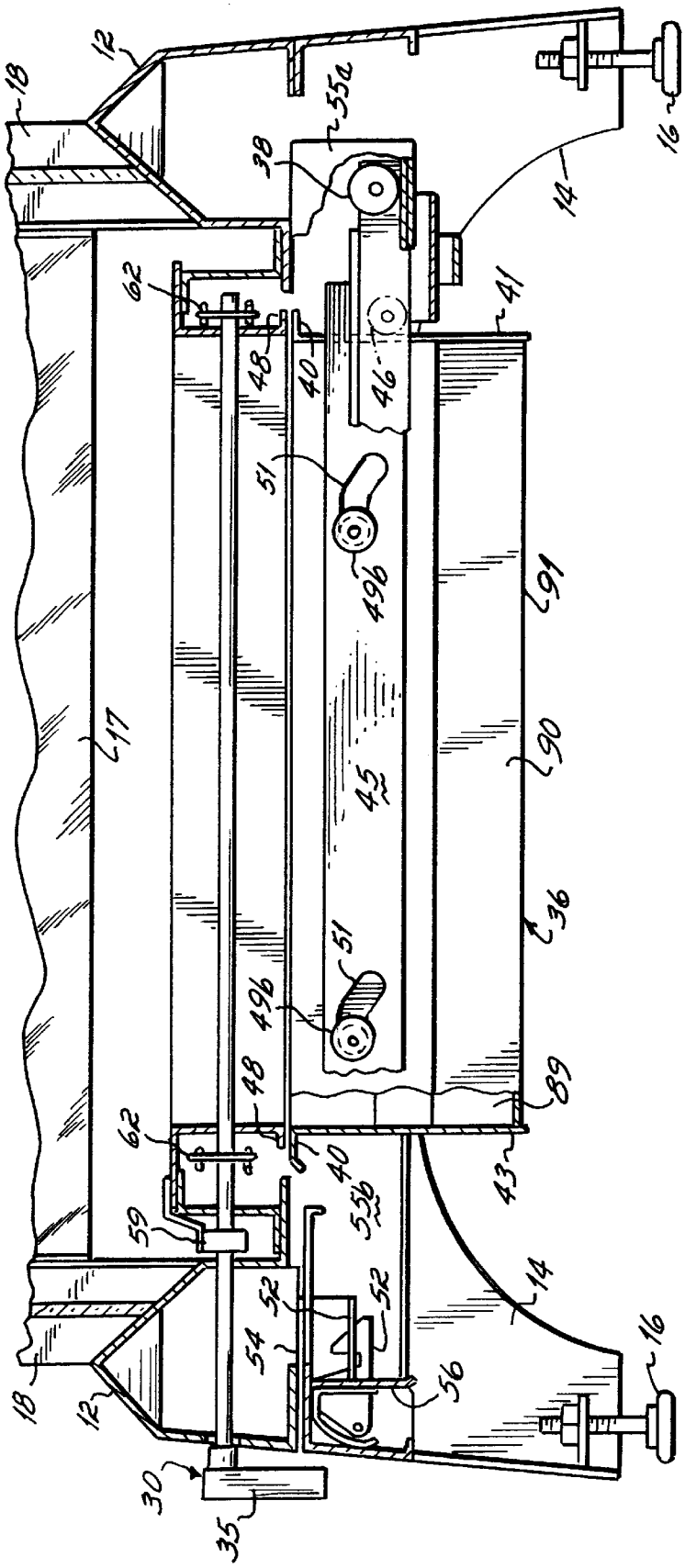
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FIG.9

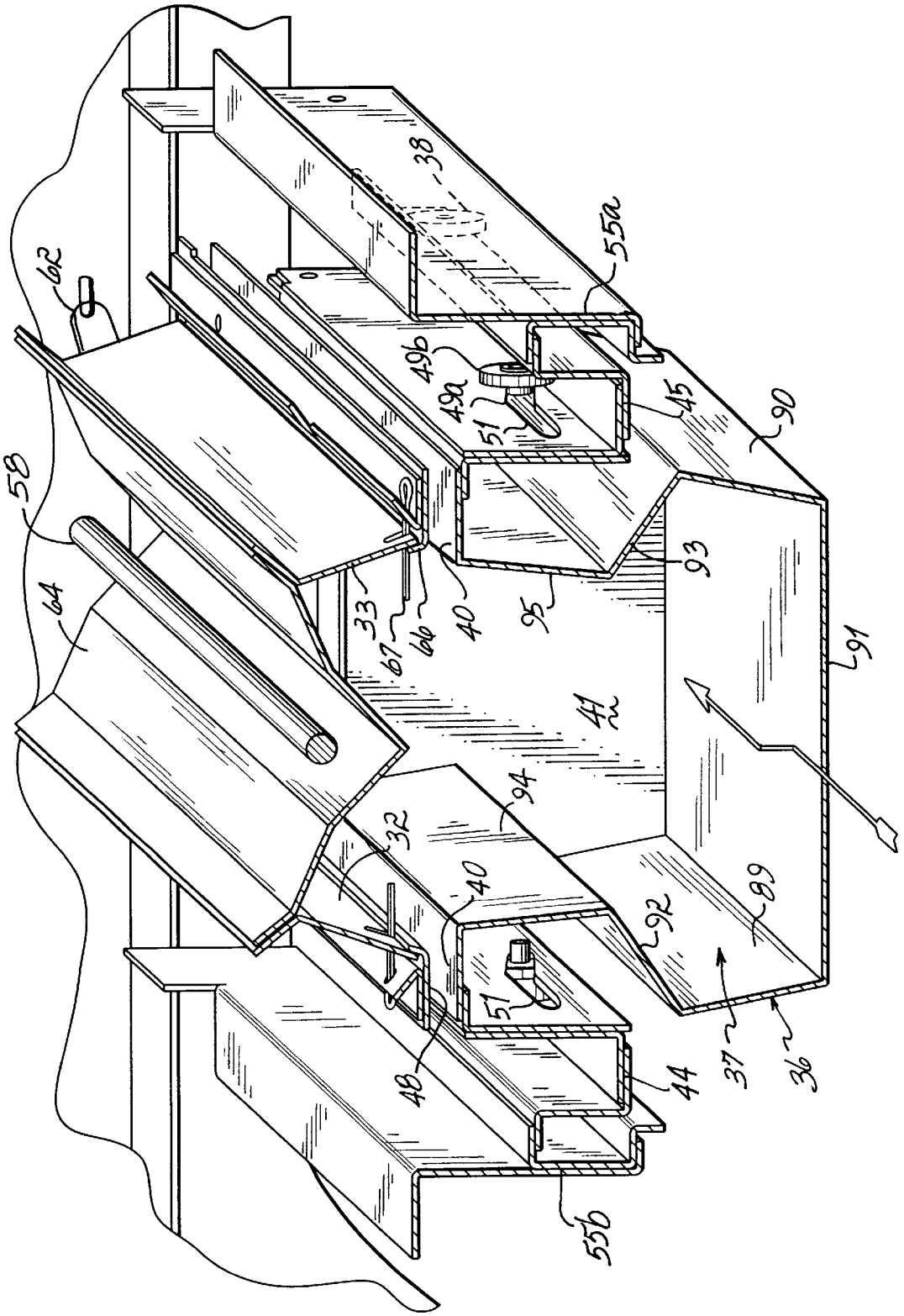
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FIG. 10

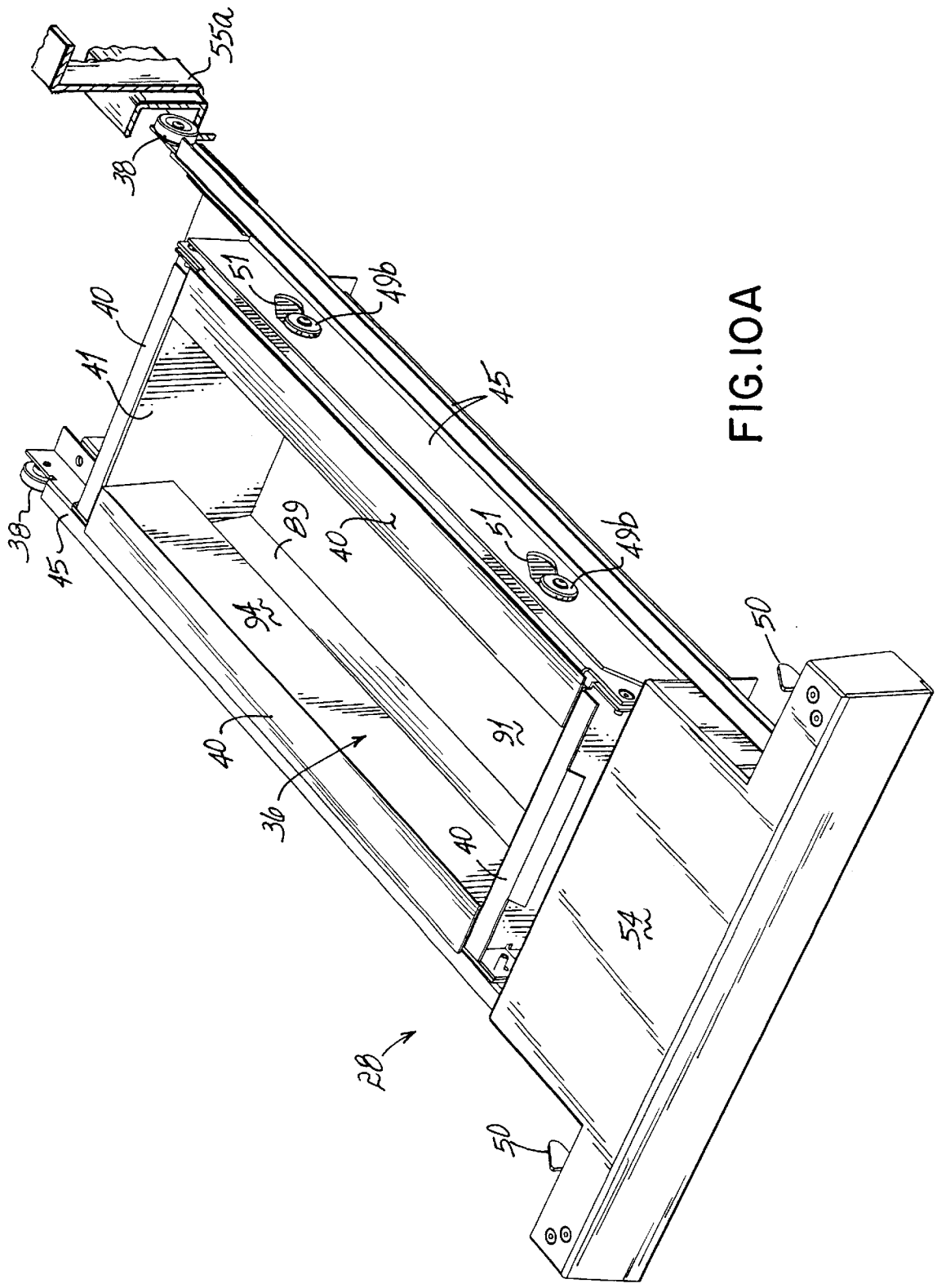

FIG.10A

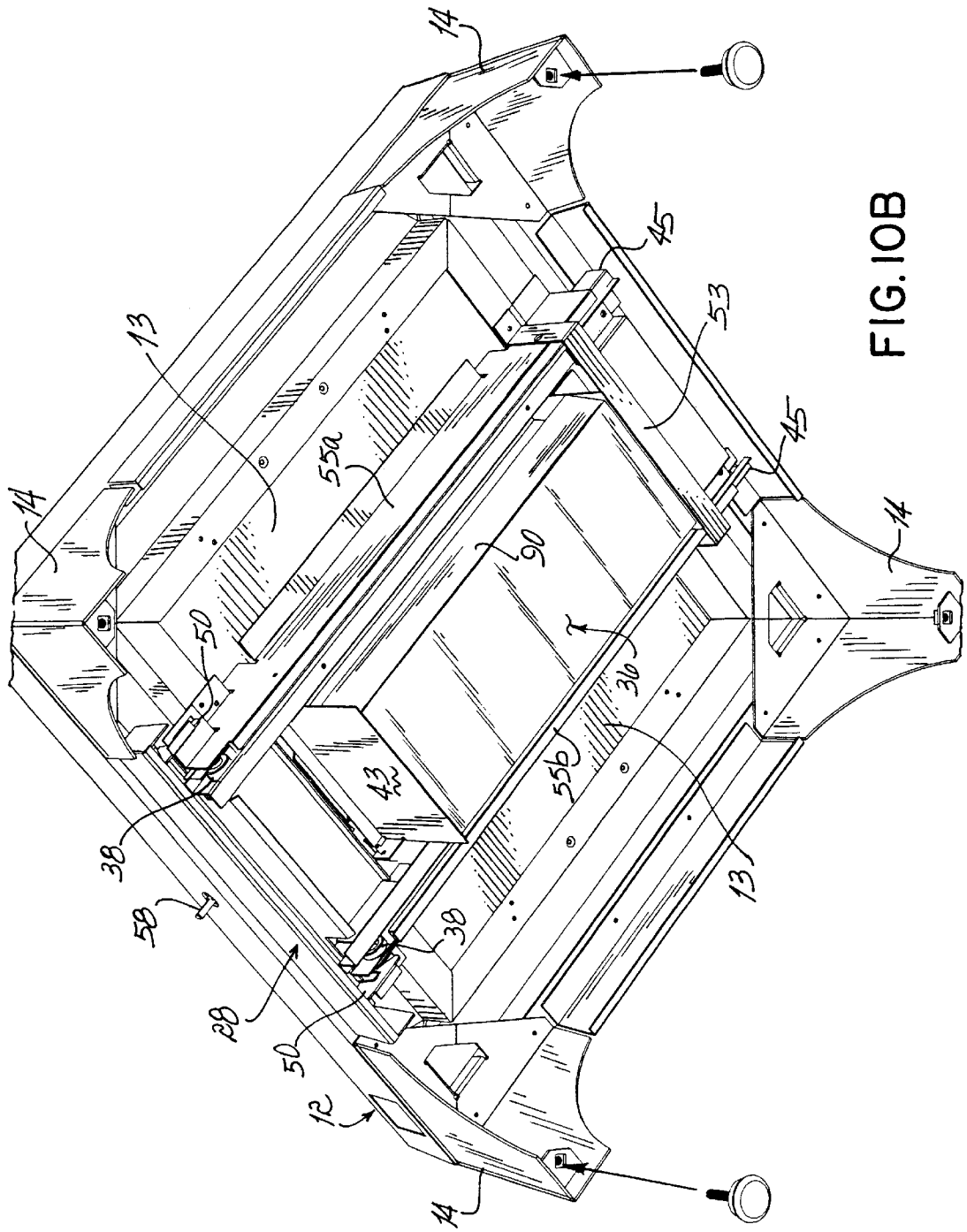

FIG. 10B

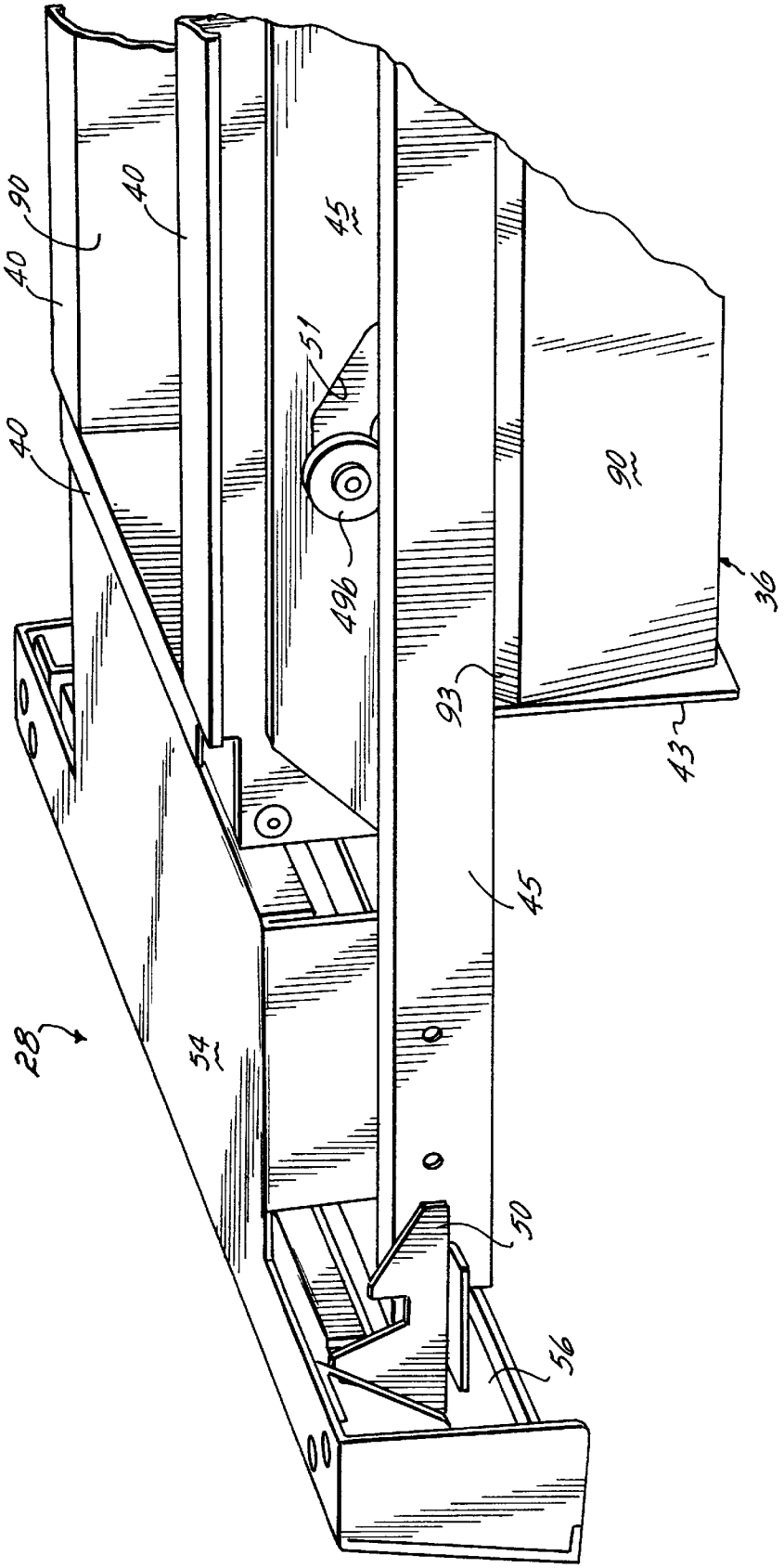

FIG.10C

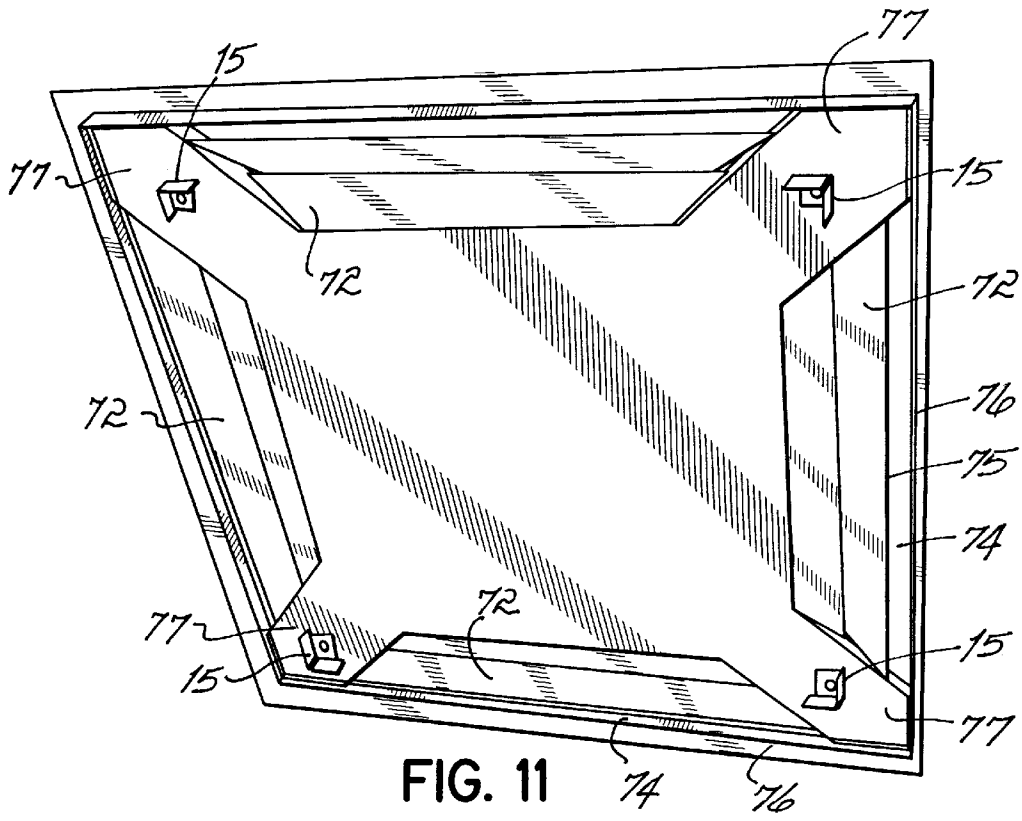
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FIG. 11

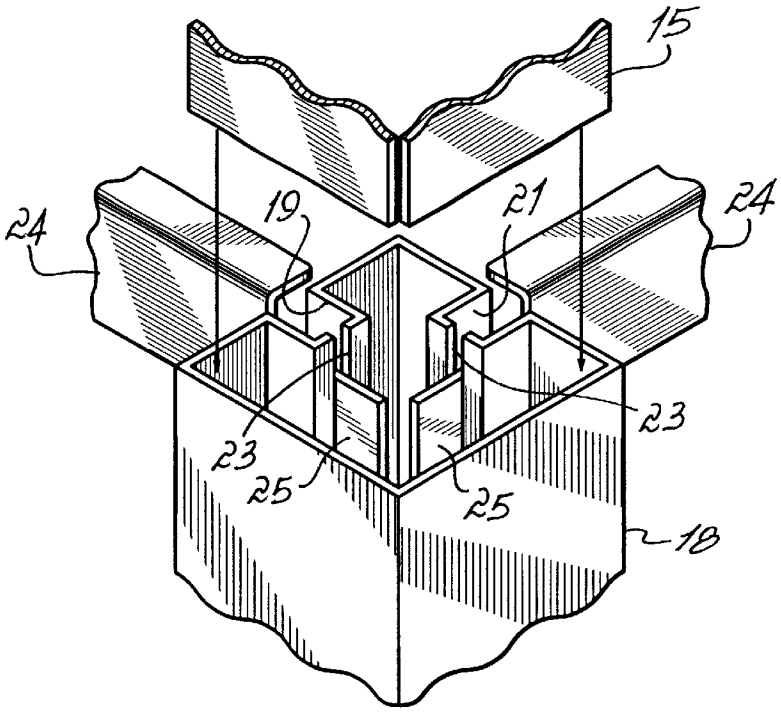
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FIG. 12

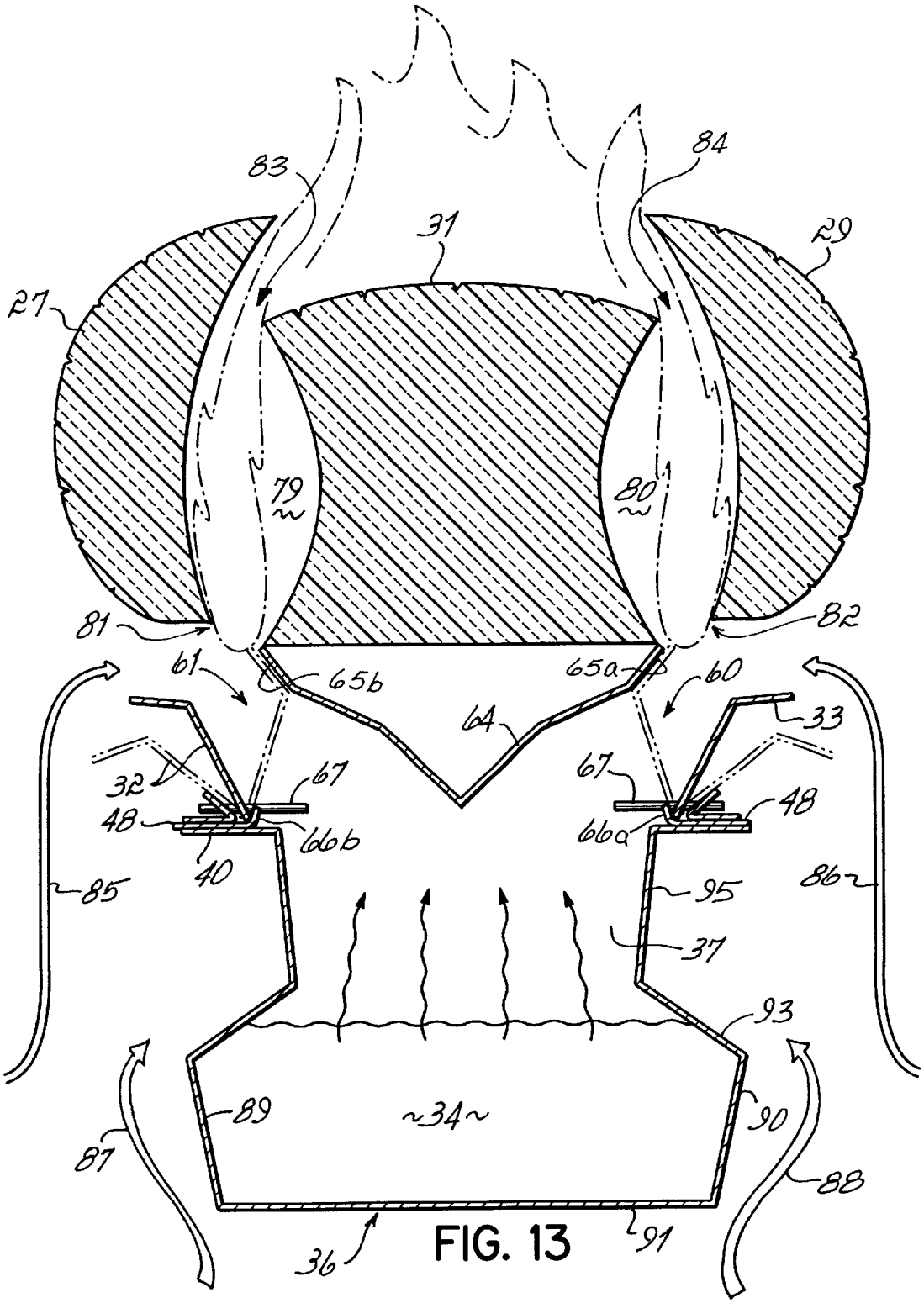
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FIG. 13

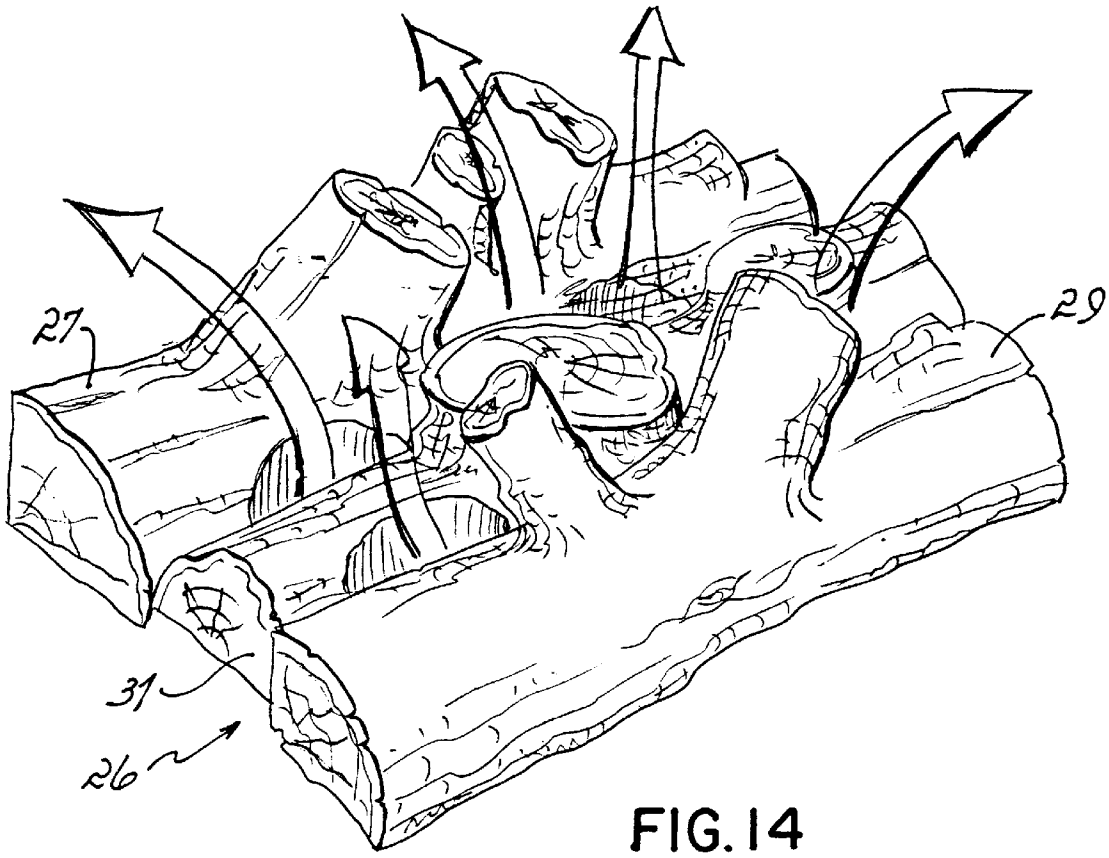

FIG. 14

FUEL WITH AUDIO AND VISUAL EFFECTS

This is a Divisional application based on U.S. Ser. No. 09/534,780 filed on Mar. 24, 2000, for FREE STANDING FIREPLACE HEARTH, now U.S. Pat. No. 6,267,113.

BACKGROUND OF THE INVENTION

This invention relates to a free standing fireplace hearth and a fuel composition for use therein.

In many patio, deck, back yard or other similar outside settings, an actively burning fire is often used to add significant ambiance to the setting. In addition to the visual appearance of the fire, the setting is enhanced by the soothing and pleasing crackling and popping sound of a wood burning fire. However, wood burning fires of this type often require significant attention to periodically add logs to maintain the fire. Wood burning fires generate a significant amount of ash, soot and the like thereby requiring clean up. Further, open kettles or the like which are commonly used to house the burning logs present a significant hazard and often do not adequately contain the fire during use thereby leading to the potential and dangerous spread of the fire through falling and burning logs, cinders or the like. Constant attention to the fire is thereby prudently required.

Therefore, there is a need for an improved outdoor fireplace or hearth which avoids these above-described drawbacks while still offering the visual and audible ambiance of a burning wood fire.

In a further aspect of the invention, it is highly desirable to provide a self-containing fire hearth which provides the ambience of a wood burning fire, that is a flame which has the appearance and sound of a wood burning flame, but without the necessity of wood fuel or cleanup of waste combustion products usually attendant a wood-fueled fire. Moreover and in this regard, it will be appreciated that an "ambience" fire or flame need not be measured by the typical parameters applied to a fire. For example, heat output, or BTUs, is a typical fire or heat performance criteria as is the heat producing efficiency from the fuel used. In a free-standing fire or hearth for ambience purposes, these parameters and efficiencies are relatively unimportant. In the case of heat production, the less heat produced, the better.

What is important are entirely different characteristics, namely burn time, fuel volume and burn characteristics. Thus, the efficiency of a decorative or ambient fire, for example, is measured in consideration of these parameters and their coalescence to provide the most desirable aesthetic result, with an acceptable burn time, at the least operational cost.

For example, acceptable burn characteristics require a fire with golden colored flame having random dancing patterns. A desirable burn time per fuel load is in the two to four hour range and the fuel cost per unit used should be low, compared to other systems within the above parameters.

Accordingly, it is a further objective of the invention to provide a freestanding fireplace hearth with an improved efficiency taking into account burn characteristics, volume of fuel used and burn time or duration per fuel unit consumed.

A further objective of the invention has thus been to provide a freestanding fireplace hearth with improved flame color and burning sound like a wood burning fire, at acceptable burn time and fuel volume used.

SUMMARY OF THE INVENTION

This invention overcomes the above-described and other drawbacks of known fireplace or hearth systems while still

offering a visually and audibly pleasing safe live fire and associated ambiance in an outdoor setting.

In a presently preferred embodiment, the invention includes a free standing fireplace hearth for burning a fuel to provide an attractive ambiance fire in an outdoor setting. The fireplace hearth includes a base having a fuel tray defining a chamber slidably mounted therein on a drawer-like structure for movement between open and closed configurations and a spring biased latch to releasably secure the tray in the closed configuration. The tray is configured with a throat as an integral part of the overall combustion system as will be described. A snuffer or burner is disposed in the hearth over the tray and provides flaps or dampers for controlling the flame height and for snuffing out the flame as desired. The tray is mounted for movement on the drawer structure between a lowered and a raised position. A plurality of cams are pivotally oriented with respect to the tray. A stop is mounted on the base relative to the tray so that as the tray approaches the closed configuration, the tray abuts against the stop. Continued movement of drawer rails on which the tray is mounted toward the closed configuration activates the cams and thereby elevates the tray relative to the snuffer into the raised position and in operative contact with the snuffer.

A log set of fiber/ceramic or other wood simulation material is operably disposed over the snuffer. Flame from the snuffer dances up through passages in the log set which has features which glow. Air moving up the passages produces lift to enhance the burn characteristics of the flames.

A pair of spaced dampers or shutters are mounted for movement to and between a closed snuffing configuration and a fully open burn configuration. Each of the damper shutters are coupled via a linkage to a rotational control knob such that rotation of the control knob in a first direction pivots the damper shutters toward the closed snuffing configuration to extinguish the burning fuel. Rotation of the control knob in a second opposite direction pivots the damper shutters toward the fully open configuration to increase the flame height through the log set.

A plurality of posts extend upwardly from the base to support a roof. The roof includes a heat shield mounted on the interior thereof to deflect hot air generated by the burning fuel from impinging upon the roof and thereby maintains the roof at a lower temperature than the heat shield during fuel burning. At least a portion of the heat shield is spaced from the roof to define space for an insulation layer of air between the heat shield and the cover. A plurality of baffles are included on the heat shield to direct the heat out from under the roof, off of the heat shield and cooler air into the insulation layer of air between the roof and the heat shield.

The present invention in another aspect includes a specific composition of fuel which is suitable for use in the free standing fireplace hearth. The fuel in a presently preferred embodiment is a gel composition which satisfies the characteristics of fireplace fuel with respect to aesthetic features such as producing golden high luminous flame without producing an offensive odor or smoke while still generating a crackle and pop sound. Further, the fuel is safe for handling and storage purposes and the formulation is of generally non-toxic components as well as being self-contained if spilled, environmentally safe in burning, producing minimal pollutants and being readily extinguishable without any smoke buildup. Further, the burnt fuel does not produce any significant amount of residue or the like.

Accordingly, it will be appreciated that the fuel tray, the fuel chamber throat in the tray, the snuffer with its dampers and the log set combine to define a combustion system

producing a flame having the random pattern appearance of a wood flame with desirable burn time and low fuel volume requirements.

In brief, the combustion system performs or acts something like a carbueration system.

When the drawer is shut the fuel chamber mates or couples with the snuffer assembly to complete the combustion system and also acts as a way to extinguish the flame. Air is mixed with the fuel. The fuel vaporizes in the fuel chamber and the air-alcohol gas mixture rises or moves through the throat out of the chamber via a plurality of flame paths created by a wedge-shaped, diverter of the snuffer and the openings on top of the snuffer assembly. The damper or doors control the height of the flames and also act when closed to snuff out the flame. The log set is decorative. As the flames move through the log set, they actually warm the log set material causing it to glow when touched by flame. The flames move through the log set with as little impingement as possible so that sooting is kept to a minimum. The passages in the log set warm up and cause convection of additional ambient air up through the passages so the fire or flame is decoupled and is lifted up therethrough. The system is self-regulating, so as the user adjusts the dampers, increasing or decreasing the size of the flame, the combustion system continues to work the same way.

A preferred fuel according to the invention is a gel composition, or mix of a lower alkyl alcohol, water, flammable organic tertiary butyl alcohol and double or single walled microencapsulated solvents, gelling agent, polyacrylic acid, cross linking agent and surfactant. Such a fuel as described herein, when used in the hearth described herein, produces desirable burn characteristics over an acceptable burn time and with an acceptable fuel volume required.

BRIEF DESCRIPTION OF THE DRAWINGS

The objectives and features of the invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a perspective view of the invention showing in phantom a withdrawn fuel tray for fueling;

FIG. **2** is a front elevational view of the invention of FIG. **1**;

FIG. **3** is a side elevational view of the invention of FIG. **1**;

FIG. **4** is a rear elevational view of the invention of FIG. **1**;

FIG. **5** is a plan view of the invention of FIG. **1**;

FIG. **6** is a bottom view of the invention of FIG. **1**;

FIG. **7** is a cross-sectional view taken along lines **7**—**7** of FIG. **1** showing the fuel tray in closed, operational position;

FIG. **7**A is a view of the fuel tray and its drawer mount similar to FIG. **7**, but showing only the tray, drawer components and snuffer in lowered partially opened position;

FIG. **8** is a cross sectional view taken along lines **8**—**8** of FIG. **7** with certain components removed for clarity;

FIG. **9** is a cross sectional view taken along lines **9**—**9** of FIG. **7**A with certain components removed for clarity;

FIG. **10** is a perspective view showing the tray, drawer components and snuffer of FIGS. **1**, **7**A and **9**;

FIG. **10**A is a perspective view of the upperside of the fuel tray and drawer of the invention;

FIG. **10**B is a perspective view of the underside of the hearth showing fuel tray and drawer components of the invention;

FIG. **10**C is a perspective view of the forward end of the fuel tray and drawer of the invention viewed from a rear perspective;

FIG. **11** is a perspective view of the roof and heat shield of

FIG. **12** is a perspective view of a corner structure of the invention as shown in FIG. **1**;

FIG. **13** is a diagrammatic elevational illustration of the combustion systems of the invention of FIG. **1**; and

FIG. **14** is a diagrammatic perspective illustrative of a log set used in the hearth of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the figures, presently preferred embodiments of a free standing fireplace hearth **10** according to this invention are shown. The hearth **10** is intended for outdoor use and is free standing and portable as needed.

The hearth **10** includes a base **12** with four downwardly projecting legs **14**, each of which include a rotationally adjustable foot **16**, all of which in combination could be used to level the base **12** and the hearth **10** as appropriate. An upwardly extending post or column **18** is mounted proximate each corner of the base **20** and the posts **18** in combination support a roof **20**. The roof **20** includes a centrally located vent cap **22** secured to and spaced from the roof **20** to provide for the free flow of air therebetween. A support arch **24** is mounted between each pair of adjacent posts **18**. A plurality of preferably artificial, although realistic appearing, logs making up log set **26** (FIGS. **13**, **14**) are positioned atop the base **12** within the hearth **10**. Log set **26** includes side logs **27**, **29** and a center log **31**, for example.

It will be appreciated that posts **18** are preferably formed, hollow columns having in two adjacent sides slots **19** and **21** (FIG. **12**). Also, each slot is provided with a groove **23** in a bottom of the slot and extending a short distance downwardly.

On assembly, the corner posts **18** are secured in appropriate recesses in base **12**. A resilient tube, gasket or bumper is inserted into a lower end of slot **19**, **21** to resiliently support a preferably transparent panel **17**, such as glass or plastic slid downwardly to the bumper in the slots so the bottom edge of panels **17** are spaced from base **12**. Thereafter, a tenon end **25** of a support arch **24** is slid into grooves **23** to lock the arches **24** in place and columns **18** together, the bottom of grooves **23** supporting the arches **24** above the glass panels **17** in slots **19**, **21**.

The roof **20** is provided with corner projections **15** (FIGS. **11**, **12**) which then fit into the top ends of corner columns **18** for securing the roof **20** and heat shield **68** thereon.

It will be appreciated that hearth **10** includes a floor **13** extending across the base **12** and alongside snuffer **42**. Floor **13** may comprise two formed components of aluminum, metal, ceramic or other suitable material on each side of snuffer **42**. One suitable, but not necessary material for the floor is a material manufactured by The Foundry in Toronto, Canada, under the name "Cool Crete".

A drawer structure **28** is slidably mounted in the base **12** for movement to and between a closed configuration (FIG. **9**) and toward an open configuration (FIG. **8**). The drawer structure **28** is slidably mounted on rollers **38**. Rear rollers **38** are mounted on drawer rails **44**, **45** and forward rollers **38** (FIG. **10**B) on stationary slide rails **55***a* and **55***b* .

A control knob **30** projects from the base **12** for adjusting dampers **32**, **33** to control flames resulting from burning fuel

34. Mounted within the drawer 28 is a fuel tray 36 defining a fuel chamber 37 for holding the vaporizing fuel 34. Tray 36 also defines a constricted throat 39 tapering inwardly over chamber 37.

The tray 36 has a rear end 41 and forward end 3 and is movably mounted on the drawer structure 28 for movement to and between a lowered position (FIG. 7A) when the drawer is moved toward an open configuration (FIGS. 7A and 8) and a raised or closed position (FIGS. 7 and 9). In the raised position, spaced uppermost flanges or lips 40 of the tray 36 are placed into operative sealing engagement with lower flanges or lips 48 (FIG. 7) of a snuffer 42 mounted within the base 12. The tray 36 in the raised sealing configuration inhibits air from entering between the lips 40 and flanges 48 during operation of the hearth 10 and allows extinguishment of the fire when desired by operation of the snuffer dampers 32, 33.

The tray 36 is operatively coupled to the slidable drawer 28 by way of a cam mechanism comprising, for example, cam followers 49 mounted on tray 36 and cam slots S1 (FIGS. 8, 9) disposed in slidable drawer rails 44, 45 (FIG. 7A). As shown, cam followers 49 comprise a cam follower portion 49 a and an enlarged flange 49*b* outwardly thereof (with respect to tray 36) to maintain the cam followers in the slots 51 in the rails 44, 45.

When the drawer 28 is pushed inwardly or rearwardly, the back end of the tray 36 engages a stop 46. Continued rearward movement, however, of rails 44, 45 pushes the cam slots 51 under or across the followers 49, raising them, and thus tray 36, upwardly toward snuffer 42, where lips 40, 48 engage effectively to cut off air passages therebetween.

In an alternative embodiment (not shown) the tray 36 is coupled to the drawer 28 by a plurality of links which are pivotally coupled at a first lower end to the tray and at a second upper end to the drawer 28. As the drawer slides or rolls from the open configuration toward the closed configuration, a back end of the tray 36 approaches a stop 46 (see FIG. 9) mounted on the base 12 so that as the drawer approaches the closed configuration, the tray abuts against the stop. Continued movement of the drawer 28 toward the closed configuration thereby pivots the links toward a more vertical orientation. Since the tray is prevented from translating in a generally horizontal direction, it rises vertically on the links into sealing engagement with the snuffer through the continued lateral movement of the drawer inwardly or rearwardly towards the closed configuration.

Once the drawer 28 is in the closed configuration and the tray 36 is in the raised position, the drawer 28 is maintained in the closed configuration by a spring biased latch 50 which engages holes 52 in a keeper plate 54 of the stationary slide rails 55*a*, 55*b*. To open the drawer, a user grasps a catch or arm 56 on the latch 50 to thereby pivot the latch out of engagement with the keeper plate 54 and permit the drawer 28 to be pulled open and the tray 36 lowered as the cam followers 49 descend in slots 51 when drawer 28 is pulled out so the tray is at least partially exposed for filling.

As shown in the figures and particularly FIGS. 8 and 9, the control knob 30 is mounted on a shaft 58 for pivotal movement to adjust the position of spaced dampers 32, 33 of the snuffer 42. These are mounted for movement to and between a closed snuffing configuration and a fully open configuration (dotted line FIG. 13), with intermediate burning positions adjusting the size of the respective openings in the snuffer 42 and thus any flame height. Such control movement of dampers 32, 33 is illustated by arrows A, B in FIG. 7. The dampers 32, 33 are coupled via a pivotable linkage 62 to the shaft 58 so that upon rotation of the shaft 58 by the control knob 30, an upper edge of the damper shutters moves into or out of engagement with an upper edge 65*a*, 66*b* of a V-shaped diverter 64 of snuffer 42 extending generally parallel to the shaft (see FIGS. 7, 7A and 13). Similarly, rotation of the control knob and shaft moves a lower edge 32*a*, 33*a* of each damper 32, 33 toward or away from respective flanges 66*a*, 66*b* of flanges 66. In this regard, the damper could be pivoted. Preferably they are slotted to receive pins 67 for motion as described. When the dampers 32, 33 are engaged with the adjacent structure as described, in closed configuration, and fuel burning is thereby extinguished. Alternatively, adjustment of the position of the dampers 32, 33 controls the air flow to the flame for regulating the intensity and height thereof. The dampers 32, 33 diverter 64, flanges 66*a*, 66*b* and related structure combine to form a flue or controller for the burning fuel.

Of course, while specific drawer and motion compartments have been described, and other suitable components could be used, it will be readily appreciated that a preferred embodiment of the invention comprises a fuel tray 36 which can easily be unlatched and drawn forwardly or outwardly of hearth 10 for loading of a gel fuel 34 (to be described) or other suitable fuel.

Thereafter, the drawer 28 and tray 36 are pushed rearwardly into hearth 10 and the tray is lifted by the ending motion of the return to operative engagement with a snuffer 42.

It will be appreciated that the lower flanges 48 of the snuffer are engaged with upper flanges or lips 40 of the tray 36 to effectively seal the chamber 37 so the snuffer 42 is operable to extinguish flame therefrom when dampers 32, 33 are closed.

A projection 35 of knob 30 extends downwardly and blocks outward motion of drawer 28 and tray 36 unless the knob 30 is positioned to close openings 60, 61 in a snuffer 42 with dampers 32, 33 (FIG. 8). Thus, for all operable open or "burn" positions of dampers 32, 33, knob 30 and projection 35 block outward movement of drawer 28. This prevents the opening or withdrawal of fuel tray 36 when any flame is burning.

Shaft 58 is engaged by a double spring clip 59 which frictionally maintains the rotary position of shaft 58 and thus that of linkage 62 and the damper position, once set.

It will be also be appreciated that stationary rails 55*a* and 55*b* are secured to base 12. Rollers 38 are oriented on the rear ends of drawer rails 44, 45 and ride in the stationary rails 55*a* and 55*b*, respectively. Forward rollers are mounted on the stationary rails 55*a* and 55*b* and support the drawer rails 44, 45 so those rails are easily pulled and pushed outwardly and inwardly as described, carrying tray 36. Also, it will be appreciated that tray 36 moves with respect to drawer rails 44, 45 after the tray is stopped by stop 46, in order that it is raised toward snuffer 42.

A strap 53 (FIG. 10B) is disposed to secure stationary rails 55*a*, 55*b* from separating apart.

The roof 20 of the fireplace hearth 10 includes a single piece heat shield 68 (FIGS. 7 and 11) mounted interiorly thereof to deflect hot air generated by the burning fuel from impinging upon the roof 20. This maintains the roof at a lower temperature to avoid someone being burned by touching the roof 20 during operation of the fireplace hearth 10. The heat shield 68 is spaced from the roof 20 to thereby provide an insulation layer of air 70 between the heat shield and the roof 20 and further minimize the transfer of heat to the roof 20. Additionally, around the perimeter of the heat

shield **68**, a raised baffle **72** is provided which terminates at the corners of the heat shield at slits **74** defined by the space between edges **75** of roof **20** and **76** of heat shield **68** (FIG. **7**). A tongue **77** connects the heat shield **68** to the roof **20** at each of the four corners. This structure allows for the hot air from the fire which impinges upon the heat shield to be directed outwardly and downwardly away from the roof **20**. Furthermore, the baffles **72** and slits **74** between the roof **20** and the heat shield **68** allow for cooler air to be drawn into and circulate around the roof **20**, entering the space between the heat shield and the roof **20** to provide the insulation of air **70** therebetween. Furthermore, air which is warmed in the insulation layer **70** rises and escapes between the cap **22** and the roof **20** and is replaced by cooler air drawn in by slits **74**. It will be appreciated that the passage from slits **74** to caps **22** are unobstructed, allowing a free flow of air between roof **20** and shield **68** with the only contact between them at the corners. This helps keep roof **20** from becoming too hot.

Log set **26** is diagrammatically illustrated in FIGS. **1**, **13** and **14**. It may be made of a fiber and ceramic material or any other suitable material for this use. The log set **26** may be formed in one piece or in a plurality of separate pieces, fitted or joined together to provide the appearance of authentic logs. FIGS. **13** and **14** illustrate side logs **27**, **29** and a center log **31**, for example, for illustrative purposes only.

However formed, the log set has a plurality of passages. Two of these are illustrated at **79**, **80** (FIG. **13**). These passages have respective entry ends **81**, **82** and outlet ends **83**, **84**. Entry ends **81**, **82** are disposed proximate the openings **60**, **61** in snuffer **42** for receiving flames therefrom, the flames extending upwardly through passages **79**, **80** to and through outlets **83**, **84**.

It will also be appreciated that inlets **81**, **82** are disposed or oriented such that ambient air can be drawn into the inlets, mixing with the flames, decoupling the flame, and lifting the flame up through the log set **26**. Further, it will be appreciated that the outer logs **27**, **29** could be lower than the center log **31**. In any event, the top edges of dampers **32**, **33** form a gap (changing when the dampers are moved) between the dampers and the logs **27**, **29** respectively. This gap allows air into inlets **81**, **82** to decouple and lift the flames through passages **79**, **80**.

As the flame moves up passages **79**, **80** they heat the surrounding log set material and this heating produces a convection effect, drawing outside air **85**, **86** into the passages **79**, **80** and into the flames. The amount of heat so generated and the resulting convection effect produced is controlled by the flames which are in turn controlled by the position of dampers **32**, **33**. The drawing in of decoupling air is thus self-regulating as a function of flame control by the dampers **32**, **33**, and as a function of the gap between top edges of the dampers and either the logs or any adjacent floor structure.

While only two passages **79**, **80** are shown in FIG. **13**, there may be numerous passages through the log set **26**, such as the passages **1–5** in FIG. **14**. As shown, it is desirable that the passages are generally oriented to reduce actual flame contact on the log set material and thereby reduce sooting of the surfaces. The manner of the formation of the log set **26** or of its individual components at this interconnection is not a part of this invention. The passages such as **79**, **80** can be formed through the log components or therebetween as desired. Preferably, there is an elongated space between the respective outer or side logs **27**, **29** and center log **31**. This space (passages **79**, **80** for example) are open at the bottom near snuffer **42**, but may be bridged at the top by contact of the side logs **27**, **29** with the center log.

Having explained and described the structural features and operation of the fireplace hearth according to presently preferred embodiments of this invention, the fuel **34** which is particularly adapted for use in the fireplace hearth comprises an additional aspect of the present invention. Specifically, the fuel source for use in the present invention is a gel composition which satisfies the characteristics of fireplace fuel with respect to aesthetic features such as producing a golden high luminous flame without producing an offensive odor or smoke and generating a crackle and pop sound. The fuel is safe for handling and storage purposes and is formulated from generally non-toxic components. The fuel is self-contained if spilled, environmentally safe in burning, producing minimal pollutants and readily extinguishable without any smoke build-up. Further the product does not produce any significant amount of residue.

The gel composition for use in the present invention is a mixture of a lower alkyl alcohol preferably ethanol, water, a flammable non-aromatic organic composition or compound which is effective to produce a golden flame during combustion, such as an aliphatic hydrocarbon preferably with an aniline point at least about 180° F., for example about 180° F. (such as odorless mineral spirits). The lower alkyl alcohol is present in the gel in an amount effective to enable the fuel to maintain a self-contained flame. Tertiary butyl alcohol, for example, at least about 2%, also produces a yellow flame and stabilizes the gel. Other yellow burning alcohols and mixtures thereof may also be used. The gel composition also includes cross-linked and double-walled microencapsulated solvents such as toluene, xylene, etc. and a gelling agent such as water and a minor amount of polyacrylic acid or polyacrylate or salts thereof in amounts to establish a viscosity effective to suspend the microencapsulated compound, along with a cross-linking agent and a surfactant. This is neutralized to a pH of 6–10 with a basic amine such as triethanolamine, diethanolamine, Ethomine (manufactured by Sonobel) and other organic bases.

The gel formulation has a viscosity of 500,000 cps or higher in a high yield value fuel with excellent suspending properties. The aliphatic hydrocarbons produce the golden yellow flame without producing smoke or soot when burned unlike normal characteristics of aromatic compounds.

Ingredients	Preferred % by Weight	% Range
Ethanol anhydrous	58.5	50 to 65
proprietary Polyacrylic acid (Carbopol E21 from BF Goodrich)	0.5	0.2–1.2
Water	28.5	25–38
Aliphatic hydrocarbons (odorless mineral spirits)	6.84	2–15
Tertiary Butyl Alcohol	5.16	0–12
Denatonium Benzoate (bittering agent, for safety)	40 ppm	40 ppm
Triethanolamine	0.4	0.3–1.0
dye	5 ppm	2–30 ppm
Toluene/Xylene capsules	0.1	0.1–1.0
	100	

The product is formulated by combining the polyacrylic acid with water to wet the polyacrylic acid. The remaining components are added into the mix under agitation. The process is completed by neutralizing the excess acid and further mixing for uniformity of the product by pumping (recirculation) of product through an in-line static mixer.

Preferably the solvent microcapsules are cross-linked and double-walled complexes formed by coacervation. Single walled complexes could be used. The cross linked gelatin double wall forms about 30% of the capsule weight. This prevents permeation of the solvents to provide a long shelf life. The encapsulated solvent has a size and composition effective to maximize crackling sound when burned. Further, the capsules should have a size greater than 500 microns, preferably 600 to 1500 microns with 50% or more of the capsules being 900–1200 microns.

Further the solvent in the microcapsule is an aromatic solvent preferably a lower alkyl aromatic solvent such as toluene or xylene at an amount having a vapor pressure of 5 to 15 millimeters mercury at 68° F. and a boiling range of 300–325° F. This produces the best crackling sound during burning.

This formulation is ready soluble in water making it easy to clean without leaving any stain on the carpet or flooring materials. Further the product is made safe to handle.

In an alternative embodiment of the fuel, the tertiary butyl alcohol (TBA) is omitted and the aliphatic hydrocarbon (odorless mineral spirits) is increased to about 12% by weight. This aids in reduction of the flame point temperature of the fuel when that might be desired, but may exhibit a small problem of separation of some of the components.

Turning now to FIGS. **13** and **14**, the preferred combustion process provided by the invention produces a flame with a random dancing pattern, of golden color as if burning from wood fuel, a crackling authentic wood burning sound, with minimal use of fuel and over a burn time of about 2–4 hours, depending on the position of dampers **32, 33**.

Initially, a load or unit of fuel **34** is introduced to tray **36**. An amount of about 64 ounces of fuel **34** is appropriate to fill tray **36**, pulled out from base **12**, to a level as illustrated in FIG. **13**. Thereafter, the drawer **28** and tray **36** are pushed into the hearth **10**. The lateral motion of tray **36** is stopped while slides or rails **44, 45** continue rearwardly, as previously described. This cams the tray **6** up into operative engagement with the snuffer **42** and the drawer **28** and tray **36** are latched in this position.

Knob **30** can now be turned to open dampers **32, 33**. Vaporization of fuel **34** occurs and the fuel vapor rises from tray **36** up through its throat **39** where it is constricted toward snuffer **42**. The vapors are diverted by diverter **64** through openings **60, 61** between the diverter **64** and dampers **32, 33**.

When the vapors are lit by a suitable ignitor, flame is produced. This flame appears at the snuffer and rises upwardly toward passages **79, 80**. As the log set **26** heats, the heat draws air **(85, 86)** into the entry ends of the passages **81, 82** between the dampers **32, 33** and the logs or any adjacent floor **13** (not shown) which may be situated just to the side and beneath the logs. This convection air decouples the flame from the snuffer **42** and tray **36** and helps lift the flame upwardly through and above log set **26**.

At the same time, air **87, 88** is drawn or convected upwardly around tray **36**, cooling the tray and keeping fuel from becoming too hot and thus regulating its vaporization.

Dampers **32, 33** can be moved through manipulation of knob **30**, turning shaft **58** and moving linkage **62** through various burn positions regulating the flame produced. Movement of dampers **32, 33** to restrict openings **60, 61** reduces the flame height and movement of dampers **32, 33** to enlarge openings **60, 61**, permitting passage of more fuel vapor, enlarging the flames and opening the side passages between dampers and logs on floors for more decoupling air.

For all positions of knob **30** wherein dampers **32, 33** are open, knob projection **35** restricts outward lateral motion of tray **36** and drawer **28** so that it cannot be extended out of hearth **10** while fuel is burning. When knob **30** is turned to move dampers **32, 33** to close off openings **60, 61** and snuff out any flame, projection **35** is moved away from its tray and drawer blocking position. This allows refueling.

When the dampers **32, 33** are moved to fully open openings **60, 61**, maximum flame height and a shorter burn time of about two hours results. When dampers **32, 33** are moved to restrict openings **60, 61** to the lowest suitable flame, an extended burn time of about four hours is provided by the 64 ounce fuel unit.

This combustion system thus operates like a carbureation system, wherein the fuel vapors are concentrated by throat **39**, throttled at dampers **32, 33** and then boosted, in flame, by the decoupling air.

While not restricted to any particular sizes, one combination of sizes of various components found suitable is as follows. Of course, these dimensions are approximations for purposes of clarity of description and may be varied in production.

Fuel tray **36** is about 12 inches long measured between two tray end panels about 4⅝ inches wide at its bottom. Sides **89, 90** of tray **36** extend up from bottom **91** and outwardly at an angle from the horizontal of about 100 degrees, for about 1½ inch. Throat panels **92, 93** then taper inwardly from upper edges of side **89, 90** for about 1 inch at an angle of about 35 degrees from the horizontal. From the inner edges of throat panels **92, 93**, the throat panels **94, 95** extend upwardly and outwardly for about 1½ inches at an angle of about 5 degrees from the vertical to the tray lip or flange **40**. Overall vertical height of the tray **36** from bottom **91** to flanges **40** is about 3½ inches. The throat **39** at the top of the panels **92, 93** is a little over 3 inches wide. When filled with a preferred unit of fuel **34**, the filled fuel level is just below the junction of panels **89, 90** with throat panels **92, 93** respectively.

The snuffer **42**, at its opening to tray **36** through throat **39** is about 12 inches long and that snuffer opening is preferably slightly larger than the upper opening of the throat **39** between the upper edges of panels **94, 95**. The openings **60, 61** in snuffer **42** are about 12 inches long and a little over one inch wide, resulting in a cross-sectional area of about 13 square inches for each opening **60, 61**.

As noted, there are preferably numerous passages, such as passages **79, 80** up through log set **26**. Fire passages 1–5 are shown in FIG. **14**. These passages are positioned in the log set to give the aesthetic appearance of an authentic wood fire by means of bridges over the logs. At the bottom of the passages 1–5 (i.e. such as **78, 80**) the entry openings **81, 82** defining a restrictive log out-take **(81, 82)** are about 12 inches long and about ½ inches wide. The logs themselves are about 16 inches long. Thus, the restrictive log take out flow area is about 6 square inches on each side (FIG. **13**). The air gap associated with these openings **81, 82** is formed by the dampers **32, 33** at their top edges and the logs or adjacent floor panels **13**. This gap is between about ¼ inches and ⅝ inches so that the effective decoupling air openings are about 12 inches long and vary from ¼ to ⅝ inches wide.

These dimensions result in a combustion system which is self-regulating when the dampers are moved for the best efficiency for all burn positions. Of course, other dimensions, shapes and sizes of all components will be appreciated. Variations in the parameters of one combustion system component will or may vary the parameter of another component.

From the above disclosure of the general principles of the present invention and the preceding detailed description of

at least one preferred embodiment, those skilled in the art will readily comprehend the various modifications to which this invention is susceptible. Therefore, we desire to be limited only by the scope of the following claims and equivalents thereof.

We claim:

1. A crackling gel fuel comprising

a fuel source, a gelling agent, and microcapsules containing a solvent wherein said microcapsules have walls that are cross-linked and are double-walled and said walls comprise about 30% of the microcapsule weight, and the size of 50% or more of said microcapsules is 900–1200 microns, effective to maximize crackling sound when burned.

2. A water soluble fuel composition providing a golden flame and generating a crackling sound without excessive smoke comprising:

a flammable lower alkyl alcohol,

a flammable non-aromatic organic compound effective to produce a golden flame during combustion, and

microcapsules containing a flammable organic solvent different from said non-aromatic organic compound and said lower alkyl alcohol wherein said microcapsules have walls that are cross-linked and double-walled and said walls comprise about 30% of the microcapsule weight, and the size of 50% or more of said microcapsules is 900–1200 microns.

3. A water soluble fuel composition which, when burned, provides a golden flame and a crackling sound without excessive smoke comprising:

a flammable lower alkyl alcohol in a concentration amount effective to enable said fuel to maintain a self-contained flame,

a flammable non-aromatic organic solvent effective to produce a golden flame, said solvent selected from the group consisting of aliphatic hydrocarbons and yellow burning alcohols and mixtures thereof,

water gelling agent comprising a polyacrylic acid and water, and

microcapsules containing an aromatic solvent wherein said microcapsules have walls that are cross-linked and are double-walled and said walls comprise about 30% of the microcapsule weight, and the size of 50% or more of said microcapsules is 900–1200 microns.

4. The fuel composition as in claim **3** wherein said lower alkyl alcohol is ethanol.

5. The fuel composition as in claim **4** wherein said aliphatic hydrocarbon has an aniline point of at least about 180 degrees F.

6. The fuel composition as in claim **5** further comprising tertiary butyl alcohol.

7. A fuel composition comprising:

50% to 65% by weight ethanol,

2% to 15% by weight aliphatic hydrocarbon having an aniline point about 180° F.,

0 to 12% tertiary butyl alcohol,

an amount of microcapsules containing a flammable aromatic solvent effective to cause a crackling sound when burned wherein said microcapsules have walls that are cross-linked and are double-walled and said wails comprise about 30% of the microcapsule weight, and the size of 50% or more of said microcapsules is 900–1200 microns, and

a gel composition comprising water and a polyacrylic acid or salt thereof in amounts effective to establish a viscosity effective to suspend said microcapsules.

8. The fuel composition as in claim **7** comprising at least about 2% tertiary butyl alcohol.

9. The fuel composition as in claim **7** wherein said gel comprises 0.2–1.2% polyacrylic acid and 25–33% by weight water base on the weight of said fuel.

10. The fuel composition as in claim **8** wherein said microcapsules contain an aromatic solvent having a vapor pressure of 5 to 15 mm Hg at 68 degrees F. and a boiling range of 300–325 degrees F.

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