

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
16 December 2004 (16.12.2004)

PCT

(10) International Publication Number
WO 2004/109195 A2

- (51) International Patent Classification⁷: **F24J**
- (21) International Application Number:
PCT/US2004/015817
- (22) International Filing Date: 19 May 2004 (19.05.2004)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/475,468 4 June 2003 (04.06.2003) US
10/801,864 17 March 2004 (17.03.2004) US
- (71) Applicant (for all designated States except US): **RIETK-
ERK, Patrick, Anthony** [US/US]; 3648 Oakbrook Lane,
Panama City Beach, FL 32408 (US).
- (71) Applicant and
- (72) Inventor: **ROMIJN, Maarten, Martinus** [NL/DE]; N°10
Grindel Weg, D-52076 Aachen (DE).
- (74) Common Representative: **RIETKERK, Patrick, An-
thony**; 3648 Oakbrook Lane, Panama City Beach, FL
32408 (US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

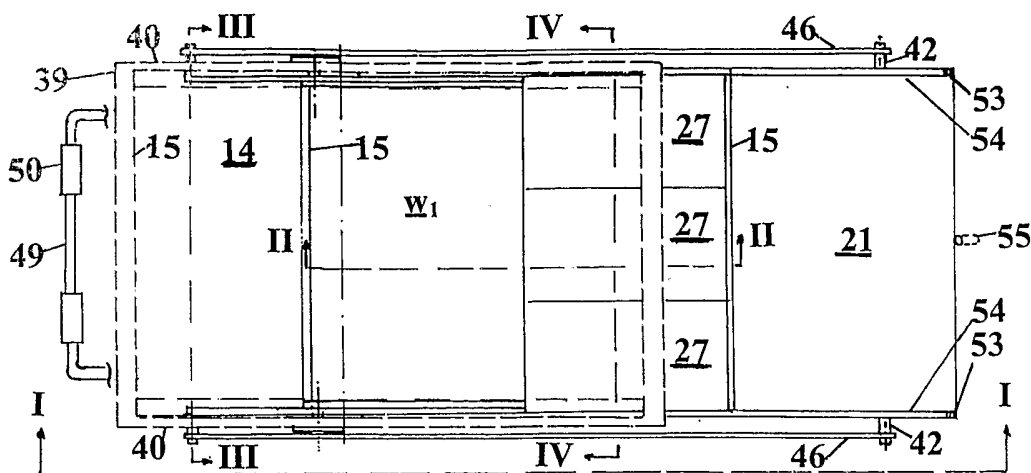
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI,
SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR ACHIEVING WORLDWIDE REDUCTION OF CARBON DIOXIDE EMIS-
SIONS AND DEFORESTATION



(57) Abstract: Method and apparatus enabling worldwide reduction of carbon dioxide emissions and/or deforestation, personal clean energy system providing for cooking and/or electricity needs, earning emission credits, monetizing values of tradable emission rights/credits accruing from emissions avoided by using the apparatus to pay for the cost of the apparatus and/or to provide ongoing revenue thereby inducing many people to substitute carbon containing fuels for cooking and/or electricity needs by a synergic combination of cooking 0 and/or electricity generation 21 on sunlight H through a low cost two-axis easy sun tracking mechanism including a bendable mirror 14 having variable curvatures r_m and tilt angles s_m optimized for the solar altitudes α_s at the latitudes, seasons and day times from equator to arctic, resulting in greatly augmented cooking power enabling high quality meals 0 through much shorter cooking times and/or longer/higher PV cell 21 outputs charging batteries 24 powering lights, refrigerator, television, computer, enabling worldwide education and sustainable development.



Published:

— without international search report and to be republished
upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

**INTERNATIONAL APPLICATION UNDER THE PATENT COOPERATION TREATY
(PCT)**

CROSS-REFERENCE TO RELATED APPLICATIONS

Specific reference is made to the provisional application for patent for the present invention
5 filed by this applicant/inventor in the United States Patent and Trademark Office on the fourth
of June of the year two thousand and three (06/04/2003), for which provisional application for
patent the United States Patent and Trademark Office has issued application number
60/475,468, confirmation number 9680 and filing receipt barcode number
OC000000010443224, which was mailed by the United States Patent and Trademark Office
10 to this applicant/inventor on the eighth of July of the year two thousand and three
(07/08/2003). Applicant/inventor has filed a non-provisional utility patent application for a
U.S patent for the present invention in the United States Patent and Trademark Office on the
seventeenth of March of the year two thousand and four (03/17/2004), return postcard
identification: 15535 U.S.PTO **10/801864**-031704.

15 Inventor: Romijn, Maarten Martinus
Citizenship: Citizen of the Netherlands
Residence: Nr. 10 Grindelweg, Aachen 52076, Germany

**METHOD AND APPARATUS FOR ACHIEVING WORLDWIDE REDUCTION OF
20 CARBON DIOXIDE EMISSIONS AND DEFORESTATION**

TECHNICAL FIELD

The present invention relates generally to the urgent need to reduce worldwide
emissions of harmful gases including greenhouse gases such as carbon dioxide.

25 More particularly the ambition of the present invention is to provide practical and cost
effective means enabling worldwide reduction of emissions of greenhouse gases including
carbon dioxide and other harmful gases emanating from the widespread burning of carbon
containing fuels including fuel wood for cooking purposes. In this context the present
invention aims to provide strong incentives for the replacement of unaccounted polluting fuels
30 burned for cooking purposes, by sunlight, as a convenient clean and safe heat and/or light
source for cooking and/or electricity generation.

With the above considerations in mind the present invention provides a method and
apparatus capable of augmenting convenience of cooking and/or electricity generation on
sunlight to such a high level that cooking and/or electricity generation on sunlight becomes
35 more convenient worldwide than cooking on carbon containing fuels like fuel wood.

BACKGROUND OF THE INVENTION

Gross National Product (GNP) in many countries of the world is directly related to the use of carbon containing fuels, resulting in emissions of carbon dioxide and other harmful gases and soot. From nation to nation GNP in U.S.dollars per metric ton of nationally
5 accounted carbon dioxide emitted has varied considerably. For example, in the year 2000 from U.S.\$ 4,110.- per metric ton in Japan to U.S.\$ 1,785.- per metric ton in the U.S.A. to U.S.\$ 365.- per metric ton in China. For the world, on average, Gross World Product (GWP) in the year 2000 amounted to about U.S.\$ 1,314.- per accounted metric ton of carbon dioxide emitted. Reducing carbon dioxide emissions, nationwide and/or worldwide by curtailing
10 economic activity casu quo economic growth, is a very costly option.

Until recently industrialized nations in North America, Europe and Asia were considered to dominate the use of fossil fuels resulting in vast carbon dioxide emissions causing global warming. The cost of carbon dioxide sequestration from fossil fuel fired power stations in Europe and the U.S.A. is reported in "Modern Power Stations", 7 October 2001 to
15 be about U.S.\$ 50.- per metric ton of carbon dioxide removed. In Europe, industries exceeding their carbon dioxide emission targets may presently be taxed the equivalent of U.S.\$ 40.- for every excess metric ton of carbon dioxide emitted, as of 2008 European industries may be taxed as much as the equivalent of U.S.\$ 100.- per excess metric ton of carbon dioxide emitted above their allowable targets. In the United Kingdom the government's consultation document
20 2001 (HMSO – London) on the "Renewable Obligation" indicated that a cost of U.S.\$ 120.- per metric ton of carbon dioxide avoided represented "good value".

A more compelling need for reduction of carbon dioxide and other harmful gas emissions has become evident recently from the "Asian Plume" caused by highly polluting, inefficient burning of carbon containing fuels like fuel wood for cooking purposes and causing
25 widespread air pollution from Asia as far as the Mediterranean, as reported from the "Indian Ocean Experiment" in "Science", 9 February 2001 and 25 October 2002.

A recent (2000) large survey in rural areas at 15° North latitude in India, as presented in "Energy Conversion and Management" 41, 2000, pages 775-831, reports average firewood consumption per person per day of 2.10 kilos for cooking plus 1.39 kilos per day for water
30 heating. This adds up to fuel wood needs of 1.275 metric tons per person per year and consequently to unaccounted annual emissions of carbon dioxide in the order of 3.0 metric tons per person per year. If this recent figure is used as representative for a rural world average, presently unaccounted emissions of carbon dioxide from worldwide fuel wood burning add up to some six thousand million metric tons per annum.

Quality of the cooked foods is poor, local overheating causes carcinogens such as acrylamides from locally overheated carbohydrates in the grains or potatoes being cooked.

The efficiency of cooking stoves in use is extremely poor. Only some 10 (ten) percent of the energy content of the firewood fuel is transferred to the food or beverage to be cooked
5 casu quo to be heated. Some 90 (ninety) percent of the energy is lost, combustion quality is very poor, the associated smoke and soot are extremely unhealthy for the cooks, the bystanders and the environment.

The relevance of cooking on light is described in a commentary called "Cooking in the Sunshine", in "Nature", dated November 29, 1990, volume 348, pages 385-386.

10 "Nature" reports that in 1990 worldwide two thousand million people depended on wood for cooking and that half the annual world wood harvest of three thousand million metric tons was used as a fuel. A similar number of people have no access to electricity, not even for such basic needs as a light bulb or a small refrigerator. In developing countries over fifty percent of all energy was used to prepare food. Firewood is in short, declining supply,
15 villagers in many rural areas in India now have to forage for firewood some eight hours per day. The cutting of firewood causes deforestation and destruction of wildlife. For every metric ton of firewood burned, some 2.35 metric tons of carbon dioxide accompanied by a host of other harmful anthropogenic gases and soot are emitted.

Apart from the scarcity of firewood and resulting deforestation the fuel wood problem
20 is aggravated by increased public awareness of global greenhouse effects caused by carbon dioxide emissions. Said burning of firewood for cooking purposes causes presently unaccounted carbon dioxide emissions in the order of six thousand million metric tons per annum, which – in perspective – is about equal to the total carbon dioxide emissions of Asia or the U.S.A. or to two times the total carbon dioxide emissions of the European Union.
25 Compensating six thousand million metric tons of presently unaccounted carbon dioxide emissions emanating from carbon containing fuels by carbon dioxide sequestration at fossil fuel fired power stations in industrialized nations would result in a recurring cost in the order of 300 billion U.S. dollars per year.

In the year 2000, for the world, average GWP amounted to about U.S.\$ 1,314.- per
30 accounted metric ton of carbon dioxide emitted. For the rural population, as per above survey in India, with an average family of 5.5 members having an income of less than U.S.\$ 150.- per family per year, the contribution to GWP is not much more than U.S.\$ 10.- per metric ton of unaccounted carbon dioxide emitted. In other words, based on present levels of technology, the industrial world emits less than one metric ton of carbon dioxide for every thousand U.S.

dollars worth of GWP achieved, whereas the fuel wood burning rural world emits in the order of one hundred metric tons, or over two orders of magnitude more carbon dioxide for every thousand U.S. dollars worth of GWP achieved. An analysis of bright sunshine hours available during the year in a typical North Indian environment at Jodhpur (26° N) has shown that for 5 333 days out of 365 bright sunshine is available for more than four hours per day, of which for 321 days bright sunshine is available for more than six hours per day. Rigorously used an advanced hot box type light cooker could save 321 times 3.49 kilos, is 1.12 metric tons of firewood per person per year casu quo over six metric tons per family per year, simultaneously reducing carbon dioxide emissions by 2.65 metric tons per person per year, 10 casu quo by some 14.5 metric tons per average family per year. Similarly casu quo additionally said advanced hot box type light cookers replacing widely used kerosene burning cookers could save on average more than a barrel of oil per person per year. More than 80 (eighty) percent of the world's population lives in the sunbelt area, between the 40° North parallel (the Beijing-Korea-Japan-New York-Madrid-Ankara-Tasjkent latitude) and the 40° 15 South parallel (the Cape Town-Melbourne-Buenos Aires latitude). In said sunbelt area and beyond an advanced hot box type light cooker of the present invention can be made to provide year-round net to food peak cooking power of 2,000 watts per square meter and/or photovoltaic cell peak sunlight irradiation of 1,500 watts per square meter of hot box light aperture area. For a six member family a .35 meter x .70 meter light aperture cooker enables 20 convenient cooking, for a four person family a .35 meter x .50 meter or a .25 meter x .70 meter light aperture is convenient, for a two adults family a .25 meter x .50 meter light aperture is convenient. For one person a .25 meter x .25 meter light aperture cooker is convenient. The estimated cost of said light cookers can be paid for in less than a year by the commercial trade value of the emission rights of the carbon dioxide avoided through the use 25 of said light cookers. The method of reducing carbon dioxide emissions emanating from the widespread use of fuels like fuel wood for cooking purposes is therefore a most cost effective and practical method for achieving worldwide reduction of carbon dioxide emissions, thereby simultaneously mitigating present and future constraints on worldwide economic growth as may become imposed by present casu quo future carbon dioxide emission limits. At the same 30 time said method provides the following additional benefits:

- a) Method enables cooking of better tasting and healthier dishes.
- b) Method enables cleaner, safer and healthier ways of cooking.
- c) Method enables freeing many millions of people from the chores of hunting for ever scarcer fuel wood and of attending to smoking, badly smelling cooking

fires causing widespread lung and eye diseases. Any time required for sun-tracking of the apparatus of the present invention is far less than the time required to keep present cooking fires under control and/or time required to find wood.

- 5 d) Method reduces the need for fuel wood, reduces deforestation and destruction of wildlife.

 In another context, many of serious and extended forest fires, such as experienced each year in e.g. Asia, Australia, Europe and the U.S.A., may be reduced in frequency if cookers on light with augmented power can be made available and convenient for use instead of the
10 wood burning camp fires and barbecues now being popular for outdoor cooking.

 In yet another context electricity may be produced efficiently and conveniently by photovoltaic cells positioned under an optimized mirror component of the apparatus of the present invention, thereby enabling worldwide affordable access to electricity, light and education, casu quo further worldwide reduction of emissions.

15

BACKGROUND ART

 Despite many efforts in industrialized countries to reduce carbon dioxide emissions for example through more fuel efficient cars, through more efficient power stations firing natural gas instead of coal and through the recently started practice in Japan of costing emissions into
20 the price of industrial casu quo consumer products, carbon dioxide emissions are still rising in virtually every country on earth with the fastest most worrying rise in developing countries. Most of said prior art casu quo state of the art efforts to reduce emissions of carbon dioxide were casu quo are being made in industrial areas as observed through prior art searches carried out in US classification 702/23, 364/493 and related classifications as well as in international
25 classification G06F and related applications wherein numerous prior art patent references were found of which for example patent no. US6,691,044 assigned to Toshiba Corporation for a "product environmental load evaluation method" is a typical example. The prior art casu quo the state of the art fails to disclose or suggest a method casu quo a mechanism capable of mobilizing casu quo inducing many people in developing countries casu quo in rural areas to
30 reduce casu quo to avoid their carbon dioxide emissions mainly emanating from their burning of carbon containing fuels for cooking and/or water heating needs. In emissions perspective, the carbon dioxide emissions that can be avoided by one family using the efficient solar cooker/PV electricity generator of the present invention, qualified for the accrual of tradable carbon dioxide emission rights casu quo tradable carbon dioxide emission credits through a

mechanism of quality assurance and/or registration numbers casu quo country and/or state license plate numbers can compensate the carbon dioxide emissions of about half a dozen compact cars, or can equal the carbon sink capacity of one acre of mature tropical forest.

Numerous prior art references describing photovoltaic solar cells, hereinafter called PV cells, for electricity generation were screened through prior art searches in US classification 257/457 and related classifications as well as in international classification H01L/27 and related classifications, of which patent no. US 6,696,731 assigned to Samsung corporation is a typical example. The prior art pertaining to PV cells casu quo PV cell modules for electricity generation fails to disclose or suggest a combination of PV cells and a solar cooker for simultaneous casu quo alternating cooking and/or electricity generating operations.

Heretofore, numerous efforts have been made to develop a practical and workable solar cooker. The following noted patents found as a result of patent searches carried out in U.S. classification 126 and related classifications as well as in international classification F24J2 and related classifications are exemplary of the known efforts made by others to attain a practical and workable solar cooker; viz. U.S. Pat. Nos. 820,127; 1,074,219; 1,158,175; 2,859,745; 2,909,171; 2,994,318; 3,038,463; 3,053,248; 3,896,786; 3,938,497; 4,077,391; 4,082,079; 4,083,357; 4,130,106; 4,220,141; 4,236,508; 4,262, 660; 4,281,644; 4,284,071; 4,292,957; 4,442,828; 4,446,854; 4,561,425; 4,583,521; 4,696,285; 4,848,320; 4,850,339; 4,913,130; 5,090,399; 5,113,845; 5,139,010; 5,524,610; 5,617,843; 5,893,360; 6,606,988; and viz. WO8703073; WO9739669; WO02075226; WO03006894; EP0099423; CN1035349; CN1040673; CN2098654U; CN2169093U; CN2181658U; CN2252966U; CN2374861U; CN2443681U; CN2451967U; CN2569029U; IN155889; IN158556; IN158891; IN159461; IN159541; IN162938; IN175856; IN178752; IN181453; IN184675; DE3120520; DE3545890; DE3607484; DE3611375; DE3616007; DE3706348; DE4009754; DE4142119; DE4218403; DE4308458; DE4338736; DE19545108; DE19603742; DE19807465; JP56097755; JP63306357; JP2101350; JP4366363; JP8233374; JP10094480; JP11325612; JP2000146309; JP2001183012; JP2001238712; FR2565678; FR2588644; FR2596503; FR2692659; FR2692660; FR2787867; FR2801097; GB2341675.

The prior art concentrating type of solar cookers such as for example the parabolic mirror type having the mirror positioned under the cooking vessel has too many drawbacks such as for example cumbersome sun tracking requirements, local hot spots burning the food, glare blinding the cook, sensitivity to wind and food spills fouling said mirror, to be considered for mass cooking. Generally the prior art fails to quantify solar energy collectable by the prior art solar cooker embodiments and also fails to disclose or suggest prior art solar

cooker performance in terms of net to food cooking power achievable in operation of said prior art solar cooker embodiments, the foregoing applies to all prior art solar cooker concepts including prior art solar cooker embodiments of the hot box type and of the concentrating flat mirror casu quo the concentrating curved mirror type.

5 An "Evaluation of the International Standard Test Procedure for testing Solar Cookers and Reporting Performance" is presented by P.A. Funk et al. in "Solar Energy" 2000, volume 68, pages 01-07, and references therein.

 All patents, articles, references, standards and the like cited herein are incorporated herein by reference in their entirety.

10 State-of-the-art hot box type cooker designs have in common that solar radiation enters the cooker cavity and is absorbed by and converted to heat on a blackened sheet of metal ("the absorber") functioning as heat conducting walls and floor of the cooker cavity. A representative design of a state-of-the-art hot box type solar cooker is shown in FIG. 1, in a sectional view showing the cooker cavity 0, the cooking vessel 2 standing on the non-
15 spectrally selective absorber plate 1, the insulation 3, the double glazed hinged lid 4 openable for access to the cooker cavity casu quo the cooking vessel, the reflecting "booster" lid 5 serving in the closed non-used position as protection of the glazed lid and the hinges 6. The cooking performance of hot box solar cookers according to the state-of-the-art is poor, especially so when solar radiation and ambient temperature are low, such as is the case in
20 winter and also in the other seasons during morning hours and late afternoon hours, when the sun is low and the angle of incidence of beam radiation is large. For the best state-of-the-art hot box type solar cookers the cooking time around mid-day in the summer for a dish is about three hours. During said three hours the position of the cooker box must be adjusted every half-hour, tracking the sun to obtain radiation in the cooker aperture. State-of-the-art cookers
25 are characterized by a very slow build-up of net to food cooking power, high heat loss through the light admitting aperture and are suitable only for the boiling type of cooking where cooking temperature does not exceed about one hundred centigrade. The quantities of heat required for physical and chemical changes involved in the cooking process proper are small relative to the sensible heat required to bring food to boiling temperature and to compensate
30 heat losses that occur during warming up and cooking. Even during optimum conditions of solar radiation the temperatures required for frying or baking cannot be sustained. Because the dominant mode of heat transfer to the food is by conduction from the absorber 1 to the vessel bottom 2 cooking time exponentially increases when the area ratio of absorber area to vessel bottom area decreases, in other words when more vessels are placed in the cooker cavity. Poor

heat transfer between the absorber and any vessel bottom leads to high temperatures of the non-spectrally selective absorber surface especially so in absorber areas at a distance from the vessel edge, and consequently high heat losses. The net sum is that typical state-of-the-art hot box type solar cookers having approximately 56 cm x 56 cm x 20 cm box dimensions, and about 46 cm x 46 cm light aperture, having an estimated local cost in the order of U.S.\$ 50.-, can only provide a net to food cooking power of about 25 watts on clear sunny days in the winter at 24° latitude casu quo about 125 watts/m², as shown in FIG. 2C. State-of-the art solar cooker designs fail to disclose or suggest inexpensive means to obtain higher net to food cooking power casu quo desirable cooking frequencies casu quo warm-keeping of meals on the table or under off-sunshine conditions. State-of-the art photovoltaic (hereinafter called PV) electricity generation systems of the non-tracking type are characterized by a slow build-up of net electric power delivery, especially so at low and/or unfavorable angles of incidence of sunlight on the PV cells. State-of-the art cooker designs fail to disclose or suggest any combination of convenient cooking and convenient electricity generating operations in one apparatus wherein PV modules are compelled by the movement of said apparatus to track the sun in a two-axis manner resulting simultaneously in optimum angles of sunlight incidence on said PV cells and said cooker. State-of-the art solar cooking designs fail to disclose or suggest any method and/or apparatus capable of inducing many people to substitute carbon containing fuels for cooking, by sunlight. The state-of-the art fails to disclose or suggest any method casu quo any mechanism whereby trade values of emission rights casu quo carbon credits accruing from emissions avoided through the use of the present method and/or apparatus can be monetized casu quo used to pay for the cost of said method and/or said apparatus and/or to create a source of ongoing revenue for the users and/or governments promoting the use of said method and apparatus. The present invention teaches such a method and apparatus offering many millions of people a substantially expanded latitude, light, temperature and time operating window for convenient cooking and convenient electricity generation on sunlight, thereby not only offering attractive new cooking operations, but also affordable access to electric light, refrigerator, television, computer, casu quo entertainment and education and offering many governments and/or organizations a practical means for sustainable development that can be implemented immediately.

DISCLOSURE OF THE INVENTION

The present invention relates generally to the urgent need to reduce worldwide emissions of harmful gases including greenhouse gases such as carbon dioxide, as an

estimated six thousand million metric tons of carbon dioxide emitted annually are emanating from carbon containing fuels such as firewood burned for cooking and/or water heating purposes by some two to three thousand million people living in developing countries casu quo in rural areas of the earth the method and apparatus of the present invention is conceived casu quo expected to qualify for the accrual of tradable carbon dioxide emission rights casu quo of tradable carbon dioxide emission credits that can be monetized to pay for the cost of the method and apparatus of the present invention and/or to create a source of ongoing revenue, thereby inducing many people to substitute said carbon containing fuels by sunlight for cooking and/or water heating and/or electricity generation and inducing many governments and/or non government organizations to support casu quo to enable the introduction to casu quo the continued use by their people of the method and apparatus of the present invention. Accordingly the present invention provides method and apparatus enabling gainful replacement of highly polluting fuels, such as for example fuel wood for cooking purposes by light, through greatly augmented convenience of cooking on light. Convenience of cooking on light is augmented according to the present invention by increasing the useful net to food cooking power of a hot box type solar cooker especially at low solar altitudes, such as prevail in early morning and late afternoon worldwide and at higher latitudes by an order of magnitude compared to state-of-the-art hot box type solar cookers presently available.

Optimized light energy transfer from available solar radiation to foods, beverages and other substances to be cooked casu quo heated is provided through the use of a hot box type light cooker comprising a cavity having well insulated side walls and lower and upper horizontal walls of a heat resistant heat conducting material coated on the illuminated side with a long-life heat resistant spectrally selective coating capable of converting light to heat. Said spectrally selective coating having a high absorptivity coefficient (α) for incoming light in combination with a low emissivity coefficient (ϵ) for reversed radiation of heat. Sheets of a suitable heat resistant transparent material, such as for example glass or Teflon[®], are provided under said lower horizontal wall and above said upper horizontal wall at a distance from said selective coatings in order to protect said selective coatings and to provide an insulating layer of air to minimize heat losses to the ambient.

Net to food cooking power augmentation according to the present invention is achieved in major part by heating the food from below with heat provided by an approximately horizontally positioned lower heat conducting wall heated by reflected light reaching the underside, the spectrally selective coated side, of said lower heat conducting wall. Non-conventional reflected solar radiation is provided to said lower heat conducting wall

from below through the use of concave bent and/or bendable mirrors/reflectors having variable tilt angles and/or curvatures optimized for desired cooking casu quo heating operations and for the solar altitudes at the time of the days, seasons and latitudes from equator to arctic where the light cooker may be used. Said mirrors/reflectors are positioned
5 under the hot box type light cooker, extending sideways and upwards therefrom in such a manner that they direct, in an optimum manner, a major part of the solar radiation, incident on the light cooker assembly, to the underside of the light cooker where light is spontaneously converted by the spectrally selective coating to heat, which heat is conducted instantly, with minimum resistance, to foods/beverages to be cooked/heated. Conventional direct solar
10 radiation is provided from above to the upper heat conducting wall on the spectrally selective coated side, where light is spontaneously converted to heat, which heat is conducted instantly with minimum resistance and radiated to the food located below said upper heat conducting wall.

Convenience of cooking is further augmented according to the present invention by
15 cooking directly on and in said heat conducting walls, said walls having been shaped by pressing said walls into tray-shaped thin-walled cooking trays. The use of conventional cooking pots is thereby avoided and heat transfer resistance to food reduced by an order of magnitude.

A further augmentation of convenience of cooking according to the present invention
20 is provided by serving the cooked hot food directly onto the table in the well insulated hot box tray, in order to keep the food warm during the meal.

The method and apparatus of the present invention are characterized by enabling a fast build-up of a convenient level of cooking power and/or a convenient level of electricity generating power within about half an hour from sunrise and maintaining said convenient
25 levels of cooking power and/or electricity generating power late in the day, until sunset.

The method and apparatus of the present invention can have a variety of embodiments, in one aspect ranging in size and net to food cooking power from a basic method and apparatus having light-acquiring apertures casu quo windows of identical sizes and an upper mirror of the same or larger sizes as said windows, to a method and apparatus having a wider
30 first window and having an upper mirror of the same or larger sizes than said wider first window. In another aspect, said cooking cavity may be positioned approximately horizontally into or above a half-barrel shaped concave reflective cavity, for cooking foods. Alternatively for cooking soups or heating water said cooker cavity may be positioned vertically, either sideways from a quarter-barrel shaped concave reflective cavity providing light to one side of

said cooker cavity or into a half-barrel shaped concave reflective cavity providing light to two sides of said cooker cavity. In another embodiment, for alternating and/or simultaneous electricity generation, PV cells may be positioned temporarily and/or permanently under said upward mirror. PV electricity power generation according to the method and apparatus of the present invention is characterized by enabling a fast build-up of high levels of PV electricity generating power that can be an order of magnitude higher than present PV power levels provided by state-of-the art non-tracking PV systems, especially so at low solar altitude angles α_s prevailing in winters, higher latitudes, early mornings and late afternoons.

In yet another embodiment a halogen light source may be provided for positioning above or under said cooker cavity for cooking operations when sunlight is not available casu quo marginal and electricity can be made available.

Cooking power, attainable worldwide at different latitudes (64° North - 0° Equator - 64° South) and different seasons (winter, spring/autumn, summer) is shown simulated in FIG. 11. PV power cell light irradiation attainable worldwide at said different latitudes and in said different seasons is shown simulated in FIG. 12.

OBJECTS OF THE INVENTION

The present invention relates generally to the urgent need to reduce worldwide emissions of harmful gases including greenhouse gases such as carbon dioxide.

Accordingly it is an object of the present invention to provide a cost effective, financially attractive and convenient method and apparatus inducing many people worldwide to rapidly substitute polluting carbon containing fuels for cooking and/or electricity generation by an abundant clean non-commercial safe heat source – sunlight. Therefore method and apparatus are provided capable of augmenting attractiveness and convenience of cooking and/or electricity generation on sunlight to such a high level that cooking and/or electricity generation on sunlight can rapidly become more attractive and more convenient worldwide than cooking and/or electricity generation on burning carbon containing fuels, such as for example fuel wood. Cost effectiveness and financial attractiveness of cooking and/or electricity generation on sunlight is augmented according to the present invention by providing method and apparatus qualifying for the accrual of tradable carbon dioxide emission rights casu quo tradable carbon dioxide emission credits that can be monetized to pay for at least the cost of said method and apparatus and alternately and/or additionally also create a source of ongoing revenue for the users and/or for governments and/or organizations that promote the introduction and continued use of the method and apparatus of the present

invention. For said qualifying, said apparatus is preferably manufactured casu quo produced under a mechanism of quality assurance and equipped with punched-in registration numbers casu quo with punched-in country casu quo state license plate numbers qualifying said apparatus for accrual of tradable carbon dioxide emission rights casu quo tradable carbon dioxide emission credits. Convenience of cooking on sunlight is augmented according to the present invention by increasing the useful net to food cooking power of a hot box type light cooker by an order of magnitude compared to state-of-the-art hot box type solar cookers having the same hot box dimensions and simultaneously decreasing the cost per watt net to food cooking power casu quo the cost per watt net electric power to a better than competitive level.

Convenience of cooking and/or electricity generation on sunlight is further augmented by the present invention by extending the operating window in the following aspects:

- Enabling cooking and/or electricity generation on sunlight more hours per day worldwide even when the sun is at low altitude:
 - a) All year from sunrise to sunset.
 - b) In the solar winter when the sun is low.
 - c) At high latitudes, where the sun is low.
- Enabling cooking at higher temperatures for cooking operations, such as for example steaming, frying, baking, simmering, roasting.
- Enabling reduction of cooking time from presently about three hours per meal to about one hour per meal, thereby also making said apparatus available for electricity generation most of a day.
- Enabling reduction of sun tracking requirements to one per meal.
- Enabling professional mass cooking on sunlight in restaurants, cafeterias, schools, hospitals, holiday camps, refugee camps, emergencies upon breakdown of conventional energy infrastructure.
- Enabling mobile cooking operations and/or electricity generation on sunlight, like barbecues, by vacationers, mountaineers, scouts and the like.
- Enabling heat processing in the broadest sense of foods, beverages and other suitable substances, resulting in:
 - a) Perfectly homogeneous cooking of foods on light, no local overheating or burning of food, excellent quality, taste, texture and vitamin content of the cooked meals, soups, beverages.

- b) Zero emission of smoke, soot, carcinogens, carbon dioxide and other pollutants detrimental to the environment, the cooks and bystanders.
- c) No carcinogens in the cooked food, no carcinogens breathed in.
- d) Cooking independence, avoiding short circuits, power failures, gas explosions, fuel spills, burns, fires, forest fires, deforestation, wildlife destruction.

- Enabling a method *casu quo* a mechanism whereby trade values of emission rights *casu quo* emission credits accruing from emissions avoided through the use of the method and apparatus of the present invention can be monetized to pay for the cost of said method and apparatus and/or to create a source of ongoing revenue *casu quo* used to offset the cost of present and/or future environmental obligations and duties or taxes such as for example carbon taxes *casu quo* carbon dioxide emission taxes.
- Enabling better quality of life for many millions of people through improved health standards by reducing emissions of harmful gases and cooking-originated carcinogens in meals and by providing affordable access to fuel-free cooking and electricity and thereby access to light and education.
- Enabling worldwide economic growth by cost effective reduction of carbon dioxide constraints.

It is a further object of the present invention to enable – simultaneously with and/or alternately to cooking, *casu quo* as a later add-on step/means – electricity generation from sunlight in a convenient, cost effective manner, especially so at low solar altitudes, by illuminating rocking PV cell modules with sunlight and/or augmented sunlight radiation provided by a tiltable and bendable mirror which is a key means of the present invention.

With the above and other objects in mind, the invention is hereinafter described with reference to embodiments thereof, the novel features of which are particularly pointed out.

Other objects and advantages of the method and apparatus of the present invention will be apparent to those skilled in the art or science *casu quo* the commerce to which this present invention pertains from the following drawings and detailed description, taken in conjunction with the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

- FIGS. 1, 2C: Show a sectional view and simulated net to food cooking power of a typical prior art hot box type solar cooker, as the lowest solid line curve.
- FIGS. 2A, 2B, 2C: Show the method and apparatus of the present invention in a basic embodiment equipped with a tiltable flat upper mirror, also showing

attainable net to food cooking power as the highest solid line curve and total power as the broken line curve.

FIGS. 3A, 3B, 3C: Show the method and apparatus of the present invention in an embodiment with a tiltable and bendable upper mirror, also showing attainable net to food cooking power as the solid line curve and total power as the broken line curve.

FIGS. 4A-4L: Show examples of useful basic cooking concepts with progressively improving thermal communication between solar radiation and food.

FIGS. 5A-7H: Show sectional views of preferred embodiments of the method and apparatus of the present invention also showing net to food cooking power attainable without booster mirrors over a solar day at various latitudes in different seasons as solid line curves, total power is shown as broken line curves.

FIGS. 8A-8E: Show examples of the method and apparatus of the present invention in a reduced cost embodiment, showing attainable net to food cooking power in different seasons as solid line curves.

FIGS. 9A-9D: Show examples of the method and apparatus of the present invention in preferred embodiments for cooking soups, heating liquids and/or sterilizing water.

FIGS. 10A-10H: Show examples of the method and apparatus of the present invention in a preferred embodiment for PV electricity generation, also showing PV cell irradiation attainable without booster mirrors over a solar day at various latitudes in different seasons, as solid line curves.

FIG. 11: Shows cooking power attainable with the method and apparatus of the present invention without booster mirrors worldwide at various latitudes in different seasons, net to food cooking power is shown as solid line curves, total power is shown as broken line curves.

FIG. 12: Shows PV cell light irradiation attainable with the method and apparatus of the present invention without booster mirrors worldwide at various latitudes in different seasons, as solid line curves.

FIG. 13: Shows examples of tray-shaped absorbers casu quo cooking trays.

FIGS. 14A, 14B: Show lower cooker cavities with tray-shaped absorbers casu quo flat absorbers.

- FIGS. 14C, 14D: Show upper cooker cavities with tray-shaped absorbers casu quo flat absorbers.
- FIGS. 15A-15B: Show total cooker cavities with tray-shaped absorbers casu quo flat absorbers.
- 5 FIG. 16: Shows total cooker cavity with lower tray-shaped absorber and downward indented upper absorber.
- FIGS. 17A-17D: Show examples of hinged, tiltable, bendable mirror, also showing upper profiled guide rail casu quo lower profiled guide rail with mirror holding casu quo mirror drive means and showing optimum bendable mirror tilt angles and bendable mirror compressions as a function of
- 10 solar altitude angle α_s and bendable mirror height h_m .
- FIGS. 18A-18I: Show examples of construction casu quo embodiments of half-barrel shaped reflective cavities.
- FIGS. 19A-19D: Show examples of embodiments of the method and apparatus of the present invention for PV electricity generation.
- 15 FIGS. 20A-20D: Show examples in afternoon orientation of embodiments of halogen light sources useful in the method and apparatus of the present invention.
- FIGS. 21A, 21B: Show examples of embodiments for water purification by heating and light irradiating water from above through a light-transparent cover and from below in a light-transparent tray-shaped absorber as shown in FIG. 21A casu quo heating water from below in an opaque tray-shaped absorber as shown in FIG. 21B.
- 20 FIG. 22: Shows an example of a preferred embodiment of the method and apparatus of the present invention for simultaneous cooking and PV power generation.
- FIGS. 23A-23C: Show examples of an embodiment of the method and apparatus of the present invention equipped with optional booster mirrors.
- FIG. 24: Shows an example of a preferred embodiment suitable for windy environments incorporating two upper guide rails supported by a
- 30 stabilized upper structure.
- FIGS. 25A-25E: Show views of a most preferred compact embodiment without upper structure, optimized for simultaneous cooking and electricity generation in one operation casu quo one movement by a bendable mirror of a

rocking PV module and furthermore equipped with guide rail plates with punched-in registration numbers intended to qualify the apparatus for accrual of emission credits.

5

LEGEND TO FIGURES 2-25

<u>Item No.</u>	<u>Brief Description</u>
0	Cooker cavity
1	Absorber, flat casu quo tray-shaped
10 2	Cooking vessel with food
3	Support frame for absorber 1
4	Insulation of side wall of support frame 3
5	Reflective surface on outer wall of support frame 3 casu quo on vertical walls of concave reflective cavity
15 6	Reflective surfaces on inner walls of support frame 3
7, 8	Plate, sheet or foil, transparent for light
9	Still-air reflective cavity, half barrel shaped concave reflective wall
10	Still-air reflective cavity, reflective end walls
11	Drain hole
20 12	Storage rolls for reflective sheet, foil or film (optional)
13	Transparent windows w_1, w_2, w_3 possessing anti-reflective coating on surfaces facing incoming light
14	Tilttable casu quo tilttable and bendable mirror reflector/cooling air chimney for PV modules
25 15	Hinges
16	Upper guide rail casu quo upper profiled guide rail
17	Lower guide rail casu quo lower profiled guide rail (alternate to 16)
18	Tension rod, tape or wire (alternate to 16)
19	Shadow casting cord, serving as azimuth tracking aid casu quo gnomon in
30	shadow-casting communication with vertical hairline casu quo bulls-eyes line on the mirror surface of mirror/reflector 14 casu quo with horizontal hairline casu quo bulls-eyes line on the upper surface of first window w_1 , said cord 19 also serving as support cord for shadow-casting rod casu quo bead 35 .

- 20 Mirror compression profile casu quo manual drive casu quo motorized drive system (optional) for tiltable casu quo tiltable and bendable mirror/reflector 14
- 21 PV cell module
- 22 Support ledges for PV cell module 21
- 5 23 Flexible connection system for air draft
- 24 Battery
- 25 Electrical conduit means between PV module and battery
- 26 Halogen light sources (optional)
- 27 Insulating cover possessing reflective surfaces
- 10 28 Tiltable booster mirror (optional)
- 29 Temperature indicator (optional)
- 30 Support structure
- 31 Ballast weights for wind stability
- 32 Castor wheels (optional)
- 15 33 Spring rod
- 34 Connecting rod for guide rail tracking by spring rods
- 35 Shadow casting rod casu quo shadow casting bead
- 36 Positioner rod for booster mirror
- 37 Hairline casu quo bulls-eyes line positioned vertically on mirror 14 casu quo horizontally on first window w_1 , serving as aid for azimuth tracking and/or solar altitude tracking through shadow-casting communication with shadow-casting cord 19 and/or shadow-casting beads 35.
- 20 38 Hairlines positioned in sundial manner horizontally on first window w_1 and/or positioned vertically on mirror 14 serving, during operation, through shadow-casting communication with cord 19, to indicate degrees off-azimuth ϕ_s of the apparatus.
- 25 39 Cross bar between rocker arms.
- 40 Rocker arm casu quo pivoted sliding lever.
- 41 Slot plate on rocker arm.
- 30 42 Pivot.
- 43 Roll on pivot.
- 44 Shaft between rocker arms.
- 45 Roll on shaft.
- 46 Connecting rod.

	47	Rocking rack.
	48	Guide rail plate, alternate to guide rails 16 and/or 17
	49	Handle bar connected to shaft.
	50	Grip on handle bar.
5	51	Dial showing tilt angle of rocker arm casu quo mirror tilt angle.
	52	Rope casu quo cord.
	53	Pulley.
	54	Support for pulley.
	55	Gnomon.
10	56	Insulation on half barrel shaped reflective cavity.
	57	Wheels (optional).
	58	Windscreen.

	<u>Symbols</u>	<u>Meaning</u>
15	α	Absorptivity
	α_s	Solar altitude angle
	ε	Emissivity
	ρ	Reflectivity
	τ	Transmisivity
20	ϕ_s	Solar azimuth angle
	θ_i	Angle of incidence
	a	Air, coolant air
	a.m.	Ante meridiem, forenoon, morning
	A	Winter solstice, on December 21 north of equator casu quo on June 21 south of
25		equator
	B	Spring/autumn equinoxes on March 21 casu quo September 21
	C	Summer solstice on June 21 north of equator casu quo on December 21 south
		of equator
	C_m	Bendable mirror compression
30	C_p	Bendable mirror compression profile on guide rail
	H	Solar beam radiation
	H_r	Reflected solar beam radiation
	h_m	Mirror height
	I	Intensity of radiation in watts per square meter PV module area

	L_n, L_s	Latitude, degrees North casu quo South
	n	Noon
	P	Power in watts per square meter net cavity area
	p.m.	Post meridiem, afternoon
5	r	Radius
	r_c	Radius of half-barrel shaped concave reflective cavity
	r_g	Radius of guide rail curvature
	r_m	Radius of bendable mirror curvature
	s_m	Mirror tilt angle
10	t	Solar time, hours
	w	Width

LEGEND TO FIGURE 4

- FIG. 4A: teaches cooking food in vessels, heated from below by a flat absorber, cavity top being insulated.
- FIG. 4B: teaches cooking food in vessels, heated from below in “au bain-marie” manner by a tray-shaped absorber, cavity top being insulated.
- FIG. 4C: teaches cooking food directly in tray-shaped absorber heated from below, cavity top being insulated.
- FIG. 4D: teaches cooking food in “steam cooking” manner above boiling water in tray-shaped absorber heated from below, cavity top being insulated.
- FIG. 4E: teaches cooking food in vessels heated from below and from above by flat plate absorbers.
- FIG. 4F: teaches cooking in vessels heated from below in “au bain-marie” manner by a tray-shaped absorber and from above by a flat plate absorber.
- FIG. 4G: teaches cooking food directly in tray-shaped absorber heated by conduction from below and radiantly heated from above by flat plate absorber.
- FIG. 4H: teaches cooking food in “steam cooking” manner, food being heated from below by steam from tray-shaped absorber and radiantly heated from above by flat plate absorber.
- FIG. 4I: teaches cooking food in vessels, heated in “au bain-marie” manner from below by a tray-shaped absorber and radiantly heated from above by a tray-shaped absorber.

FIG. 4J: teaches cooking food, directly in tray-shaped absorber, food being heated by conduction from below and radiantly from above by tray-shaped absorbers, food temperature being made visible by a temperature indicator casu quo a thermometer.

5 FIG. 4K: teaches cooking food directly in and between tray-shaped absorbers heated by conduction from below and from above by tray-shaped absorbers.

FIG. 4L: teaches cooking food in "hamburger" manner directly between tray-shaped absorbers, heated by conduction from below and from above by tray-shaped absorbers.

10

DEFINITION OF TERMS

The term "mirror tilt angle" s_m is the angle between the horizontal plane and the mirror surface facing the sun.

15 The term "angle of incidence" θ_i is the angle between the light rays and the surface normal.

The term "solar altitude angle" α_s is the angle between the sun's rays and the horizontal plane.

20 The term "solar azimuth angle" ϕ_s is the angle of the sun's rays measured in the horizontal plane from due south, westward being designated as positive. For the southern hemisphere it is measured from due north, eastward positive.

The term "incident" is intended to mean: falling on or falling upon.

25 The term "spectrally selective surfaces" is intended to mean: surfaces having high absorption properties (α) for light radiation in wavelengths of the full solar spectrum combined with low heat radiation casu quo heat emission properties (ϵ) in wavelengths of the infrared spectrum.

The term "sunny side" is intended to mean: the side casu quo the surface receiving casu quo seeing incoming light.

The term "casu quo" is intended to mean: or, as the case may be.

30 The term "au bain-marie" is intended to mean: standing on casu quo in a layer of a liquid.

The term "convex" is intended to mean: outwardly curved casu quo bulging out.

The term "concave" is intended to mean: inwardly curved casu quo hollow.

The term "cavity" is intended to mean: a hollow space.

The term "net cavity area" is intended to mean: the area in square meters of the cross section in the horizontal plane of said cooker cavity.

MODES FOR CARRYING OUT THE INVENTION

5 BASIC APPARATUS USEFUL IN THE METHOD

Referring now to FIG. 2A/2B the method and apparatus of the present invention is shown in a first useful basic conceptual design in forenoon and afternoon orientation.

A cooker cavity 0, having well-insulated side walls 4, is provided with a concave tray 1 pressed into a desired shape and dimensions from a sheet of heat conducting heat resistant metal coated on the convex casu quo the illuminated side with a heat resistant spectrally selective coating, capable of converting light energy to heat. For protection of said selective coating and for reduction of heat losses to the ambient a sheet casu quo plate 7 of a heat resistant material highly transparent for sunlight, such as for example a fluorocarbon such as Teflon FEP® or a tempered low-iron glass with an anti-reflective coating is provided and positioned under said coating. A second sheet casu quo plate 8 of said transparent material may be installed under said sheet casu quo plate 7 for enhanced protection and further reduction of heat loss.

Said cooker cavity is positioned, with the spectrally selective coating downward, facing the reflected light into casu quo onto a still-air concave reflective cavity 9 having the shape of a half-barrel with a horizontal axis of rotation. The concave walls 9 of said half-barrel are highly reflective and are facing the underside of said cooker cavity. The two end walls 10 of said half-barrel perpendicular to said axis of rotation of the half-barrel are highly reflective and may be flat, the curved part of said half-barrel parallel to its axis of rotation is cylindrical and may be a continuous curve or made up of a sequence of flat and/or curved segments approximating any desired shape of for example circular, catenary, parabolic, elliptic or polygonal shape or any combination of said curved shapes and flat shapes. Said desired shape is preferably made partly or wholly of a flexible reflective sheet casu quo foil material, enabling variable shape casu quo curvature optimized for desired cooking casu quo heating operations.

Said still-air concave reflective cavity 9 is located partly under said cooker cavity 0, partly extending sideways therefrom and terminating as an approximately horizontal light admitting aperture w_1 , hereinafter called first window, covered with a plate or sheet 13 of a material highly transparent to sunlight. Above said first window w_1 is provided a hinged tiltable mirror/reflector 14 facing the sun, tiltable on hinges 15, reflecting sunlight to said first

window w_1 and to the top of the cooker, said mirror having a height approximately equal to the diameter of said half-barrel. The optimum light collecting tilt angle of said hinged tiltable mirror facing the sun in the flat shape can be established for example by means of an upper guide rail 16 or a lower guide rail 17 and is governed by the relationship $s_m = 60^\circ + 2/3 \alpha_s$ casu quo the mirror tilt angle above the horizontal plane is equal to sixty degrees plus two thirds of α_s wherein s_m is the mirror tilt angle and wherein α_s is the solar altitude angle above the horizontal plane. α_s depends on the time of the day, the day of the year and the latitude. At sunrise and sunset the optimum mirror tilt angle is 60° for said mirror in the flat shape facing the sun.

A cover cavity 0, conveniently a duplicate of the cooker cavity is provided and positioned in upside down arrangement above the cooker cavity with the convex side of said tray 1, the spectrally selective coated side upward facing the light. For protection of said selective coating and for reduction of heat losses to the ambient a sheet casu quo plate 7 of a heat resistant material highly transparent for sunlight, such as for example a fluorocarbon like Teflon FEP[®], or a tempered low-iron glass with an anti-reflective coating, is provided and positioned above said selective coating. A second sheet casu quo plate 8 of said transparent material may be installed above said sheet casu quo plate 7 for enhanced protection and further reduction of heat loss. The space enclosed between said cover cavity 0 and said cooker cavity 0 is the total cooker cavity 0 and may have a total height that admits cooking vessels.

For cooking operations, the apparatus of the present invention is oriented to face the sun, cord 19 casting its shadow on a vertical hairline on the mirror surface of mirror 14. The tiltable mirror facing the sun is adjusted to the solar altitude angle, for example by means of a guide rail 16. At a solar altitude angle α_s of 15° the optimum mirror tilt angle is 70° , at α_s of 30° the optimum mirror tilt angle is 80° , at α_s of 45° the optimum mirror tilt angle is 90° and so on until the α_s is 90° and the optimum mirror tilt angle is 120° from whereon the mirror tilt angle is reduced as the sun goes lower.

Light is collected by the tiltable mirror and reflected through said first window w_1 via a second window w_2 to the underside of the cooker cavity where it is converted to heat by the selective coating and conducted to the food positioned on the tray. At low angles of solar altitude α_s said reflected light is the major source of cooking power. Part of the light collected by the tiltable mirror is reflected through the light aperture area w_3 , hereinafter called third window, to the spectrally selective coated side of the cover casu quo the top of the cooker cavity where it is converted to heat which is conducted through the cover tray and radiated to the food below the cover tray.

As the sun rises and the solar altitude angle α_s increases, more and more direct radiation is transmitted through said first window w_1 via said second window w_2 to the underside of the cooker cavity and through said third window w_3 to the top of the cooker cavity.

5 Simulated net to food cooking power of said basic apparatus as a function of the solar altitude α_s at the time of the day for 21 December, the winter solstice at about 24° N is shown, as the highest solid line curve in FIG. 2C. Total power is shown as the broken line curve, and is about 2,000 watts/m² net cavity aperture area, a 50 cm x 50 cm cooker cavity, equipped with a 50 cm x 50 cm first, second and third window having a transmissivity of 92% and a one
10 meter high by one half meter wide mirror having a reflectivity of 90% in flat shape, provides a net to food peak power of about 500 watts for fast warm-up, but a sustainable net to food cooking power of 1,000 watts or more per square meter net cavity area cannot be reached.

Net to food cooking power is augmented considerably, especially so at low solar altitudes prevailing in mornings, afternoons, in winter or at higher latitudes, by bending said
15 tilttable mirror, for example by compressing said tilttable mirror with a profiled upper guide rail 16 or a tension rod, tape or wire 18 combined with a profiled lower guide rail 17, as shown in FIGS. 3A/3B in forenoon and afternoon orientation and in FIGS. 17A/17B. By optimizing the bending casu quo the curvature of said tilttable mirror in combination with its tilt angle it becomes a practical possibility to reflectively direct a major part or all of sunlight acquired by
20 said tilttable bent mirror onto and through said first window w_1 , with more favorable angles of light incidence to the underside of said cooker cavity.

Simulated net to food cooking power of said basic apparatus acquiring sunlight with said tilttable mirror in bent shape as a function of the solar altitude α_s at the time of the day for December 21, the winter solstice at about 24°N, is shown as the solid line curve in FIG. 3C.
25 Peak power for fast warm-up is about 1,750 watts/m² cooker box aperture area. Sustainable net to food cooking power to the cooker cavity bottom is augmented by more than 40 (forty) percent from about 870 watts/m² to about 1,230 watts/m² net cavity area. A target sustainable cooking power of 1,000 watts/m² to said cooker cavity bottom can be made available for about 6 (six) hours per day, a 50 cm by 50 cm cooker cavity equipped with a 50 cm by 50 cm first
30 window and a 50 cm wide by 1 meter high mirror in optimum bent shape and tilt angle being capable of providing net to food sustainable bottom cooking power of 250 watts or more for about 6 (six) hours, e.g. from 09.00 to 15.00 hours.

Upon completion of cooking the food can conveniently be served in the cooking cavity and kept warm during the meal by placing an insulating lid or board over the cavity with food.

As the cooker cavity is removed, the cover cavity with its tray can take over the cooking work by positioning the cover cavity with the convex side downward into casu quo onto said still-air concave reflective cavity 9. The next meal or dish can then be cooked, either by placing a third cover cavity or by placing an insulating lid or board over the food while cooking proceeds on heat supplied from below only. For professional all-day cooking it is convenient to provide a plurality of cooking cavities with different trays taking turns in cooking/heating a variety of dishes and/or beverages. A high degree of versatility can be provided through the use of special trays and/or inserts for particular cooking operations.

Turning now to FIGS. 4-25 an overview is shown of several embodiments casu quo examples of the method and apparatus of the present invention useful to augment convenience of cooking on light by increasing net to food heating power from the energy contained in available solar radiation. A novel and crucial inventive feature of the present invention resides in a) creating substantially improved light and thermal communication especially at small solar altitude angles casu quo when the sun is low, between the energy contained in solar radiation available to the cooker area and the food to be cooked casu quo the beverage to be heated, casu quo to a PV cell module area and b) in reducing heat losses drastically, especially so from the top and bottom of the cooker cavity.

Regarding a): Surprisingly I have found that solar conductive food heating from below is far more effective than solar radiant food heating from above. This surprising discovery may be explained in part because in a hot box type light cooker of the present invention reflectively directed solar radiation from below reaches said cooker tray 1 casu quo absorber 1 unobstructed and uses the full area of the absorber 1, which conducts the heat directly to the food resting on it. Furthermore, because the absorber is located in casu quo on a still-air cavity 9 above the ambient, the buoyancy of any heated air under the absorber 1 prevents convective heat carrying currents downwards from the absorber 1. Substantially improved thermal communication between the food to be cooked casu quo the beverage to be heated and available solar radiation has thus been accomplished by augmenting net to food heating power from the underside of said cooker casu quo the underside of said food.

Also surprisingly I have found that by providing a spectrally selective coating on the underside of said cooker tray 1 in combination with one or more convection-suppressing sheets or plates 7, 8 of a light transparent material positioned under said cooker tray heat losses are reduced and net to food cooking power increased.

Surprisingly I have further found that by positioning said cooker tray 1 with said transparent sheet 7 in or on a still-air concave reflective cavity 9 heat losses are further

reduced to a very low level. Similarly hot cooked food in said cooker tray stays hot longer if said tray is placed on a place mat of reflective material.

More surprisingly I have found that by fabricating the curved part of said half-barrel shaped concave reflective cavity 9 from a flexible material, such as for example an aluminized polyester film, the curvature and the position of the nadir casu quo the lowest point of said curve can be varied, both vertically and horizontally, thereby enabling optimum transfer of sunlight from said first window w_1 , said sunlight reaching the underside of said cooker cavity at optimum angles of incidence for conversion of light to heat by said selective surface.

Still more surprisingly I have found that especially at low solar altitudes, by bending said hinged tiltable mirror 14 located above said first window w_1 to a mirror curvature which varies with the mirror tilt angle s_m and the solar altitude angle α_s , all the light that a flat mirror would reflect to said third window w_3 , can be reflected in an optimum manner by said bent mirror 14 to a PV cell module positioned under said mirror 14 or to said first window w_1 and onwards via concave reflective cavity 9 to the underside of the cooker cavity. For example, in said basic apparatus, by said bending of said tiltable mirror, long duration bottom cooking power is increased by about 40% while peak cooking power is reduced by only about 12%. Improved light communication between available solar radiation and said PV cell module or the spectrally selective coating on the underside of the cooker is accomplished, especially so when the sun is low, in winter, at higher latitudes and worldwide at sunrise and sunset, enabling fast build-up of high levels of electric power and/or cooking power.

Regarding b):

In prior art hot box type solar cookers the major heat loss is through the light admitting aperture casu quo window w_3 on top of the cooker cavity. Surprisingly I have found that by positioning a metal sheet 1, coated on at least one side with said spectrally selective coating, said coating facing the sunlight, under said window above the food, casu quo the cavity, loss of heat through the top of the cooker cavity can be reduced by 50% or more, especially so at higher food temperatures.

More surprisingly I have found that large thermal efficiency losses caused by poor heat conducting contact between various cooking vessel bottoms and the much hotter absorber plates characterizing prior art hot box type solar cookers can be avoided by using said bottom tray 1, heated by light from below directly as a large area evenly heated cooking tray.

NOVEL COMPONENTS USEFUL IN THE METHOD AND APPARATUS

As a first novel component in the present invention is introduced a first heat conducting metal plate 1 of a metal quality that is resistant to corrosion by both the ambient and the cooker cavity atmospheres. On at least one surface, the surface facing sunlight when in use, of said first metal plate 1, a spectrally selective surface is provided. Said spectrally selective surface is characterized by being an excellent absorber (α) for incoming full spectrum solar energy radiation and being a poor emitter (ϵ) of infrared heat radiation. Said first metal plate 1 thus functions as a new, one way spontaneous converter of solar radiation to heat which is instantly conducted and put to use to heat food at only minor back-radiation of heat energy to the ambient. Said first metal plate 1 serves as the solar energy collecting approximately horizontal underside 1 of the cavity 0 of the well insulated hot box type light cooker of the present invention. Said first metal plate 1 may be flat, with metal cooking vessels placed upon the plate, or formed in the shape of a tray 1, as shown in FIG. 13, or a vessel by, for example, a well-known deep drawing operation under a press. If formed into a tray 1 said first metal plate advantageously functions also as the cavity of the cooker, cooking vessels may be placed upon the tray bottom. In a preferred cooking manner of the "au bain-marie" type, having excellent thermal communication, a thin layer of water is provided on the bottom of the tray. Said thin layer of water next to and under the cooking vessel continuously vaporizes and condenses, transferring latent heat to the vessel bottom and vessel side. During warm-up said water conducts heat to said vessels. In addition, being an excellent infrared radiator with high emissivity in the infrared wavelengths, said water radiates heat upwards to the cylindrical part of said vessels. The rims of said cooking vessels are to be flat, so as to maximize the heat conduction contact area between said vessel rims and a heat conducting plate located above said vessel rims. In another, more preferred cooking manner without cooking vessels, said first metal plate in the shape of a tray 1 of cavity dimensions directly receives the food to be cooked on the bottom of said tray 1 in loose form or in a cooking bag. Intimate thermal communication between the food to be cooked and the energy source is thereby created. Likewise said tray 1 may function as a simmering or frying pan, or other cooking variants such as for example "Chinese wok" stir frying operations. In yet another more preferred cooking manner without cooking vessels, and enabling superior thermal communication between the food to be cooked and the solar energy driven heat source, the tray bottom 1, a thin layer of water is poured on the bottom of the tray 1. Above said layer of water a sieve tray is placed containing foods, such as rice, noodles, lintels, vegetables, fish, meats for steaming casu quo steam cooking. During warm-up and cooking said water supplies

latent heat (steam) to said food. At the end of the day said water may serve as a reservoir of heat for extended cooking and/or warm-keeping of foods.

As a second novel component in the present invention is introduced a first sheet 7 of a material transparent to sunlight. Said material may be low-iron glass having an anti-reflective coating or a heat resistant polymer having a high light transmittance and a low refractive index. Said first transparent sheet is installed approximately horizontally below said tray and attached to said cooker cavity at a distance of approximately 10 (ten) to 20 (twenty) millimeters below said first metal sheet 1 *casu quo* metal tray 1. Useful functions of said first transparent sheet 7 comprise:

- a) protecting said spectrally selective coating on said metal sheet 1;
- b) suppression of any air currents between the ambient and said first heat conducting metal sheet *casu quo* tray 1.

As a third novel component in the present invention is provided a well-insulated movable cavity 0, as shown in FIG. 14A-B, accommodating said first absorber tray 1. Said insulation 4 is preferably a combination of a moisture-proof high temperature insulation closest to the tray, backed-up by moisture-proof highly insulating medium temperature insulation of for example poly-isocyanurate, phenolic or polyurethane foam type encased in an outer enclosure of a suitable low cost material such as for example wood or plywood, alternatively a foam-aluminum sandwich or a foam-steel sandwich. Reflective surfaces are advantageously provided on outer wall 5 of said enclosure, exposed to reflected radiation and on all inner walls 6. Depths of said cavity can be tailored to particular cooking operations to be performed, for optimal results. Preferred cavity depths are approximately:

- a) for cooking directly in trays: approximately 10 to 100 millimeters
- b) for cooking in vessels: approximately 10 to 200 millimeters

Said cavity 0 may be a single cavity *casu quo* a plurality of smaller cavities for individual eaters.

Turning the attention now to the topside of the hot box type light cooker of the present invention, a fourth novel component in the present invention is introduced: a second heat conducting metal plate 1, having the same corrosion resistant quality as said first heat conducting metal plate 1 and provided with the same said spectrally selective coating on at least one surface, the surface facing incoming sunlight when in use, is provided. Said second heat conducting metal plate 1 is located in an approximately horizontal position immediately above the cavity 0 of said hot box type light cooker with the spectrally selective coating facing upwards to the light. Said second metal plate 1 thus performs in the same manner as said first

metal plate 1 as a one way converter of incoming solar energy, spontaneously converted to heat energy, which is instantly, with minimal thermal resistance through the thin metal sheet 1, conducted to cooking vessels positioned directly under and in pressed, heat conducting communication with said second metal plate 1. Said second metal plate 1 serves

5 simultaneously as the underside of an openable cover located above said cooker cavity 0, and as a common flat lid for the cooking vessels. Said second metal plate 1 may be flat or advantageously indented upwards, thus acquiring the shape of an inverted casu quo upside down cooking tray, as shown in FIGS. 14C-D. A heat resistant paint with a high emissivity (ϵ) such as for example black alkyd or epoxy enamel, is advantageously provided on the

10 underside of said second metal sheet, as a heat radiator for grill-type cooking. In operation, upper plus lower cavity make up a total cooker cavity 0, as shown in FIGS. 15A/15B. In certain cooking operations without cooking vessels, using a cavity shaped first metal tray 1, it may be advantageous to use a downward indented version of said second metal plate 1, as shown in FIG. 16. Once the food has been heaped on said first metal tray 1, either loose casu quo enclosed in a cooking bag, said covering cavity incorporating said downward indented

15 version of said second metal plate 1, is lowered thereby pressing the indented part of said second metal plate 1 onto and/or slightly into the food to be cooked. In so doing creating highly effective intimate full plate area heat conducting communication from above and from below between the food to be cooked and solar energy from above and from below.

20 As a fifth novel component in the present invention is introduced a hinged, tiltable flat mirror 14 which is bendable like a large flat spring having its center of curvature approximately on a horizontal plane at the level of said hinges 15, as shown in FIGS. 17A/17B. The degree of bending of said mirror 14 casu quo said mirrors curvature casu quo radius r is varied during a solar day, approximately according to the relationship $r_m = h_m/2 \sin(90^\circ - s_m^\circ)$ following said mirrors tilt angle s_m , following solar altitude angle α_s , for an optimum harvest of sunlight, reflected onto said PV cell module 21 casu quo onto and through said first window w_1 and onwards via concave reflective cavity 9 to the underside 1 of the cooker cavity 0. In operation, at sunrise, said bendable mirror is positioned to face the sun, for example, with the aid of an azimuth tracking aid in the embodiment of a shadow-casting cord

30 or string casu quo an elastic rubber cord 19 installed between a center point at the edge of w_1 and the center point at the top edge of said bendable mirror 14. Said shadow-casting cord 19 to cast its shadow, as shown, for example, in FIGS. 9, 19, 22 and 23, on a vertical center line casu quo a hairline casu quo a bulls-eyes line positioned on the mirror surface of said bendable mirror 14 and/or on a horizontal hairline casu quo bulls-eyes line on the upper

surface of said first window w_1 . Optimum bending casu quo compression of said bendable mirror **14** is provided by said profiled guide rail **16, 17** approximately according to the relationship:

$$\text{mirror compression } C_m = h_m \times \left[\frac{.01744 (90^\circ - s_m^\circ)}{\sin (90^\circ - s_m^\circ)} - 1 \right]$$

by directing the mirror from its flat starting shape under a profiled guide rail **16**, possessing a mirror compression profile C_p , as shown in FIG. **17A/17B**, which compresses said mirror to its first, most curved shape of the day. For a one meter high mirror, as shown in FIG. **17A**, illuminating a half-meter wide first window w_1 casu quo PV cell module **21** of the same width, said first compression is about 4.6% (46 millimeter) at a corresponding mirror tilt angle of 60° , facing the eastern sun. As the solar altitude angle α_s increases over the morning, the bendable mirror proceeds under the guide rail to larger mirror tilt angles s_m approximately according to the relationship $s_m^\circ \cong 60^\circ + .42 \times \alpha_s^\circ$ and to progressively less mirror curvature casu quo less mirror compression, for example at a mirror tilt angle of 70° , said compression is reduced to about 2% (20 millimeter). At a mirror tilt angle of 80° , said compression is reduced to about .5% (5 millimeter). The mirror position thus becomes more upright and the mirror springs back to a less curved shape. At a mirror tilt angle of approximately 85° corresponding to a solar altitude angle α_s of approximately 60° , the mirror has sprung back to its original flat shape. In the sunbelt, where the solar altitude angle may reach about 90° , a 1 m high mirror continues (flat) following the guide rail approximately according to the relationship $s_m^\circ \cong 85^\circ + .77 \times (\alpha_s^\circ - 60^\circ)$ until it reaches its maximum tilt angle of approximately 108° for cooking casu quo 112° for PV generation at noon facing the southern sun casu quo the northern sun. Said apparatus is then positioned to face and follow the sun in westerly direction and said mirror is made to follow said guide rail, initially in flat shape, until a tilt angle of 85° , thereafter compressed to a progressively more curved shape until at 60° mirror tilt angle, said 1 m high mirror reaches the second most compressed and most curved shape of the day, at sunset. Said mirror is thereupon released from said guide rail and left flat overnight in approximately horizontal position, covering and protecting the apparatus. At 24° North latitude on December 21, the winter solstice, the maximum solar altitude angle α_s is 42.6° , at noon, optimum mirror tilt angle at noon is about 78° and the optimum mirror track is from 60° at sunrise to 78° at noon and then back to 60° at sunset, the mirror remaining curved, albeit with variable curvature from sunrise to sunset. For a 1.5 m high mirror, as shown in FIG. **17B**, illuminating a half meter wide first window w_1 casu quo PV cell module **21** of the same width, the solar day starts with a mirror tilt angle of about 55° at a mirror

compression of about 6.4% (96 millimeter), the mirror then proceeds in bent shape approximately according to the relationship $s_m^\circ \cong 55^\circ + .43 \times \alpha_s^\circ$ till a mirror tilt angle of about 85° , corresponding to a solar altitude angle of about 70° , then onwards in flat shape approximately according to the relationship $s_m^\circ \cong 85^\circ + .95 \times (\alpha_s^\circ - 70^\circ)$ till a tilt angle of

5 about 104° for cooking casu quo 107° for PV generation corresponding to a maximum solar altitude angle of about 90° at noon in the sunbelt. Said apparatus is then positioned to face and follow the sun in westerly direction. Guide rails and their mirror compression profiles are optimized and made convenient for use in different seasons and their latitudes of destination. Mirror tilting and bending casu quo azimuth tracking of the apparatus may be by manual

10 positioning, alternatively by a pre-programmed spring-driven or electrically driven mini-motor attached to said mirror casu quo said guide rails and tracking said mirror guide rails. Said manual positioning is made convenient by providing one or more shadow-casting rods casu quo shadow-casting beads **35**, hereinafter called shadow-casters. Said shadow-casters **35** are made of a non-scratching material such as, for example, rubber or a polymer, and installed

15 in sliding arrangement on said shadow-casting cords **19** in such a manner that said shadow-casters are maintained in a horizontal position on said cords, with said shadow-casters longest dimension in parallel to said hinge line of said tiltable casu quo tiltable and bendable mirror. Said shadow-casting cords **19** are installed between suitable points on the surface casu quo the upper edge of said mirror **14** and suitable points located on the meeting line where said

20 window w_1 casu quo said PV cell module meets said second window w_2 . Said shadow-casters serve to obstruct light reflected by said mirror and are to cast their shadow lines on the surface of said PV cell module casu quo on the surface of said first window at about said meeting line between said PV cell module casu quo said first window and said second window. Visibility of said shadow lines can be improved by momentary hand shading of incoming direct (non-

25 reflected) light. For example, shadow-casters communicating with said mirror surface at about half mirror height result in reflected light from the upper half of said mirror being directed onto said PV cell module casu quo onto and through said first window. Similarly shadow-casters communicating with said mirror surface at about one quarter height result in reflected light from the upper three quarters of said mirror surface being directed onto said PV cell

30 module casu quo onto and through said first window. Said bendable mirror is characterized in operation by its ability to accommodate large ranges of solar altitude angles as shown in FIGS. **17C** and **17D**. For example, at a ratio of mirror height h_m to first window width w_1 of 3/1 said bent mirror positioned at 75° mirror tilt angle s_m can accommodate a range of solar altitude angles α_s from about 33° to about 45° , which is more than the solar altitude path

between 10 a.m. (34.3°) via 12 noon (42.6°) to 2 p.m. (34.3°) on the winter solstice day at 24° latitude, thereby enabling the cooking of several hot lunches without a change of position of said bendable mirror on said guide rail. For PV electric power generation said mirror 14 is advantageously fabricated using a multi-channel extruded double or triple walled polymer cardboard and installed with said multiple channels in upward direction, as shown in FIG. 21, functioning as chimneys providing draft for air, warmed-up after cooling the underside of said PV cell modules positioned on ridges under and/or sideways from said mirror 14. Said multi-channel extruded polymer cardboard may have its own resilience, alternatively one or more spring steel rods casu quo glass fiber reinforced polyester or epoxy spring rods 33 may be inserted in said extruded channels in order to provide and maintain long-lasting resilience of said bendable mirror. A horizontal connecting rod 34 may be attached to said spring rods for long term wear resistant, accurate guide rail tracking.

A sixth novel component is introduced for the construction of said half-barrel shaped concave reflective cavity 9, as shown in FIGS. 18A-18E, in the form of a flexible curved mirror of variable shape or curvature that may be circular, catenary, parabolic, elliptic or polygonal, preferably having their center of curvature on or slightly to the right of the meeting line of said first and second window. The shape, the curvature, the depth, and the location of the nadir casu quo the lowest point of said flexible, curved mirror are adjustable, both vertically and horizontally as a function of window transmissivity and/or mirror reflectivity for optimization of light transfer from said bendable mirror via said first window w_1 , enabling the most favorable angles of light incidence to the underside of the cooker cavity at various latitudes and solar altitude angles, deeper cavities reducing reflections and improving said angles of incidence. Said mirror may be flexible, installed in half-barrel shape concave curvature by hanging it from two sides parallel to the axis of rotation of said half-barrel shaped concave reflective cavity and provided with drain holes in the nadir line for draining-off unwanted incursions from rain, food spills and the like. In a preferred embodiment, as shown in FIGS. 18F-18J, two rolls are provided, parallel to said axis of rotation, on each side of said half-barrel shaped concave reflective cavity to be. On each roll, part of the reflective sheet material is rolled. The rolls are installed at both ends of said reflective concave cavity to be and the flexible sheet mirror material is unwound and lowered to form a concave reflective cavity of desired shape, curvature and location of the nadir. Alternatively said mirror sheet material is placed on both rolls as one endless band, with the reflective side on the outside. Said preferred embodiments can provide a perfectly clean flexible curved mirror at all times,

any incursion of dust, rain, food spills and the like can be cleaned off conveniently by rolling-on of the flexible mirror, wiping clean any unclean section as it moves over a roll.

A seventh novel component is introduced for generating electricity by PV cells in the form of PV cell modules **21** positioned in approximately horizontal position, as shown in FIG. **19A**, casu quo vertical position under and/or sideways from said bendable mirror **14**, as shown in FIG. **19D**. The electricity delivered by said PV cell module may be used to charge a battery. Said electricity generation may be positioned when the apparatus is not used for cooking or simultaneous with cooking whenever too much cooking power is available. Electricity generation may also be a continuous operation, either as part of or an attachment to the apparatus, as shown in FIG. **19B**, or as a stand-alone embodiment, as shown in FIG. **19C**.

An eighth novel component is introduced in the form of a halogen light source **26**, installed in an insulated, reflective box or a support structure that can be positioned above said cooker cavity, as shown in FIGS. **20A/20B**, casu quo under said cooker cavity, covered with an insulating board as shown in FIGS. **20C/20D**, for cooking operations when sunlight is not available casu quo marginal and electricity can be made available, for example, from said battery or from other sources.

As other low cost, but very useful novel components are introduced shadow-casting cords **19** serving as azimuth tracking aids through shadow-casting communication with hair lines casu quo bulls-eyes lines **37** positioned vertically on the reflective surface of said mirror **14** casu quo positioned horizontally on the upper surface of said first window **w₁**, preferably between multiple shorter hairlines **38**, positioned in sundial manner on the upper surface of said first window **w₁**, casu quo on the reflective surface of said mirror **14** at the locus of said hinge line **15** as shown in FIGS. **9B, 18D, 18E, 19B, 22, 23A** and **23B**. Said shadow-casting cords **19** serve simultaneously as support cords for shadow-casting rods casu quo shadow-casting beads **35** serving as bendable mirror positioning aids casu quo solar altitude tracking aids through shadow-casting communication with said hair line **37** on said first window **w₁**, casu quo with the upper light collecting surface of said PV cell module **21** casu quo of said first window **w₁**.

Optional novel components are introduced in the form of flat tiltable booster mirrors/reflectors **28**, positioned with hinges near outer edges of said first and second windows perpendicular to said axis of rotation of said half-barrel shaped concave reflective cavity as shown in FIGS. **23A, 23B** and **23C**. Said booster mirrors serve to acquire and direct additional sunlight onto said PV cell modules and/or onto and through said first and third

windows especially so in sunbelt latitudes and/or whenever said apparatus is left off-azimuth, thereby relaxing azimuth-tracking requirements.

As yet other useful components in the present invention are provided a second and a third sheet 7 of a material transparent to sunlight. Said transparent sheets 7 are installed
5 window-like, in approximately horizontal position above said heat conducting second metal plate 1 casu quo above said second selectively surfaced absorber 1 at a distance of 10 (ten) to 20 (twenty) millimeters of said second metal plate 1, and of each other, thereby forming two insulating air chambers above said second metal plate casu quo indented tray casu quo absorber 1. Preferred transparent materials are low-iron glass having an anti-reflective coating
10 for the upper, outermost casu quo third sheet and a highly transparent thin Fluoropolymer, for example Teflon FEP® for the intermediate sheet casu quo the second transparent sheet.

As yet other useful components in the present invention are provided sheets 13 of a material transparent to sunlight. Said transparent sheets 13 are installed in approximately horizontal position under said cooker cavity and sideways from said outer wall of said cooker
15 cavity, closing off the windows casu quo apertures w_1 and w_2 above said concave reflective cavity 9, thereby creating a closed-off, still-air, concave reflective cavity 9, protected from incursion of for example rain, wind, dust, debris, spilled foods and the like. Preferred transparent materials are low-iron glass, having an anti-reflective coating on the surfaces facing the light and/or highly transparent polymers such as, for example, fluoropolymers,
20 acrylics, polyesters, polycarbonates.

MATERIALS USEFUL IN THE METHOD AND APPARATUS OF THE PRESENT INVENTION

First 1 and second 1 heat conducting metal plates are used as lower and upper high
25 temperature light absorbers in food cooking environments. Preferred economical long life materials resistant to corrosion in said environments are ferritic stainless steels, sheet metal, for example types 409, 430 or 434, in the bright annealed surface quality. Said preferred material can have a 0.2% yield strength of 205 MPA at a stagnation temperature of 300 centigrade, said yield strength being higher than the yield strength of conventional more
30 expensive 18% chrome, 8% nickel austenitic stainless steels, such as type 304. Further advantages of said preferred material are a low thermal expansion coefficient of less than sixty percent of said conventional stainless steel and last but not least an excellent heat conductivity of 24 watts per meter centigrade in the temperature range of twenty to two hundred centigrade; that means more than fifty percent better heat conductivity than said conventional

austenitic stainless steel. Preferred sheet metal thickness ranges from about one tenth of a millimeter for small portable light duty cookers to about two millimeter for heavy duty professional cookers. Said sheet metal can be easily formed, even in said spectrally selective coated state into said cavity shaped first and second trays by well-known simple deep drawing techniques without intermediate reheating. Said ferritic stainless steel sheet metal is eminently resistant to stress corrosion and more importantly, to pitting types of corrosion caused by halogen ions such as chlorides as may be present in many waters and salted foods. For a 500 watts peak power cooker, convenient for a six person family, a total quantity of about one square meter of said ferritic steel material is required.

A preferred economical long life spectrally selective coating to be deposited on said ferritic stainless steel sheet metal is black chromium oxide in the benign trivalent state. Said black chromium oxide coating on ferritic stainless steel has been tested for high temperature stability up to four hundred centigrade and has shown no signs of degradation. Coatings absorptivity to coatings emissivity ratios (α/ϵ) of over 90/10 can be reached for long-life coatings on bright annealed ferritic stainless steel surfaces. Said coatings can be deposited by a continuous coil coating operation, alternatively on sheets, by a batch process.

Non-stick fluorocarbon (Teflon) coatings can be advantageously applied on one side (the side in contact with the food) of said coated ferritic stainless steel sheets.

For said shadow-casting cords **19** a suitable material is a stretchable casu quo elastic rubber, opaque casu quo black and provided with UV protection additives against aging casu quo provided with a textile, spun around said rubber cord for protection.

For the lower, first transparent sheet **7** a preferred material is 3 to 5 (three to five) millimeter thick low iron glass, advantageously equipped with a low reflection surface on the sunny side. A more preferred material, especially for mobile, transportable cookers is a light weight, highly transparent fluoropolymer, for example tradenamed Teflon FEP[®] 100A/200A or Hostaflon[®] thin film of 0.025 to 0.05 millimeter thickness, as this material is characterized by the highest available light transmissivity (in the order of 96 percent) combined with the lowest available refractive index of 1.34 and the highest critical angle of light incidence. The resistance of said fluoropolymer to photo-degradation is excellent, even at the high temperatures in the 200 centigrade range that may occur during stagnation conditions. In combination with said selective surfaces **1**, its overall solar energy collection performance is better than glass and its low refractive index combined with its high critical angle of light incidence allows for more solar energy collection, thereby extending the operating window for solar cooking early in the morning and late in the afternoon, as well as in winter, spring and

autumn seasons and on cloudy or hazy days when the diffused or scattered light component is large. Said fluoropolymer sheet is further characterized by excellent non-stick qualities, facilitating easy cleaning, should any food spill on and stain said normally transparent fluoropolymer sheet.

5 For the same reasons, for said upper transparent sheets **7, 8**, a combination of a 3-5 (three to five) millimeter thick outer sheet of said glass and a 0.025 to 0.05 millimeter thick intermediate sheet of said fluoropolymer is recommended.

For mobile, lighter duty cooking operations two lighter, unbreakable polymer sheets are preferred as transparent windows above said second absorber **1**, for example two of said
10 fluoropolymer sheets **7**, or a combination of a fluoropolymer intermediate sheet and a Tedlar[®], acrylic, polyester or polycarbonate outermost sheet, communicating with and cooled by the ambient .

For said transparent sheets **13** suitable transparent materials are said glass, for stationary versions of said apparatus of the present invention. Transparent polymers such as,
15 for example, fluoropolymers, acrylics, polyesters, and polycarbonates in the form of plates or films are preferred transparent materials for light-duty casu quo mobile applications. Materials with a transmissivity of 92% are readily available, materials with a transmissivity of 97% are available. For said 500 watts peak power cooker a total quantity of about 1.5 square meters of transparent sheet casu quo foil material is required.

20 For said half barrel shaped concave reflective cavity casu quo reflector **9** a variety of highly reflective materials may be used, depending on the cooking operation. Said materials may be in the form of curved glass mirrors or coated aluminum reflectors, for said stationary, heavy duty cooking operations. For mobile casu quo lighter duty cooking operations said highly reflective materials may be rigid, or low cost semi-rigid, such as for example
25 aluminized cardboard. For many cooking operations said highly reflective materials may be flexible, fabricated for example from aluminized polyester films, aluminized foams. Materials with a reflectivity of 90% are readily available, materials with a reflectivity of 94% are available.

For said vertical upper **14** and lower flat reflectors **10** and the reflective sides **5, 6** of
30 said hot box, similar considerations and resulting materials apply as for said concave reflective cavity.

For said 500 watts peak power cooker a total quantity of about 3 square meters of reflective casu quo mirror surface material is required out of which bendable mirror material is about one square meter.

For a PV cell module attaining 500 watts net to cell sunlight irradiation about one square meter of bendable mirror is required.

For a quality of life supply of PV electricity, enabling a six person family to enjoy electric light, a refrigerator and a television set casu quo a computer, about one third of a square meter of PV module will be required.

For non-metal support walls **3** of the cooking box, wood or plywood of a water and heat resistant type is a suitable material.

For electricity generation state-of-the-art PV cell panels casu quo modules can be positioned in approximately horizontal position under said bendable mirror **14**.

BEST MODES FOR CARRYING OUT THE PRESENT INVENTION

Referring now to FIG. **5A**, a preferred embodiment of the apparatus is shown. The basic features of said preferred embodiment are similar to said basic apparatus, however, the height of said bendable mirror **14** is increased, thereby enabling said bendable mirror to acquire more additional sunlight and – advantageously using its tiltable and bendable advantages – reflectively direct with favorable angles of incidence, said more additional sunlight onto said PV cell module casu quo onto and through said first window **w₁** and onwards via said half-barrel shaped concave reflective cavity **9** to the underside of said heat conducting tray **1** above said second window **w₂**, thereby further augmenting net to food cooking power.

Surprisingly I have found that increasing the height of a tiltable and bendable mirror is much more rewarding in terms of augmented net to PV module irradiation casu quo net to food cooking power than increasing the height of a fixed flat casu quo a tiltable only flat mirror, this even more so when the sun is low, such as is the case in winters, at high latitudes, and worldwide in early mornings and late afternoons. As the height of said tiltable and bendable mirror is increased, the optimum mirror tilt angles track is modified, said track starting in the morning casu quo ending in the evening at a lower tilt angle and more curved shape, said track reversing at noon at a lower tilt angle. The apparatus of said preferred embodiment is capable of providing further augmented net to food cooking power, for example, at 24°N, December 21, winter solstice, simulated net to food cooking power for said preferred embodiment with 50% higher mirror is shown in FIG. **5B**. Peak warm-up power is increased to about 2,100 watts/m² cooker box light aperture, availability of more than 250 watts net sustainable bottom power for a 50 x 50 cm cooker cavity is increased to about 8 hours, from 08.00 hours to 16.00 hours.

Bringing half a liter of 15° C water to boiling temperature of 100° C in a kettle on a one kilowatt natural gas fired gas range burner takes about six minutes casu quo one hundred watt hours of gas to transfer a net amount of heat of fifty watt hours to the water, thermal efficiency being about fifty percent. For convenient fast warm-up and cooking times a hot box
5 type light cooker according to the present invention, adequate for a six person family, consisting of two adults and four children, should be sized for a net to food peak power of about 500 watts.

Referring now to FIG. 6A, a further preferred embodiment of the apparatus useful in the method is shown. The basic features of said further preferred embodiment are similar to
10 said basic apparatus, however the width of said first window w_1 is increased casu quo widened, thereby widening the light-acquiring aperture between said cooker cavity and the hinged edge of said bendable mirror, and increasing the width perpendicular to said axis of rotation of said half-barrel shaped concave reflective cavity. Furthermore the height of said bendable mirror is increased to double the widened width of said first window w_1 , thereby
15 enabling said widened first window w_1 and said higher bendable mirror to acquire still more additional sunlight with favorable angles of incidence onto said PV cell module casu quo onto and through said first window w_1 and onwards via said widened half-barrel shaped concave reflective cavity 9 to the underside of said heat conducting tray above said second window w_2 , thereby providing still further augmented net to food cooking power. For example, at 24°N,
20 December 21, winter solstice, at the same insolation as in the base case, an apparatus having a 30% wider first window w_1 combined with a 30% higher tiltable and bendable mirror enables an increase in net to food peak warm-up power to about 2,100 watts/m².

Simulated net to food cooking power for said further preferred embodiment is shown in FIG. 6B. In this further preferred embodiment an apparatus having a 50 cm by 50 cm
25 cooker cavity, a 50 cm by 65 cm first window and a 50 cm wide by 1.30 m high tiltable and bendable first booster mirror in operation at 24°N, December 21, winter solstice, can provide a peak warm-up power of about 525 watts and a sustainable bottom power availability of more than 250 watts for about 8 hours (08.00 – 16.00), casu quo of more than 350 watts for about 5 hours (09.30 – 14.30).

30 Referring now to FIG. 7A a still more preferred embodiment of the apparatus useful in the method is shown. The basic features of said still more preferred embodiment are similar to said basic apparatus, however, the width of said first window w_1 is 30% wider than the width of said second and third windows w_2 and w_3 and the height of said hinged, tiltable and bendable mirror is further increased to three times the width of said window w_1 , thereby

enabling said widened first window w_1 and said heightened bendable mirror 14 to acquire still more sunlight with favorable angles of incidence onto said PV cell module 21 casu quo onto and through said widened first window w_1 and onwards via said widened half-barrel shaped concave reflective cavity 9 to the underside of said heat conducting tray 1 above said second window w_2 , thereby providing still more augmented net to food cooking power. For example at 24°N, December 21 winter solstice, for said apparatus having a 30% wider first window w_1 , and having bendable mirror height of three times the width of said window w_1 , simulated net to food cooking power is shown in FIG. 7B. With said still more preferred embodiment peak warm-up power can be increased to about 2,500 watts/m² cooker box aperture. In said still more preferred embodiment, for example, an apparatus having a 35 cm x 70 cm cooker cavity, a 45 cm x 70 cm first window combined with a 70 cm wide x 1.35 m high bendable mirror can provide at 24°N, December 21, winter solstice, a peak warm-up power of about 600 watts and a sustainable bottom power availability of more than 300 watts for about 8 hours (08.00 – 16.00) casu quo of more than 400 watts for about 6 hours (09.00 – 15.00). For said still more preferred embodiment according to FIG. 7A simulated net to food cooking power in watts/m² cooker cavity light aperture area as a function of solar altitude angle α_s during the day on winter solstices, spring and autumn equinoxes and summer solstices is shown:

In FIG. 7C at 24° parallels

In FIG. 7D at 32° parallels

In FIG. 7E at 40° parallels

In FIG. 7F at 48° parallels

In FIG. 7G at 56° parallels

In FIG. 7H at 64° parallels

Net to food cooking power, attainable worldwide at said different latitudes and in said different seasons based on glass transmissivity of 92% and mirror reflectivity of 90% is shown simulated in FIG. 11. Net to food cooking power attainable as shown can be increased by about 10% through the use of presently less readily available glass material having about 97% transmissivity and mirror material having about 94% reflectivity.

Referring now to FIG. 8A a reduced cost embodiment of the apparatus useful in the method is shown, suitable for cooking on light in equatorial casu quo tropical regions and/or under very windy circumstances precluding the use of high mirrors. The basic features of said reduced cost embodiment are similar to said basic apparatus of FIG. 2A, however, the width of said window w_1 is increased, the upper mirror is flat and its height is reduced to about equal to the width of said first window w_1 and said cover cavity 0 with its tray 1 are replaced by an

insulating board. Simulated net to food cooking power of said reduced cost embodiment of the apparatus useful in the method on December 21, the winter solstice at 24°N, is shown in FIGS. **8B/8C**, peak power is about 1,100 watts/m² (at the equator about 1,200 watts/m²) and a target sustainable power of 1,000 watts/m² to said cooker cavity bottom can be made available for
5 about 4 hours per day (at the equator about 6 hours per day). Simulated net to food cooking power at spring and autumn equinoxes and summer solstice at 24°N is shown in FIG. **8D** and **8E**.

Referring now to FIG. **9**, another preferred embodiment of the apparatus useful in the method is shown. In this other embodiment a set of two PV cell modules casu quo a light-
10 transparent cavity is installed, permanently or temporarily, casu quo removable in approximately vertical and central position in said half-barrel shaped concave reflective cavity, now having two light acquiring apertures casu quo first windows, **w_{1a}** and **w_{1b}**, sideways of said light transparent cavity. Said light transparent cavity being capable of receiving casu quo accommodating a movable cooker casu quo heater cavity suitable for
15 heating liquids and/or of receiving casu quo accommodating commercially available 1.5 liter PET water bottles, which are convenient for purification of drinking water by a combination of light and heat. Said light transparent cavity may be made of said low-iron glass having an anti-reflective surface, the surface when in use facing incoming light, alternatively made of a highly transparent polymer. Said movable cooker casu quo heater cavity may be made of said
20 highly heat conducting material, having outer surfaces, the surfaces when in use facing incoming light, coated with said spectrally selective coating. Said movable cooker casu quo heater cavity being maintained in said transparent cavity with a distance of 10 (ten) to 20 (twenty) millimeters between the outer walls of said cooker casu quo heater cavity and the inner walls of said light transparent cavity, thereby creating an insulating air chamber
25 reducing heat losses. The central, lower part of said half-barrel shaped concave reflective cavity is advantageously lifted up, for example by means of a bar or a roller bar, thereby converting said half-barrel shape into two approximately quarter-barrel shapes both having variable curvature optimized for augmented net to liquid cooking power casu quo augmenting net to drinking water light and heating power.

30 Referring now to FIG. **10A**, **19** and **22** for cooking and for electricity generation, preferred embodiments of the apparatus useful in the method are shown. In these embodiments PV panels casu quo modules, hereinafter called PV module **21**, are positioned in approximately horizontal position on ridges **22** perpendicular to said mirror **14** under casu quo sideways from said hinged tiltable and bendable mirror casu quo reflector **14**, acting

simultaneously as a chimney providing draft for a warmed air stream warmed-up upon cooling the underside of said PV cell module.

The height of said mirror **14** can be variable, for example from one to many times the width of said PV module. A practical mirror **14** height is about three times the width of said PV module as measured perpendicular to the hinge line of said mirror **14**. For said preferred embodiments having said practical ratio 3 of mirror **14** height h_m to PV module width w_1 simulated net to PV cell sunlight irradiation as a function of solar altitude angle α_s during the day is shown in FIG. **10B**. At 40°N, December 21, the winter solstice, net to cell peak net irradiation is about 1,600 watts/m² of PV module area even at a low α_s of only 26.6°, where a state-of-the-art non-tracking PV module is shown to reach about 250 watts/m² peak net to cell irradiation. At 08.00 a.m. and 16.00 p.m., when α_s is about 6°, a state-of-the-art non-tracking PV module receives no net to cell sunlight irradiation, whereas a PV cell module incorporated into the apparatus useful in the method receives a practical and convenient net to cell sunlight irradiation of about 500 watts/m². At 40° and higher latitudes in spring and summer practical levels of PV power can be generated and used to charge batteries in the early hours of a day before there is a demand for cooking power. An additional advantage of said preferred embodiment is that at lower solar altitude angles α_s , ambient temperatures are generally lower. PV cell performance *casu quo* efficiency of conversion of sunlight to electricity is augmented by about 0.4 percent for every degree centigrade drop in temperature. For said preferred embodiment for electricity generation according to FIG. **10A** simulated net to cell sunlight irradiation in watts/m² as a function of solar altitude angle α_s during the day on winter solstices, spring and autumn equinoxes and summer solstices is shown:

In FIG. **10C** at 24° parallels

In FIG. **10D** at 32° parallels

In FIG. **10E** at 40° parallels

In FIG. **10F** at 48° parallels

In FIG. **10G** at 56° parallels

In FIG. **10H** at 64° parallels

PV power cell net light irradiation attainable worldwide at said different latitudes and in said different seasons is shown simulated in FIG. **12**, based on cover glass transmissivity of 92% and mirror reflectivity of 90%. Net light irradiation attainable as shown can be increased by about 10% through the use of presently less readily available materials, such as glass having about 97% transmissivity and mirror material having about 94% reflectivity.

INDUSTRIAL APPLICABILITY

Several embodiments were tested by the inventor in the Almeria area in Southern Spain in November 2003 for various cooking operations, for example in FIG. 24, a preferred embodiment suitable for windy environments is shown, incorporating two upper guide rails 16 supported by a stabilized upper structure 30 with tie-rods 30 for maintaining optimum mirror guide rail profile 20 position in relation to said mirror hinge line 15 and fine (one degree) tuning of mirror tilt angle, said preferred embodiment as shown in FIG. 24, having three cooking trays with top insulation, bendable mirror surface area 1.35m x .625m, first window area .45m x .625m, trays area three times .35m x .20m. was tested for cooking foods such as: cooking of brunch consisting of fried eggs, fried bacon and fried tomatoes. In tray 1: fried eggs for three persons, in tray 2: fried bacon for three persons, in tray 3: fried tomatoes for three persons. Said food items were fried in 20 grams each of olive oil in less than 15 minutes at 144°C oil in tray temperature. Said cooked food items had the following characteristics: Fried eggs, sunny side up, well done. Fried bacon: crisp, well done. Fried tomatoes: juicy, tender, well done. All said fried food items had excellent taste and texture.

For said test the following geographical climatic and insolation data are of relevance:

Date of test: November 12, 2003.

Location of test: Almeria area, Southern Spain. Latitude: ~ 37°N, longitude: ~ 2°W.

Sunrise at 07.00 hrs; sunset at 17.00 hrs (universal times)

Time of test: 13.00 – 13.15 hrs (local time = universal time + 1 hour).

Ambient temperature: 18°C, Wind speed: 4-5 Beaufort, Sky: hazy.

Solar radiation on horizontal ground: 535 watts/m², beam radiation: 920 watts/m².

Solar radiation measured with calibrated Kipp pyranometer.

Solar altitude angles: ~ 36°, Solar azimuth angles: ~ 2° - 6°.

Mirror tilt angles: 75°,

13.00 hrs: Olive oil in tray temperature: 144°C. Top insulation slabs lifted off, eggs, bacon slices and tomato segments positioned in trays.

13.03 hrs: Top insulation slabs positioned on trays.

13.15 hrs: Eggs, bacon slices and tomato segments ready to be eaten.

Temperature measurements: in tray temperatures were measured with K-type (chromel-alumel) thermocouples and bimetal thermometers, temperatures inside the half-barrel shaped concave reflective cavity were measured with bimetal thermometers, a temperature of 71°C was measured between 13.00 and 13.15 hours.

For example in FIGS. **25A-25E**, views are shown of a most preferred compact embodiment without upper structure, optimized for simultaneous convenient cooking and/or convenient electricity generation on sunlight. In this embodiment a tiltable and bendable mirror/reflector **14** is suspended by means of two long hinges, hereinafter called upper and lower hinges. By means of the upper hinge **15** said mirror is attached in a rocking manner to a cross bar **39** rigidly connecting the ends, hereinafter called the upper ends of two pivoted sliding levers *casu quo* two sliding rocking arms, hereinafter called rocker arms **40**. By means of the lower hinge **15** said mirror is attached in a rocking manner to the frame of the cooker at the locus line of the outer edge of said first window w_1 . Each of said rocker arms is equipped with a slot **41** plate *casu quo* a slot having a width adequate for snugly accommodating a pivot **42** *casu quo* a roll **43** on said pivot and having a slot length at least equal to the maximum desired mirror compression C_m as shown in FIG. **17C** *casu quo* **17D** as a function of h_m . The other ends of said rocker arms, hereinafter called the lower ends, are preferably connected to each other by a shaft **44** *casu quo* a hollow shaft equipped with rolls **45** adequate for snugly following rocker arm pulling guide rail profiles *casu quo* mirror compression guide rail profiles, hereinafter called guide rail profiles C_p . The ends of said shaft are preferably equipped with extensions *casu quo* extensions with rolls functioning as pivots **42** *casu quo* pivots with rolls **43** adequate for snugly accommodating slots **41** *casu quo* slits in *casu quo* on connecting rods **46** installed on both sides of said cooker frame and connecting said shaft extensions to pivots **42** positioned on a hinge **15** supported rocking rack **47** carrying a PV cell module **21** *casu quo* PV cell modules. In operation, said rolls **45** and said shaft **44** are forced to travel under said guide rail profiles which are preferably incorporated in wear resistant guide rail plates **48** equipped with punched-in serial numbers *casu quo* registration numbers *casu quo* National and/or State license plate numbers qualifying for emission credits and installed in a stable, rigid manner below and perpendicular to said hinge lines **15** of said mirror **14** on each side of the frame of said cooker. For ease of said forcing a handle bar **49** with grips **50** can be attached, preferably in a rocking manner to said shaft **44**, as shown in FIGS. **25A** and **25B**. Said guide rail plates are characterized by possessing a profile that results in said mirror compression C_m , as shown in FIG. **17C** *casu quo* **17D** as a function of h_m , yielding an optimum mirror curvature r_m in combination with a corresponding mirror tilt angle s_m for a particular mirror height h_m approximately according to the relationship:

$$r_m = \frac{h_m - C_m}{2 \sin(90^\circ - s_m^\circ)}$$

On each side of the cooker frame, a series of lines at desired degree intervals pointing at said lower hinge **15** line are installed on casu quo under said guide rail plates **48** like sundial type dials, hereinafter called dials **51**. Said dials show the tilt angle of said rocker arms **40** casu quo the tilt angle of said mirror **14**. In operation said dials enable easy and accurate positioning of said rocker arms, thereby enabling optimum mirror tilt angles in combination with optimum mirror curvatures for optimum sunlight harvesting and onward reflective transport of harvested sunlight by said mirror **14**, simultaneously easy and accurate azimuth tracking is enabled, a person conveniently standing in the shade behind said mirror **14** can, in one movement, aim the whole apparatus including mirror **14** and PV cell module **21** at the sun by simply putting casu quo keeping said rocker arm **40** casu quo the vertical edge of said mirror **14** and elastic cord **19** in a vertical plane parallel to the rays of the sun.

In operation, as said shaft **44** with said rolls **45** are forced to travel back and forth casu quo down and up and down under said guide rail profile, connecting rods **46** attached to said shaft **44** are forced to push casu quo pull a hinge **15** supported rocking rack **47** holding a PV cell module **21** casu quo PV cell modules into positions optimized for acquiring sunlight onto said PV cell modules at optimum angle of incidence, thereby enabling highly efficient electricity generation in a low cost two-axis sun tracking manner that can be optimized for all latitudes and/or seasons. Optional rocking flat booster mirrors **28** having a height up to about equal to the height of said bendable mirror **14** and having a width up to about half the width of said bendable mirror **14** are attached with hinges **15** to said rocker arms **40** on both sides of said bendable mirror **14**. Said booster mirrors serve in open position with an optimum opened angle of about 120 degrees to further increase the acquisition of sunlight or serve - at the option of the cook - as blinds, in closed position blocking the glare of said bendable mirror **14** whenever the cook needs to work on casu quo in said cooking trays.

To accommodate variations of solar altitude angles α_s at different latitudes and/or in different seasons the points of engagement of said connecting rods **46** on said PV cell support rack casu quo the location of the pivots **42** on said support rack can be optimized, thereby enabling at all latitudes and in any season favorable angles of incidence of sunlight on said PV cells. For example in FIG. **25B** the outer curve indicating the PV cell modules tilt angles corresponds to operations between the tropics, e.g. between 0° and 24° latitude where α_s may reach about 90° . For PV cell cooling draft purposes a minimum PV cell module slope angle of 10° is maintained at all latitudes and all seasons. More inward curves correspond for example to operations in tropical winters. Similarly the inner curve shown corresponds to operations at about 40° latitude where in summer α_s reaches about 74° at the most.

As an alternate embodiment to said connecting rods compelling the rocking movement of said PV cell module support rack, pulling ropes casu quo cords **52** are installed between suitable points of engagement on said rocker arms **40** and said PV cell support rack, for example via pulleys **53** installed on casu quo in supports **54** extending from the frame of said cooker. Optimization of PV cell tilt angle for latitudes and/or seasons can be accomplished by
5 optimizing the points of engagement of said ropes casu quo said cords on said rocker arms and/or said PV cell support rack. For ease of optimizing tilt angle of said PV cell support rack, a shadow-casting gnomon **55** is positioned on the outer edge of said PV cell support rack, as shown in FIG. **25B**, and whereby a small or no shadow is indicative of an optimum position.

10 In this embodiment the curved and flat reflective surfaces casu quo walls of said half-barrel shaped concave reflective cavity are insulated on their convex side casu quo their outside surfaces. In operation, said insulated **56** reflective walls under said cooking trays enable an increase in temperature inside said half-barrel shaped concave reflective cavity, by putting to good use any heat resulting from non-ideal reflections inside said concave reflective
15 cavity. As a result the hot surfaces on the underside of said cooking trays “face” a “space” and a reflecting surface which is hot and has a low absorptivity, consequently heat losses from said cooking trays are reduced, net to food cooking power is increased and higher food processing temperatures can be reached faster and maintained longer.

To further reduce heat losses from said concave reflective cavity through said first
20 window w_1 reflective hinged wind shields **58** are installed, perpendicular to said lower hinge **15** line of said mirror **14** on both sides of said first window w_1 . In operation said windshields **58** can be held upright by shadow-casting elastic cords **19** with shadow-casting beads **35** installed between said windshields and said cross bar **39**.

This most preferred compact embodiment provides a practical personal clean energy
25 system, other embodiments of the present invention enable many enhanced natural sunlight operations such as for example accelerating the growth of plant seedlings or sunning the human body by taking a sunbath under said tiltable and bendable mirror **14**.

The present invention has been described in an illustrative manner. In this regard it is evident that those skilled in the art or science casu quo the commerce to which the present
30 invention pertains, once given the benefit of this disclosure, may now make modifications to the method and the specific embodiments described herein without departing from the spirit of the present invention. Such modifications are to be considered within the scope of the present invention which is limited solely by the scope and spirit of the appended claims.

CLAIMS

What I claim as my invention is:

1. A method for achieving worldwide reduction of carbon dioxide emissions and/or worldwide reduction of deforestation characterized by providing for many people the steps
5 for casu quo the opportunity for earning casu quo accruing emission rights casu quo emission credits casu quo tradable emission rights casu quo tradable emission credits casu quo tradable carbon dioxide emission rights casu quo tradable carbon dioxide emission credits, the value of which rights casu quo the value of which credits can be monetized for paying wholly or partly for the cost of said method and for the cost of an apparatus qualified for casu quo licensed for
10 said accruing of said rights casu quo for said accruing of said credits and/or for alternately casu quo additionally creating a source of ongoing revenue for users of said method and apparatus and/or for governments and/or organizations that promote the introduction and ongoing use of the method and apparatus of the present invention, said method being further characterized in operation by a synergic combination of augmented net to food cooking power
15 on sunlight with augmented net electricity generating power on sunlight, thereby augmenting convenience of cooking and/or electricity generation on sunlight to such a high level that many people are induced to substitute carbon containing fuels for lighting and/or cooking by sunlight and in so doing said people are avoiding exposure to harmful emissions causing widespread lung and eye diseases and/or said people are rewarded by affordable access to
20 electricity, entertainment, education and improved health, said method furthermore being characterized in operation by the steps for greatly accelerating and greatly augmenting net to food cooking power and/or net electric power from sunlight at all solar altitude angles, especially so at low solar altitude angles, resulting in better quality meals through shorter cooking times casu quo resulting in shorter battery charging times, conveniently resulting in
25 reduced sun tracking labor, more frequent and more varied usefulness during prolonged periods of usefulness and more widespread usefulness over wider latitudes, the foregoing favorable characteristics resulting from compounding power augmentation contributions by a sequence of individual inventive net to food cooking power augmentation steps and/or net electric power augmentation steps, said method comprising any or all of the following steps:
30 (a) the step for acquiring sunlight onto PV cells, assembled into modules, hereinafter called PV cell modules and/or through approximately horizontal transparent surfaces, hereinafter called first window casu quo windows and second window casu quo windows, positioned approximately side by side above a concave reflective cavity casu quo cavities of approximately half-barrel shape having its axis of rotation parallel to the meeting line of said

first window with said second window and being capable of reflectively directing a major part or all of sunlight acquired by said first window to the underside of said second window, said second window transmitting said acquired sunlight onwards to a highly heat conducting underside of a well insulated cooker cavity casu quo a plurality of said cooker cavities, positioned above said second window, thereby providing augmented net to food cooking power to food, positioned on said highly heat conducting underside of said cooker cavity;

(b) the step for acquiring additional sunlight onto an adjustably tiltable and adjustably bendable reflector casu quo mirror, positioned with lower hinge means near the outer casu quo the external edge of said first window, parallel to the axis of rotation of said half-barrel shaped concave reflective cavity, said mirror hereinafter called bendable mirror, said bendable mirror being capable of having variable tilt angle and variable curvature, enabling said bendable mirror to reflectively direct a major part or all of said additionally acquired sunlight onto a PV cell module and/or through said first window with more favorable angles of light incidence for onward reflective transport of said sunlight to the underside of said second window for upward transmission of said sunlight through said second window to said heat conducting underside of said cooker cavity casu quo plurality of cooker cavities, positioned above said second window, thereby providing further augmented and accelerated net to food cooking power to food, positioned on said highly heat conducting underside of said cooker cavity casu quo said plurality of cooker cavities, said step for acquiring additional sunlight also comprising the step for providing guide means for simple, accurate azimuth tracking and comprising also the step for providing one or more shadow-casting rods casu quo beads communicating in shadow-casting manner with said bendable mirror and said PV cell module casu quo said first window and comprising furthermore the step for providing a guide rail casu quo for providing a plurality of guide rails, equipped with a mirror bending by mirror compression profile casu quo equipped with a plurality of mirror bending by mirror compression profiles and mirror position marker means and/or mirror position holding means enabling positioning of said adjustably tiltable and adjustably bendable mirror in a simple, reproducible manner in optimum mirror tilt angle and optimum mirror curvature for optimum acquisition of additional sunlight at every solar altitude angle prevailing at a relevant time of the day, day of the year and latitude and for optimum instantaneous reflective direction of a major part or all of said additionally acquired sunlight onto said PV cell module and/or onto said first window with more favorable angles of incidence onto said PV cell module thereby providing further augmented and accelerated PV cell power and/or onto said first window for onward transmission of said additionally acquired sunlight via said half barrel shaped concave

reflective cavity and through said second window to said highly heat conducting underside of said cooker cavity casu quo a plurality of said cavities positioned above said second window, thereby providing still further augmented and accelerated net to food cooking power to food, positioned on said highly heat conducting underside of said cooker cavity casu quo said

5 plurality of cooker cavities;

(c) the step for acquiring further additional sunlight onto a PV cell module casu quo modules, positioned on a rocking rack supported in a hanging manner by hinge means attached parallel to said lower hinge means of said bendable mirror to an upper edge of said rocking rack and the edge of the structure of the apparatus furthest away, parallel to and at the
10 level of said lower hinge means of said bendable mirror, said PV cell module hereinafter called rocking module being compelled by said additional sunlight acquiring movements of said bendable mirror and/or said structure of the apparatus to track the sun in a two-axis tracking manner for optimum acquisition of said further additional sunlight with favorable angles of incidence onto said rocking module casu quo rocking modules at all times and
15 latitudes;

(d) the step for acquiring still further additional sunlight onto and through a third approximately horizontal transparent surface, hereinafter called third window, provided and positioned above a well insulated cover cavity casu quo a plurality of cover cavities provided with the same dimension as said cooker cavity, said cover cavity being positioned in mirror-
20 image casu quo upside down arrangement above casu quo on top of said cooker cavity casu quo said cooker cavities, said third window transmitting said acquired still further additional sunlight to a highly heat conducting topside, positioned under said third window of said cover cavity, furthermore providing the surface, illuminated when in operation of said highly heat conducting topside of said cover cavity with said spectrally selective coating possessing said
25 high absorptivity for said acquired further additional sunlight and possessing low emissivity for radiation of infrared light casu quo radiation of heat from said illuminated spectrally selective surface, said spectrally selective surface enabling instant conversion of a major part or all of the energy contained in said acquired still further additional sunlight to heat, heat being conducted instantly, with minimum resistance through said highly heat conducting
30 topside of said cover cavity from where heat is radiated to foods, beverages or any materials positioned in the cavity under casu quo below said highly heat conducting topside of said cover cavity, thereby providing still more augmented net to food cooking power to said foods, beverages or other materials;

(e) the step for acquiring optimum quantities of sunlight onto said PV cell module, onto said tiltable and bendable mirror and onto and through all said windows by enabling in one movement easy and accurate aiming of the whole apparatus comprising said PV cell module, said mirror and all said windows at the sun by a person conveniently standing in the shade
5 behind said tiltable and bendable mirror;

(f) the step for converting instantly a major part or all of the energy contained in said acquired and additionally acquired sunlight reaching said PV cell module to electricity and/or converting said sunlight reaching said highly heat conducting underside of said cooker cavity to heat by means of a spectrally selective coating deposited on the surface illuminated when in
10 operation, said spectrally selective coating possessing high absorptivity for said reflectively transmitted sunlight, said coating possessing low emissivity for radiation of infrared light casu quo radiation of heat from said illuminated spectrally selective surface, said spectrally selective surface enabling instant conversion of said light energy to heat, said heat being conducted instantly with minimum resistance through said highly heat conducting underside
15 of said cooker cavity, thereby providing greatly augmented net to food cooking power to food, positioned in intimate heat conducting communication on said highly heat conducting underside of said cooker cavity casu quo said plurality of cooker cavities;

(g) the step for storing said electricity generated by said PV cell modules in a battery casu quo in batteries, said battery casu quo batteries preferably being positioned within the
20 structure of said apparatus, said battery casu quo batteries simultaneously serving as ballast, providing wind stability;

(h) the step for acquiring optimum quantities of sunlight onto said selective surfaces by providing reflective surfaces on the inner walls of said support frames of said absorbers casu quo said trays, said reflective surfaces serving simultaneously as reflective insulation against
25 heat losses from said trays to the ambient;

(i) the step for reducing heat losses by providing insulation on the outer walls of said support frames of said absorbers casu quo said trays, said insulation possessing reflective surfaces;

(j) the step for reducing heat losses by temporarily positioning insulating slabs over the
30 tops of said trays casu quo said cooker cavities apertures, said insulating slabs possessing reflective surfaces;

(k) the step for reducing heat losses by providing insulation on the outside surfaces of said reflective walls of said half-barrel shaped concave reflective cavity;

(l) the step for reducing heat losses by installing reflective wind shields perpendicular to said lower hinge means of said bendable mirror on both sides of and upwards from said first window, optionally for convenience also from said second window;

(m) the step for reducing heat losses, simultaneously protecting spectrally selective surfaces by providing thin sheets of a highly transparent material, such as for example a fluorocarbon polymer such as Teflon FEP[®], one of said thin sheets being installed at some distance under said highly heat conducting underside of said cooker cavity, thereby providing protection to said spectrally selective surface coated on said highly heat conducting underside simultaneously providing two insulating air chambers between said spectrally selective surface and said second window, thereby reducing heat losses and providing still more net to food cooking power, another of said thin sheets being installed at some distance above said highly heat conducting topside of said cover cavity, thereby providing protection to said spectrally selective surface coated on said highly heat conducting topside of said cover cavity and providing two insulating air chambers between said spectrally selective surface and said third window, thereby reducing heat losses and providing still more net to food cooking power;

(n) the step for improving heat transfer to foods, beverages or any other materials, simultaneously reducing surface temperatures of light absorbing surfaces, conveniently reducing radiant and convective heat losses from said light absorbing surfaces by executing casu quo forming casu quo shaping said highly heat conducting underside of said cooker cavity, optionally also of said highly heat conducting topside of said cover cavity as concave trays, said concave trays together enclosing a cavity suitable for positioning foods casu quo beverages directly on the lower one of said concave trays, for cooking casu quo heating said foods casu quo beverages, while in direct, intense, intimate heat conducting communication with said highly heat conducting underside casu quo concave tray of said cooker cavity as heat source, said concave trays having been provided on their convex surfaces, the surfaces illuminated when in operation, with said spectrally selective coating, net to food heat transfer coefficients being improved compared to prior art cooking in vessels by an order of magnitude, thereby providing greatly augmented net to food cooking power;

(o) the step for enabling fast response to available solar radiation by providing improved angles of incidence for solar radiation onto said PV cell modules and/or onto said windows and by reducing thermal inertia of cooking operations by cooking foods casu quo heating beverages directly on casu quo in a highly heat conducting thin-walled light-weight low-thermal inertia cooking tray casu quo a plurality of cooking trays having a spectrally selective

coating on its casu quo their convex outer surface, characterized in operation by instantly reacting positively to acquired sunlight, instantly converting said sunlight to heat, simultaneously delaying heat losses by temperature-dependent heat radiation, said cooking tray casu quo trays, while in operation, furthermore being characterized by being in whole tray surface contact casu quo intimate highly heat conducting communication with foods casu quo beverages positioned directly on said tray casu quo trays, resulting in augmented energy fluxes from acquired light to food, while simultaneously reducing temperatures of light-absorbing surfaces, resulting in reduced heat losses enabling providing still more and faster augmented net to food cooking power;

10 (p) the step for enabling the cooker cavity to warm up to a temperature of convenience for the food being cooked, shielding partly or wholly said first and/or third window with said insulating slabs whenever temperature threatens to exceed allowable temperature limits for food casu quo cooker materials;

15 (q) the step for enabling supervision of cooking progress and/or performing stirring casu quo food turning operations conveniently by lifting off momentarily said cover cavity casu quo said insulating slab, heat continuing to be supplied to said food from below by said first heat conducting tray;

20 (r) the step for enabling continued cooking casu quo warm-keeping of hot foods in late solar afternoons when the sun goes down and ambient temperature drops and enabling warm-keeping of cooked foods on the eating table casu quo eating place by serving said cooked food in said first tray, kept warm by said insulation on said outer walls of said support frame of said tray and by said insulating slab over the aperture of said tray;

25 (s) the step for enabling cooking operations casu quo warm-keeping of hot foods by means of a halogen light source, electricity being supplied for example from a battery charged by said PV cell modules;

(t) the step for enabling augmented electricity generation alternating with casu quo simultaneously with casu quo independent of cooking operations by positioning PV cell modules under casu quo sideways from said bendable mirror for optimum irradiation of PV cell modules by said bendable mirror;

30 (u) the step for enabling cooling of PV cell modules by providing under said PV modules an air channel communicating with air channels casu quo chimneys incorporated in casu quo on said bendable mirror;

(v) the step for enabling varied cooking operations, cooking foods directly on said trays, for example of the classical type, the steam-cooking type, the stir-frying type, the baking type, the grilling type;

5 (w) the step for enabling water purification by heat and light by providing said first tray, optionally also said second tray, as a highly light transparent tray made of an anti-reflectively coated low-iron glass or a polymer, such as for example polyethylene terephthalate (PET) / polybutylene terephthalate (PBT), acrylic, polycarbonate;

10 (x) the step for enabling cooking of soups, heating water casu quo other liquids in a cooker cavity positioned in approximately vertical position in said half-barrel shaped concave reflective cavity, parallel to said axis of rotation of said half-barrel shape, said cooker cavity having an opening in its top for receiving liquids and preferably having said spectrally selective surfaces as all of its outside surfaces, facing light, transmitted from all sides by said transparent low iron glass cavity casu quo said transparent polymer cavity, positioned at an optimum distance around said cooker cavity;

15 (y) the step for enabling purification of drinking water by heat and light by means of a light transparent glass or polymer cavity, suitable for holding water, positioned approximately vertically in said half-barrel shaped concave reflective cavity parallel to said axis of rotation of said half-barrel shape, said transparent cavity being also capable of receiving casu quo accommodating transparent glass or polymer bottles holding water;

20 (z) the step for protecting PV cell modules, glazings of said windows and other cooker materials upon finalizing operations, by providing said bendable mirror with dimensions at least sufficient in horizontal (off-duty) flat position to cover and protect itself and said cooker structure, said windows casu quo trays and said PV cell modules against overheating, hail, rain, dust or sand storms, winds, debris, vandalism and the like.

25 2. The method of claim 1, further comprising the step for organizing and implementing a quality assurance mechanism casu quo program for supervising the manufacture casu quo the production of said solar cookers/solar electricity generators whereby said cookers/generators can be certified casu quo qualified for the accrual of emission credits casu quo for the accrual of tradable emission rights comprising tradable carbon dioxide emission rights/credits and can
30 be provided with registration numbers casu quo country and/or state license plate numbers qualifying said cookers/generators for the accrual of said emission credits/tradable emission rights in the countries and/or states where said cookers/generators are going to be used.

3. The method of claim 1, further comprising the step for earning casu quo accruing emission credits casu quo tradable emission rights and/or credits for operating a solar

cooker/solar electricity generator on sunlight qualified for casu quo registered for casu quo licensed for the accrual of tradable emission rights/credits comprising tradable carbon dioxide emission rights/credits thereby substituting carbon containing fuels by sunlight for cooking and/or water heating and/or electricity generation.

5 4. The method of claim 3, further comprising the step for keeping a record of cooking and/or electricity generating operations on sunlight and submitting said record at regular intervals to a designated entity casu quo to a designated authority for emission credits.

10 5. The method of claim 4, further comprising the step for offering casu quo selling said earned casu quo accrued emission credits casu quo tradable emission rights comprising tradable carbon dioxide emission rights/credits to a willing buyer.

15 6. The method of claim 4, further comprising the step for gathering casu quo accumulating casu quo amassing a plurality casu quo a multitude of said earned emission credits casu quo tradable emission rights comprising tradable carbon dioxide emission rights/credits by an entity such as for example a state, a nation, an organization, a charity, a business, an exchange, into larger marketable packages and offering casu quo selling or auctioning said marketable packages to prospective buyers casu quo to willing buyers.

7. Earning casu quo accruing emission credits casu quo tradable emission rights accruing from emissions avoided by practicing any or all of the steps for the method of claim 1.

20 8. Earning casu quo accruing carbon dioxide emission credits casu quo tradable carbon dioxide emission rights accruing from carbon dioxide emissions avoided by practicing any or all of the steps for the method of claim 1.

25 9. Earning casu quo accruing emission credits casu quo tradable emission rights accruing from emissions avoided by practicing any or all of the steps for the method of claim 1, using apparatus provided with registration numbers casu quo country and/or state license plate numbers qualifying said apparatus for accrual of emission credits casu quo tradable emission rights.

30 10. Earning casu quo accruing carbon dioxide emission credits casu quo tradable carbon dioxide emission rights accruing from carbon dioxide emissions avoided by practicing any or all of the steps for the method of claim 1, using apparatus provided with registration numbers casu quo country and/or state license plate numbers qualifying said apparatus for accrual of carbon dioxide emission credits casu quo tradable carbon dioxide emission rights.

11. Apparatus for acquiring sunlight, for converting acquired sunlight to heat for cooking purposes and/or to electricity, characterized by a synergic combination of tiltable and bendable mirror means, half barrel shaped concave reflective cavity means, hot box light

cooker means and/or rocking PV cell module means, said combination being capable of acquiring augmented sunlight with optimum angles of incidence for instant conversion of sunlight to greatly augmented and evenly distributed net to food cooking power and/or to augmented net electric power, said apparatus comprising any or all of the following means:

5 **(a)** complementary cavity means, having an approximately horizontal lower transparent aperture, hereinafter called second window means, for acquiring reflected light onto and through transparent sheet means casu quo plate means and onwards onto a lower light to heat converting surface means being the underside of a highly heat conducting approximately horizontal tray means casu quo plate means, hereinafter called first tray means and having an
10 approximately horizontal upper transparent aperture, hereinafter called third window means for acquiring direct sunlight onto and through transparent sheet means casu quo plate means and onwards onto an upper light to heat converting surface means being the topside of a highly heat conducting approximately horizontal inverted casu quo upside down tray means casu quo plate means, hereinafter called second tray means for radiating heat to food
15 positioned below said second tray means, said first and second tray means comprising tray support means having insulated outer walls and possessing reflective surface means on inner walls facing said tray means and having reflective surface means on any outer walls casu quo outer walls of insulation facing reflected light;

20 **(b)** additional approximately horizontal transparent aperture means, hereinafter called first window means, positioned directly sideways next to said second window means for acquiring sunlight and additional casu quo reflected sunlight for further transmission via approximately half-barrel shaped concave reflective cavity means to and through said second window means to said light to heat converting underside of said first tray means;

25 **(c)** insulated lower mirror means of approximately half-barrel concave shape having its axis of rotation parallel to the meeting line of said first window means with said second window means, said half barrel being provided with insulation means around the convex outside surface casu quo on the flat outside surfaces, said lower mirror means, hereinafter called half-barrel shaped concave reflective cavity means for reflectively transporting said sunlight and said additional sunlight, acquired onto and through said first window means to
30 the underside of said second window means and onwards to said lower light to heat converting surface means on the underside of said highly heat conducting first tray means, said half-barrel shaped concave reflective cavity means, preferably being of a flexible reflective sheet casu quo foil material and further having means for vertical and/or horizontal variation of the position of the nadir line casu quo the lowest line parallel to the axis of rotation of said half-

barrel shaped concave reflective cavity means, for optimum reflective performance, for example from shallow to deep catenary, circular, parabolic, elliptic casu quo polygonal shape or any combination of said shapes, for varied reflective tasks, deeper half-barrel shapes generally resulting in more favorable angles of incidence of said sunlight and said additional
5 sunlight onto and through said second window means and subsequently onto said light to heat converting surface means on the underside of said first tray means, said half-barrel shaped concave reflective cavity means having drain hole means on said nadir line for removal of incursions of rain, food spills or any other kind, said half-barrel shaped concave reflective cavity means optionally also having roll means for storing and/or rolling on of said reflective
10 sheet material casu quo foil material for convenient cleaning of said reflective surface of said half barrel shaped concave reflective cavity means, the two reflective end walls perpendicular to said axis of rotation of said half-barrel shaped concave reflective cavity means also being made of said flexible reflective sheet material casu quo foil material, alternatively of semi-rigid casu quo rigid reflective material;

15 (d) upper mirror means, casu quo upper reflector means, hereinafter called bendable mirror means, positioned with lower hinge means near the far side of said first window means, the side furthest away from said second window means, said bendable mirror means being a hinged, adjustably tiltable and adjustably bendable mirror capable of having variable tilt angle and variable curvature, for optimum acquisition and optimum reflective direction of said
20 additional sunlight onto and through said first window means casu quo onto a PV cell module means positioned at about the locus of said first window means;

(e) bendable mirror guide rail means possessing mirror indicator means for mirror tilt angle, mirror holding means for maintaining mirror in a chosen position and mirror compression profile means for compression of said bendable mirror means to a curvature
25 optimized for the ratio of said bendable mirror height to said first window width, said bendable mirror guide rail means enabling in one operation casu quo one movement the positioning of said bendable mirror means and said rocking module means in the most favorable combination of mirror tilt angle and corresponding mirror curvature at any prevailing solar altitude angle for optimum acquisition and onward reflective direction of said
30 additional sunlight with superior angles of incidence onto said first window means and for optimum acquisition of said further additional sunlight with favorable angles of incidence onto said rocking module means;

(f) rocking PV cell module means for converting sunlight to electricity, said rocking module means being positioned during cooking operations on a rocking rack means, rocking

parallel to said bendable mirror means at about the locus of the edge of said second window means parallel to and furthest away from said bendable mirror means, said rocking module means being also suitable for being positioned during off-cooking intervals under said bendable mirror means at the locus of said first window means for optimum acquisition of sunlight onto said PV cell module means for augmented generation of electricity;

(g) pivoted sliding lever means casu quo sliding rocker arm means, hereinafter called rocker arm means, rigidly connected at one end by a crossbar means equipped with hinge means for suspending said bendable mirror means in a rocking manner, said rocker arm means being connected at their other ends by a shaft means equipped with roll means for tracking a bendable mirror compression profile means and equipped with pivot means for pushing and pulling connecting rod means, said rocker arm means also being equipped at a convenient distance from said shaft means with slot plate means casu quo slot means made of a rigid wear resistant material for holding said rocker arm means in rocking and sliding communication with and on pivot means installed on the structure means of the apparatus approximately at the locus of the axis of said lower hinge means of said bendable mirror means;

(h) connecting rod means for connecting said pivot means on said shaft means with pivot means installed on said rocking rack means supporting said rocking module means, thereby enabling simultaneous positioning of said bendable mirror means and said rocking module means for optimum acquisition of sunlight;

(i) rope means for connecting suitable points on said rocker arm means via pulley means installed on support means extending from the structure means of said apparatus at a level above said rocking rack means with suitable points of engagement on said rocking rack means, thereby enabling simultaneous positioning of said bendable mirror means and said rocking module means for optimum acquisition of sunlight;

(j) gnomon means, installed on the lower edge of said rocking rack means for optimization of tilt angles of said rocking module means;

(k) cooling means for cooling of PV cell module means positioned under said bendable mirror means, said cooling means comprising a cooling air channel means under said PV cell module means, said cooling air channel means being in cooling air draft communication via a flexible connection channel means with an upwards flow air channel means casu quo a plurality of upwards flow air channel means casu quo chimney means incorporated into casu quo onto said bendable mirror means;

(l) battery means for storage of electricity generated by said PV cell module means, said battery means simultaneously serving as ballast means;

(m) insulated halogen light means of dimensions fitting said cooker cavity means, for enabling continued cooking casu quo warm-keeping of cooked foods towards casu quo after sunset casu quo during intervals of insufficient sunshine;

(n) electrical conduit means for electricity transport from said PV cell module means to said battery means and from said battery means to said halogen light source means;

(o) insulating slab means for reduction of heat losses from said cooker cavity means towards casu quo after sunset casu quo during intervals of insufficient sunshine casu quo when cooking above a halogen light source means casu quo when said cooker tray means with cooked food are on the eating table or eating place;

(p) temperature indication means for simple accurate reading of cooker cavity means contents temperature casu quo for protection of cooker means materials against overheating;

(q) stretchable casu quo elastic cord means installed between said cross bar means and said reflective windshield means for enabling in operation the upholding of said windshield means and for enabling simple, accurate azimuth tracking of the sun by the apparatus during a solar day, said cord means being maintained in light shading communication onto said rocker arm means casu quo the vertical edges of said bendable mirror means, said elastic cord means being conveniently equipped with one or more shadow-casting rod means casu quo shadow-casting bead means whereby their shadow cast on said first window means at the locus of the meeting line between said first window means and said second window means is indicative of an optimum position of said bendable mirror means;

(r) rocking rack means for supporting casu quo holding said rocking PV cell module means;

(s) hinge means for supporting in a rocking manner said bendable mirror means, said rocking rack means, said reflective windshield means and said booster mirror means;

(t) shaft means for connecting said rocker arms, said shaft means being equipped with a rocking handlebar means with grip means and equipped with roll means for accurate tracking of said bendable mirror compression profile means installed on casu quo in said guide rail means casu quo said guide rail plate means and equipped with shaft end means casu quo pivot means with roll means for controlled pushing casu quo pulling of said connecting rods means;

(u) cross bar means for rigidly connecting said rocker arm means and for supporting said upper hinge means whereon said bendable mirror means is suspended in a rocking manner;

(v) guide rail plate means for the accurate positioning and bending of said bendable mirror means and made of rigid wear resistant material means and incorporating said bendable mirror compression profile means casu quo curve means, for accurately accommodating said

roll means on said shaft means connecting said rocker arm means, said guide rail plate means being equipped with a series of line means at desired degree intervals in a sundial manner for accurately indicating the tilt angle of said rocker arm means casu quo of said bendable mirror means, said guide rail plate means being installed in a structurally rigid manner on the
5 structure means of the apparatus below and perpendicular to the axis of said lower hinge means of said bendable mirror means, said guide rail plate means also being equipped with punched-in registration number means casu quo country and/or state license plate number means qualifying said apparatus for accrual of emission credits casu quo for accrual of tradable emission rights, casu quo tradable carbon dioxide emission credits;

10 (w) reflective windshield means for reducing heat losses, installed perpendicular to the axis of said lower hinge means on both sides casu quo on both edges of said first window means;

(x) wheel means, for ease of positioning casu quo moving of said apparatus;

(y) structure means for said apparatus, comprising a stable support structure means properly ballasted for wind stability for maintaining said rocker arm pivot means and said
15 guide rail plate means casu quo said guide rail means in a stable rigid position on the apparatus;

(z) bendable mirror means having dimensions sufficient in horizontal (off-duty) flat position for covering and protecting itself and the structure means of the apparatus including transparent window means, cooker tray means and PV cell module means against stagnant
20 overheating, hail, rain, dust, sandstorms, winds, debris, vandalism and the like.

12. The apparatus of claim 11, wherein the height of said tiltable and bendable mirror means is from about the width of said first window means to about ten times the width of said first window means.

13. The apparatus of claim 11, wherein said tiltable and bendable mirror means comprises
25 air channel means casu quo a plurality of air channel means casu quo air chimney means for enhancing cooling air draft for cooling PV cell module means positioned under casu quo below said tiltable and bendable mirror means.

14. The apparatus of claim 11, wherein the width of said first window means is from about the width of said second window means to about three times the width of said second window
30 means.

15. The apparatus of claim 11, wherein the depth casu quo the dimension in vertical direction of said half-barrel shaped concave reflective cavity means is from about half the width of said first window means to about three times the width of said first window means.

16. The apparatus of claim 11, wherein said bendable mirror guide rail means casu quo said bendable mirror guide rail plate means possess bendable mirror compression profile means for exerting no compression for a bendable mirror means in flat shape and/or for exerting mirror compressions equal to or greater than about

$$C_m = h_m \times \left[\frac{.01744 (90^\circ - s_m^\circ)}{\sin (90^\circ - s_m^\circ)} - 1 \right]$$

for a bendable mirror means in bent condition for compelling bendable mirror means compression from zero in flat condition to compelling said mirror means compressions equal to or greater than about $C_m = h_m \times \left[\frac{.01744 (90^\circ - s_m^\circ)}{\sin (90^\circ - s_m^\circ)} - 1 \right]$

$$\sin (90^\circ - s_m^\circ)$$

for a bendable mirror means in bent condition and for compelling bendable mirror means curvatures having a radius from infinite for a bendable mirror means in flat shape to radii equal to or smaller than about $r_m = \frac{h_m - C_m}{2 \sin(90^\circ - s_m^\circ)}$

for a bendable mirror means in bent condition for optimum acquisition of additional sunlight onto said PV cell module means casu quo onto and through said first window means.

17. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means, said metal alloy comprising any and/or all of the elements iron, chromium, nickel, molybdenum, titanium, manganese, aluminum, copper, tin, zinc, carbon.

18. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means provided with casu quo coated on at least one surface, the surface when in use exposed to light, with a spectrally selective coating.

19. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means painted casu quo enameled on at least one surface, the surface when in use exposed to light, with a non-selective coating casu quo a black paint.

20. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means coated casu quo enameled on one surface, the surface when in use in contact with foods, with a non-stick coating, such as for example a fluorocarbon polymer coating such as Teflon®.

21. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means formed into tray means of shapes and dimensions fitting a desired cooker cavity means.

22. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise flat metal alloy plate means having dimensions fitting a desired cooker cavity means.

23. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise metal alloy tray means casu quo metal alloy plate means, the metal alloy comprising a stainless steel alloy coated on at least one surface, the surface when in use exposed to light, with a spectrally selective coating.

24. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise ferritic stainless steel alloy tray means casu quo ferritic stainless steel alloy plate means coated on at least one surface, the surface when in use exposed to light, with a spectrally selective chromium oxide coating.

25. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise glass tray means casu quo glass plate means.

26. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise polymer tray means casu quo polymer plate means.

27. The apparatus of claim 11, wherein said highly heat conducting tray means casu quo plate means comprise a plurality of said plate means, casu quo plate means formed into a plurality of concave tray means fitting a plurality of desired cavity means for a plurality of simultaneous cooking operations for a variety of dishes casu quo meals casu quo individual portions of food.

28. The apparatus of claim 11, wherein said transparent sheet means are made of a fluorocarbon polymer such as for example Teflon[®] casu quo Tefzel[®].

29. The apparatus of claim 11, wherein said first, second and third window means comprise highly transparent glass plate means having low iron content, said glass plate means having also been provided with a low reflection surface casu quo a low reflection coating on one or both of their surfaces facing incoming light.

30. The apparatus of claim 11, wherein said first, second and third window means comprise highly transparent polymer plate means casu quo polymer sheet means casu quo polymer film means or foil means, provided with an anti-reflection coating on one or both of their surfaces facing incoming light.

31. The apparatus of claim 11, wherein said hot box type light cooker means is made up of a transparent cavity means positioned vertically with its largest surfaces parallel to said axis of rotation in the center part of said half-barrel shaped concave reflective cavity means for heating liquids casu quo for cooking soups in metal container means having walls coated with said spectrally selective coating means casu quo for sterilizing water positioned in light transparent glass or polymer bottle means in said transparent cavity means casu quo directly in said transparent cavity means by a combination of light and heat.

32. The apparatus of claim 11, wherein two of said PV cell module means for generating electricity are positioned vertically, back to back, separated by a common vertical cooling air channel means casu quo chimney means in the center part of said half-barrel shaped concave reflective cavity means, said PV cell module means having their PV cell surfaces oriented in parallel to said axis or rotation of said half-barrel shaped concave reflective cavity means.

33. Emission credits casu quo tradable emission rights earned casu quo accruing from emissions avoided through the use of any or all of the means of the apparatus of claim 11.

34. Carbon dioxide emission credits casu quo tradable carbon dioxide emission rights earned casu quo accruing from carbon dioxide emissions avoided through the use of any or all of the means of the apparatus of claim 11.

35. Emission credits casu quo tradable emission rights earned casu quo accruing from emissions avoided through the use of any or all of the means of the apparatus of claim 11, possessing registration number means casu quo country or state license plate number means qualifying said apparatus for accrual of emission credits casu quo tradable emission rights.

36. Carbon dioxide emission credits casu quo tradable carbon dioxide emission rights earned casu quo accruing from carbon dioxide emissions avoided through the use of any or all of the means of the apparatus of claim 11, possessing registration number means casu quo country or state license plate number means qualifying said apparatus for accrual of carbon dioxide emission credits casu quo tradable carbon dioxide emission rights.

37. Accelerating growth by enhancing natural sunlight insolation of plant seedlings positioned under said bendable mirror means of the apparatus of claim 11.

38. Sunning the human body by enhancing natural sunlight insolation of human bodies taking a sunbath under said bendable mirror means of the apparatus of claim 11.

39. Personal clean energy system providing for cooking, growing, sunning and/or electricity needs and/or enabling earning of emission credits casu quo of tradable emission rights by practicing any or all of the steps for the method of any or all of claims 1 through 10 and/or by using any or all of the means of the apparatus of any or all of claims 11 through 38.

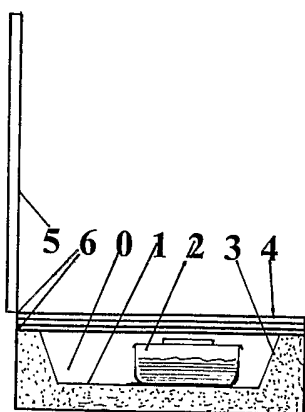


FIG. 1 PRIOR ART

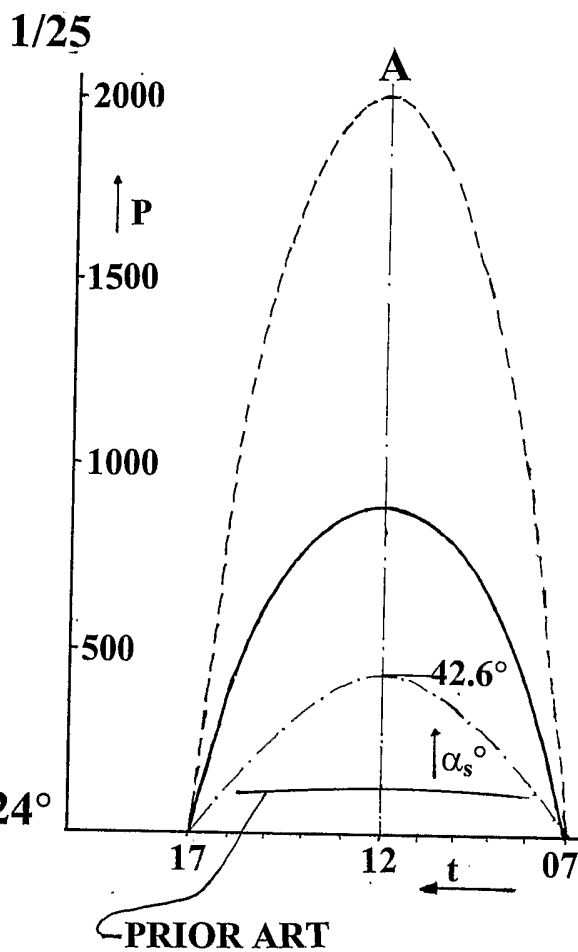


FIG. 2C ~ L=24°

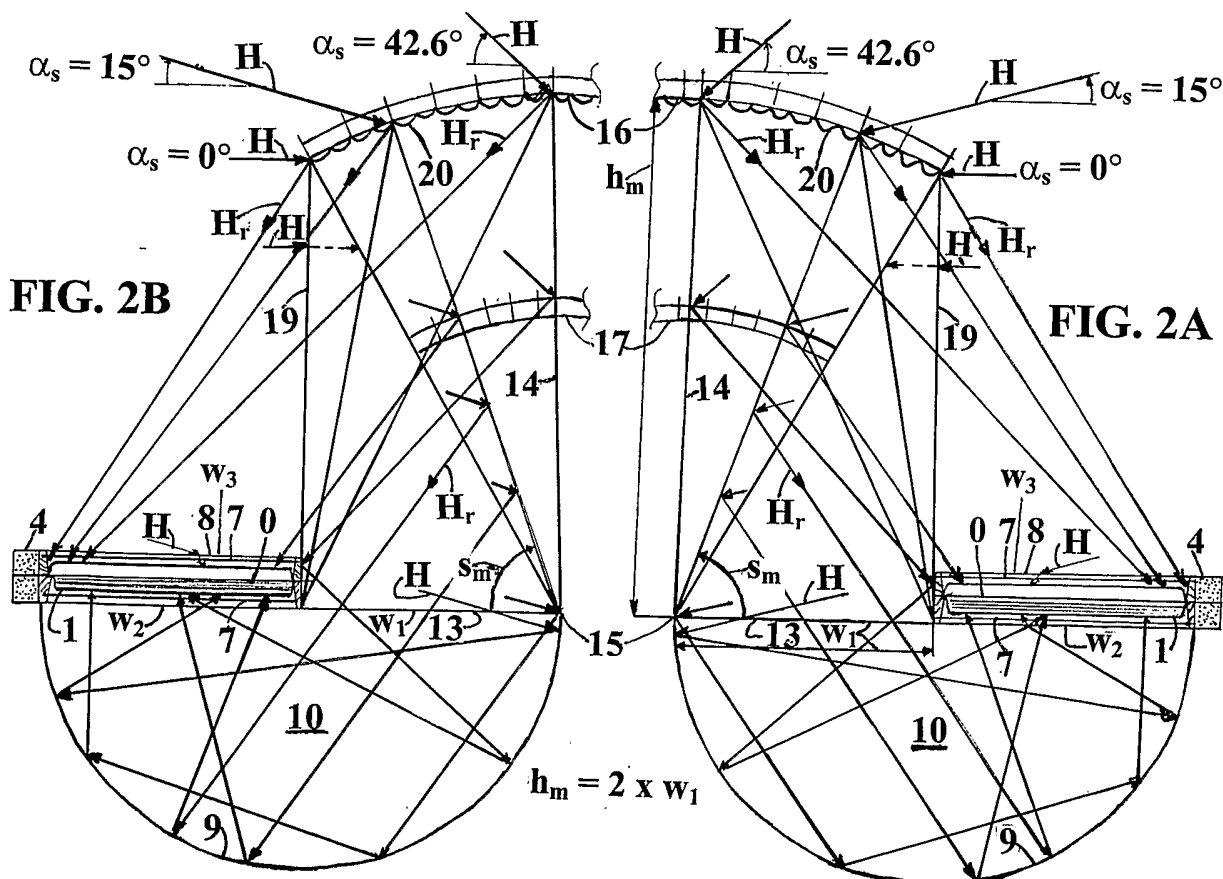
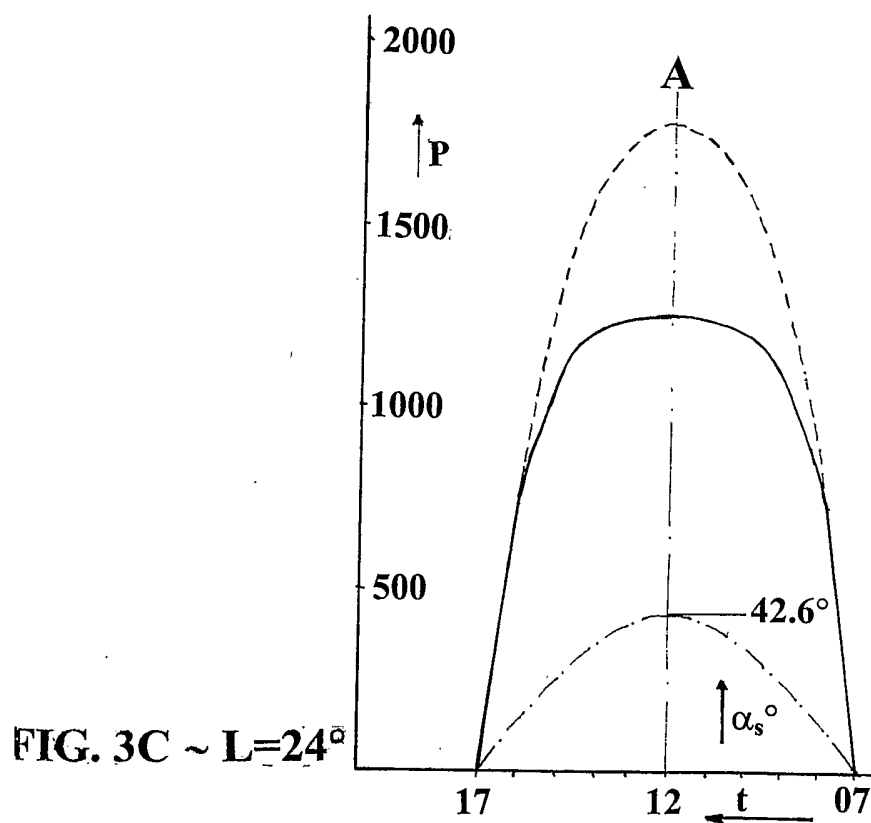
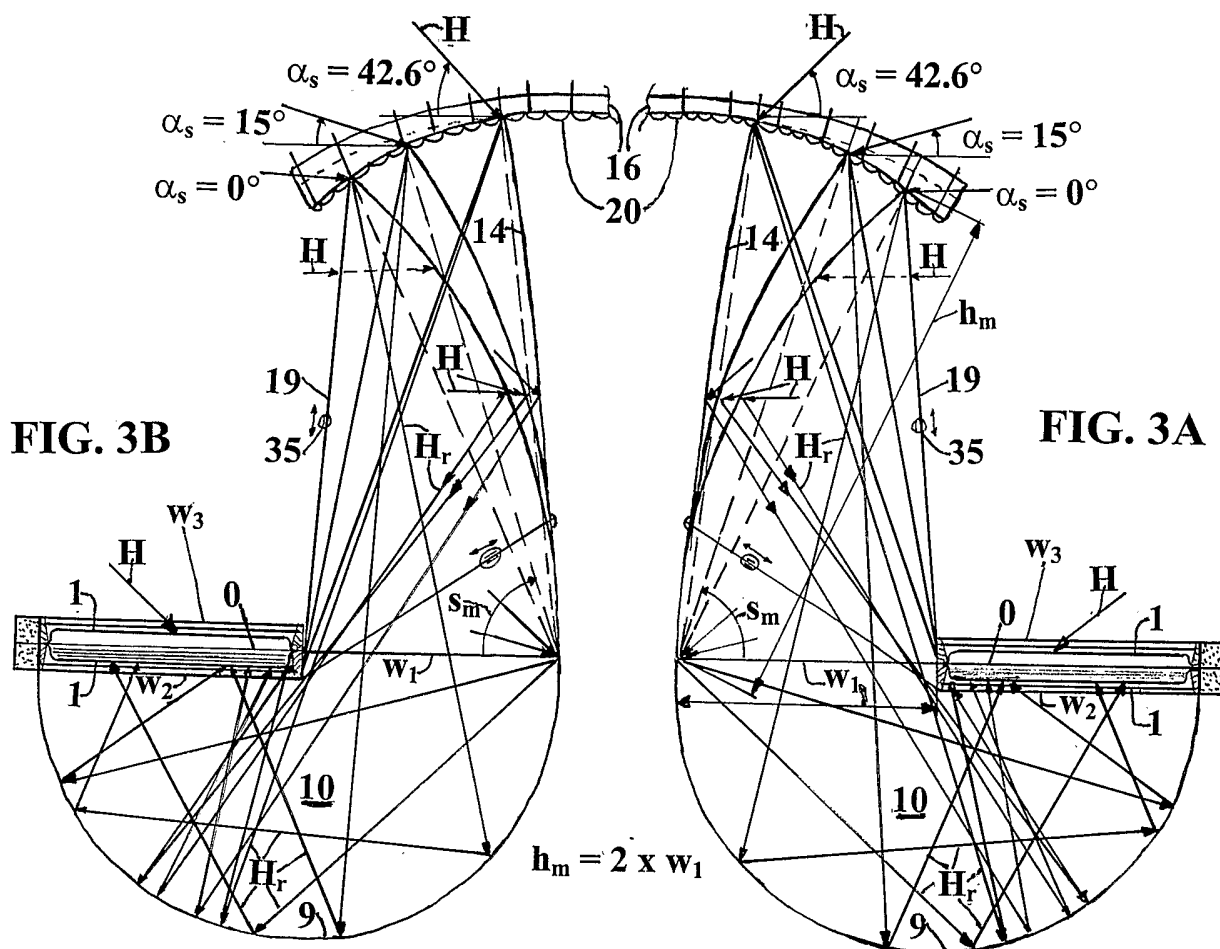


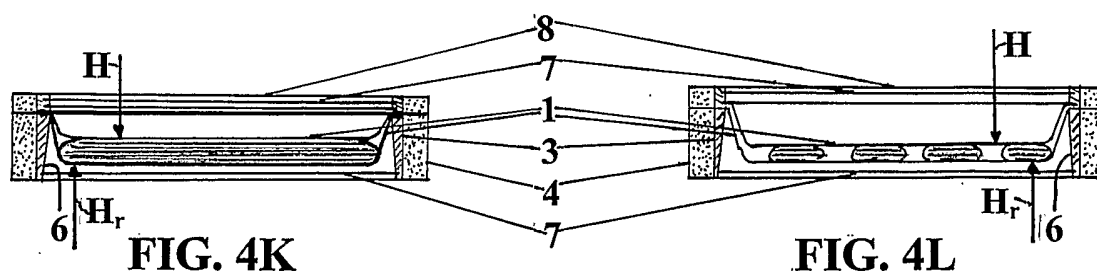
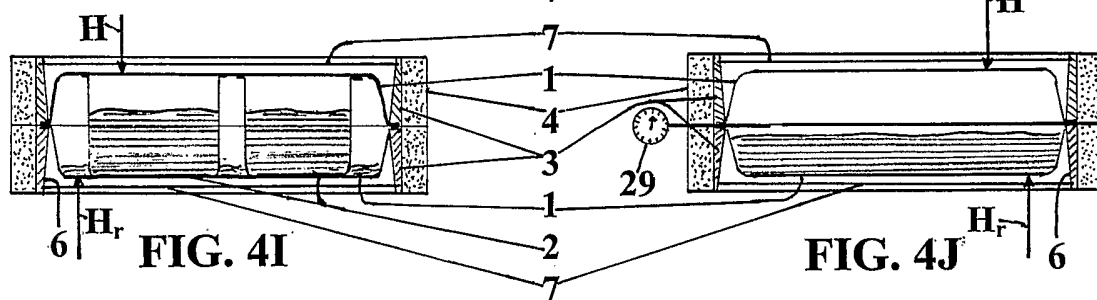
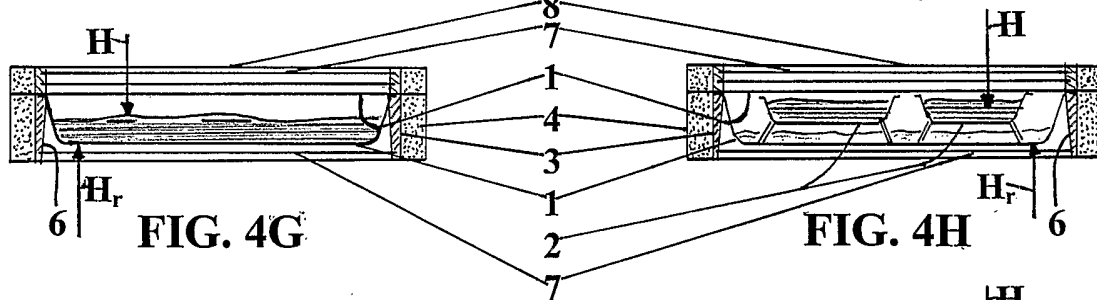
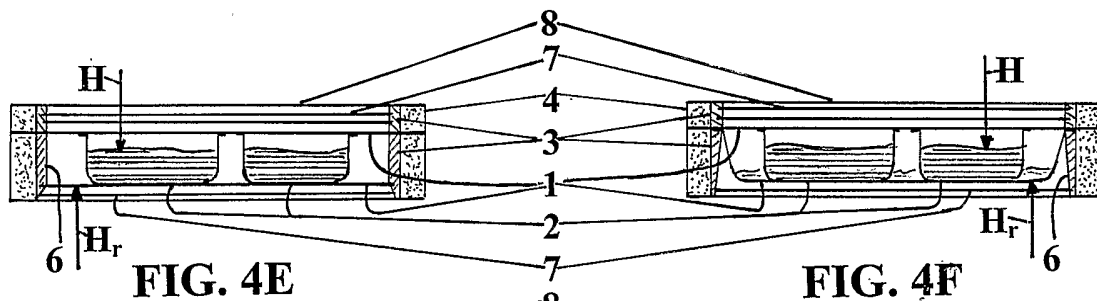
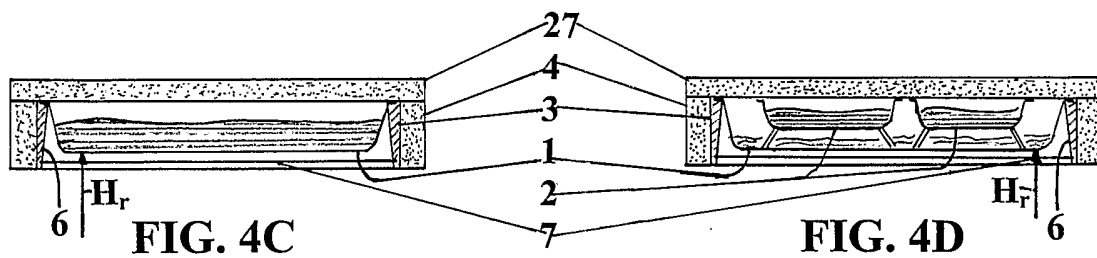
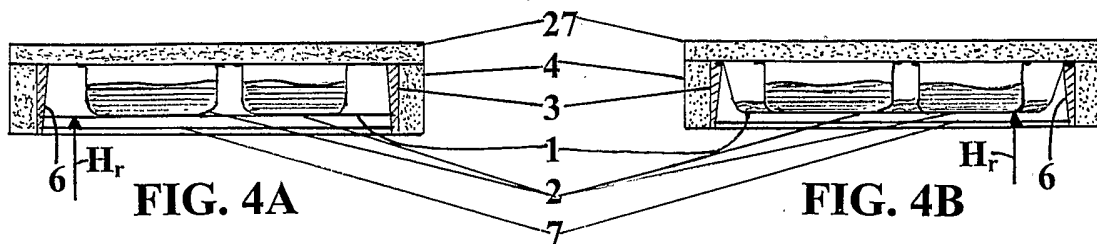
FIG. 2B

FIG. 2A

2/25



3/25



4/25

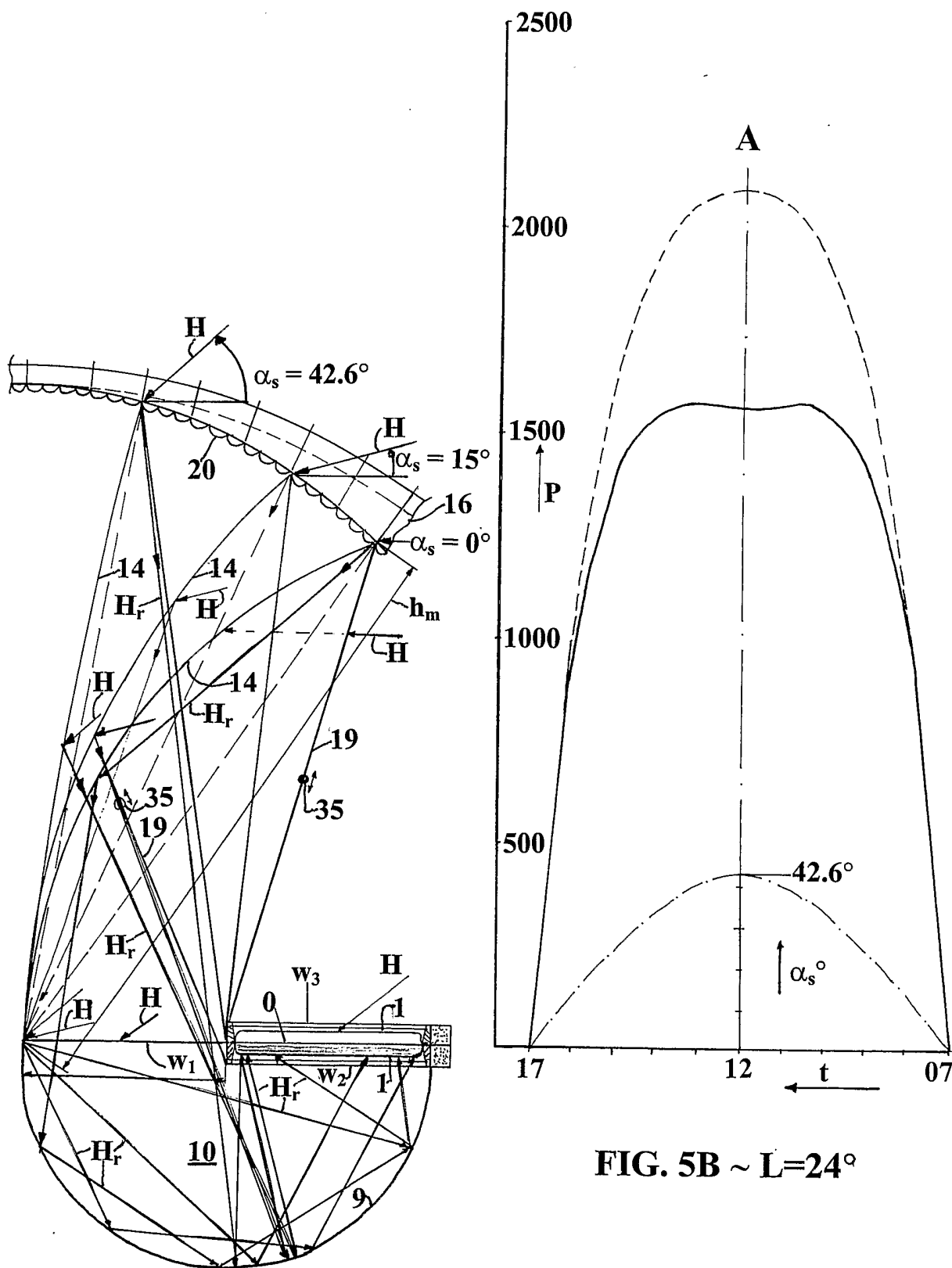


FIG. 5A : $h_m = 3 \times w_1$

FIG. 5B ~ $L=24^\circ$

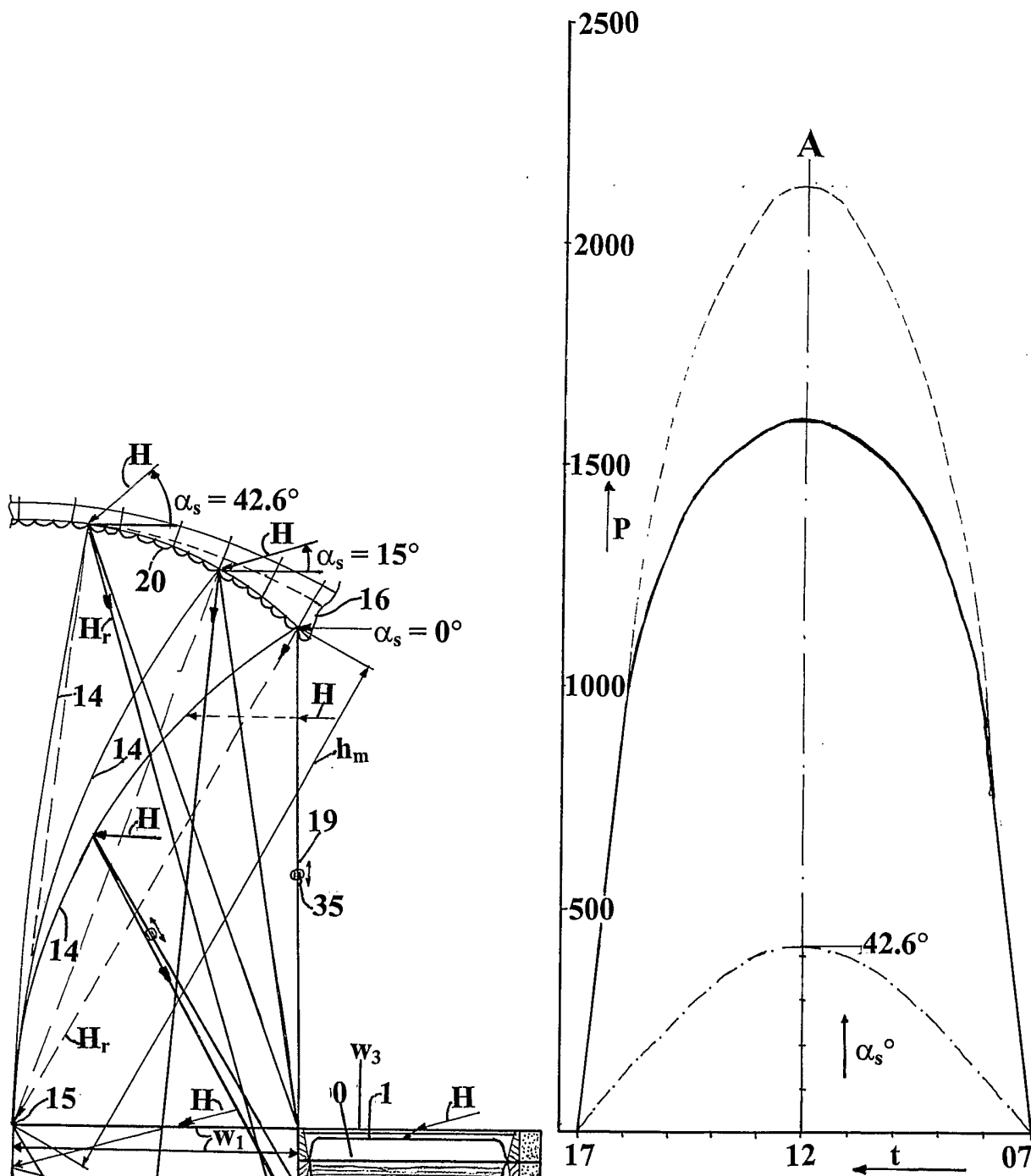


FIG. 6B ~ L=24°

FIG. 6A $h_m = 2 \times w_1$

6/25

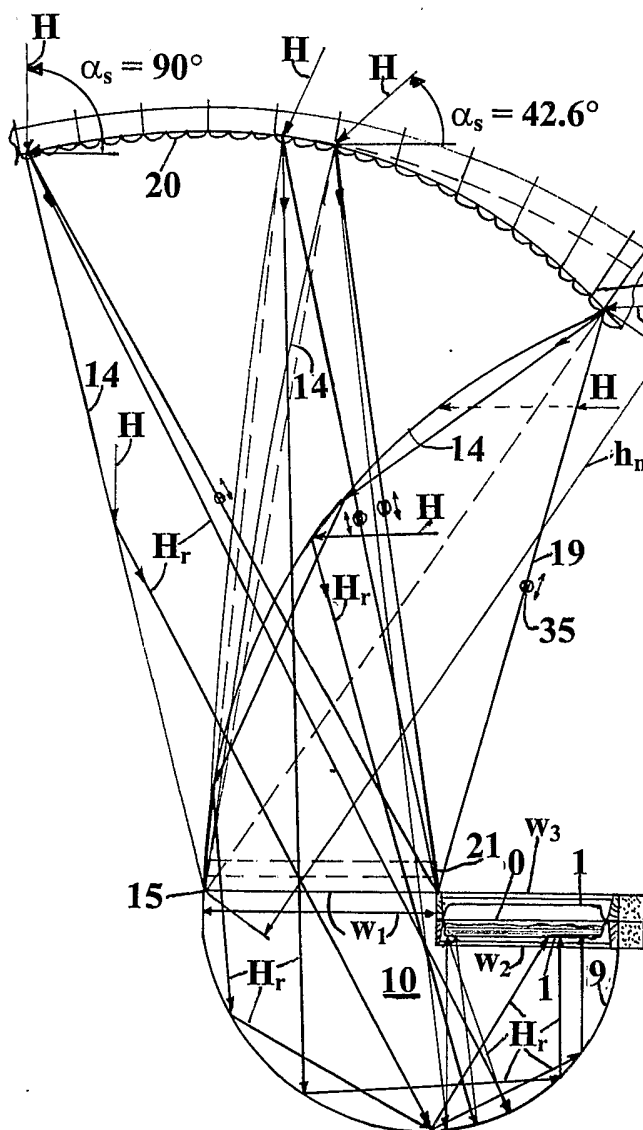


FIG. 7A $h_m = 3 \times w_1$

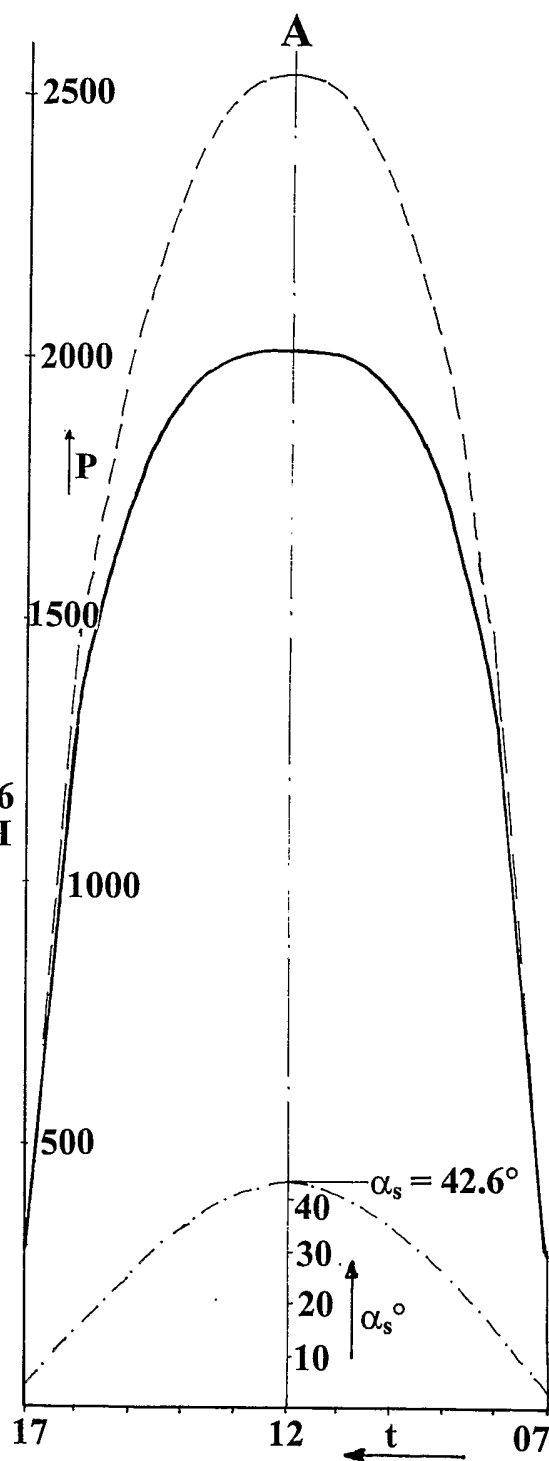


FIG. 7B ~ L=24°

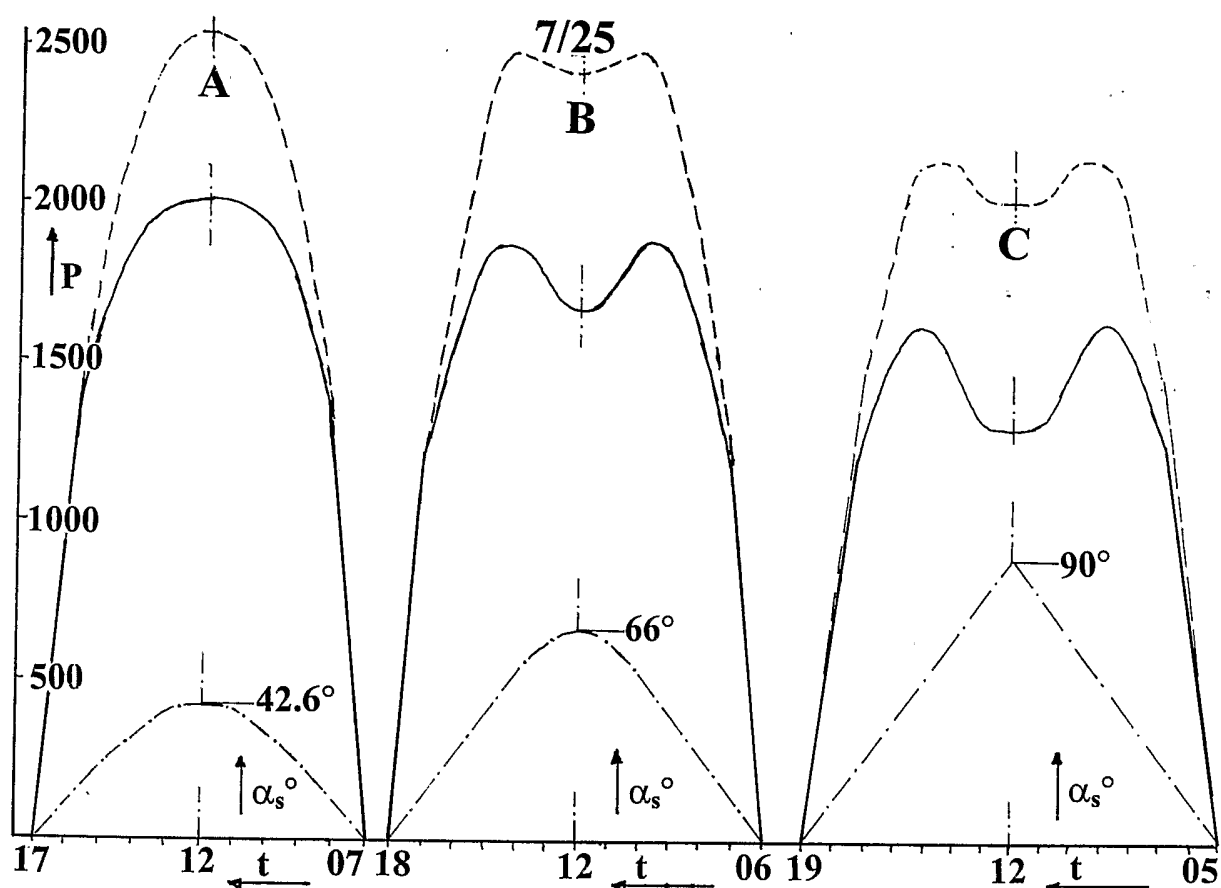


FIG. 7C ~ L=24°

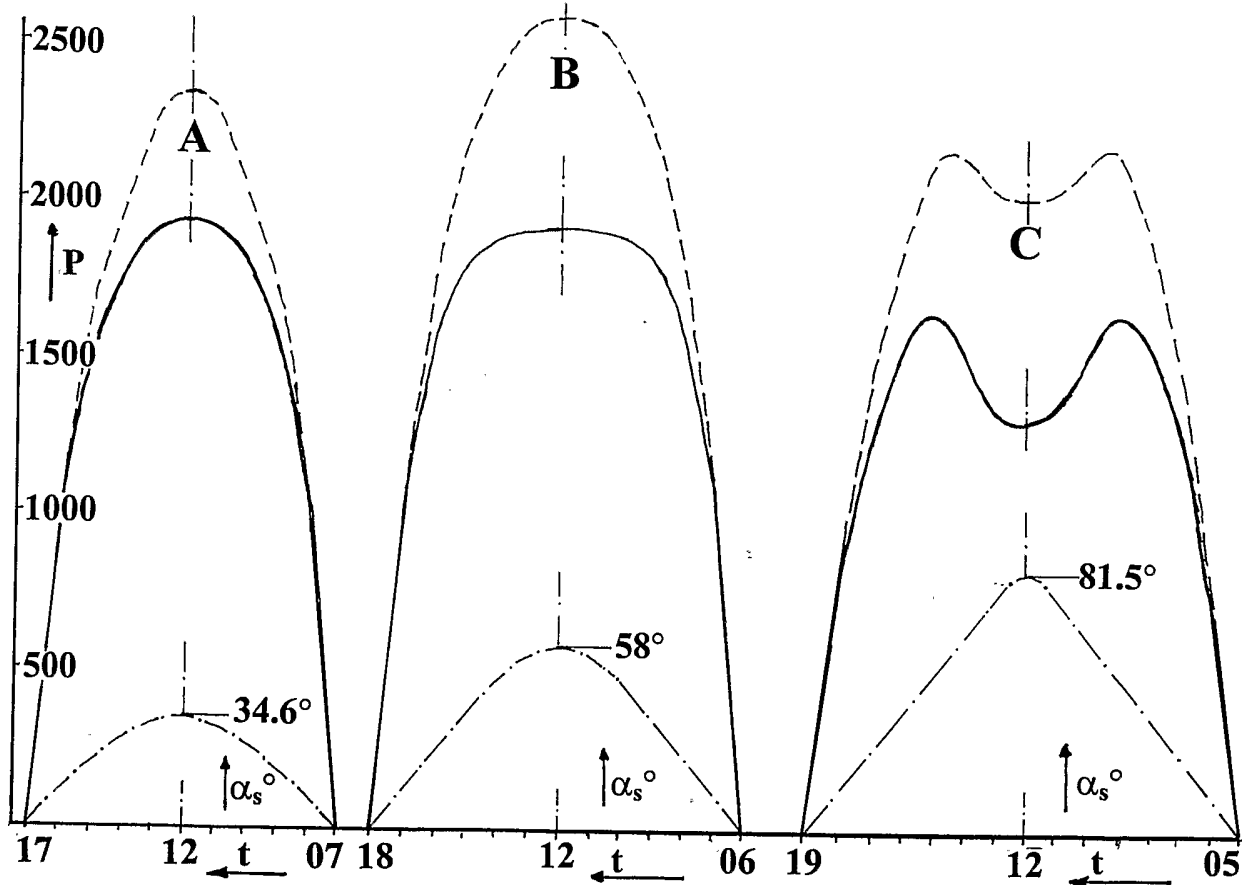
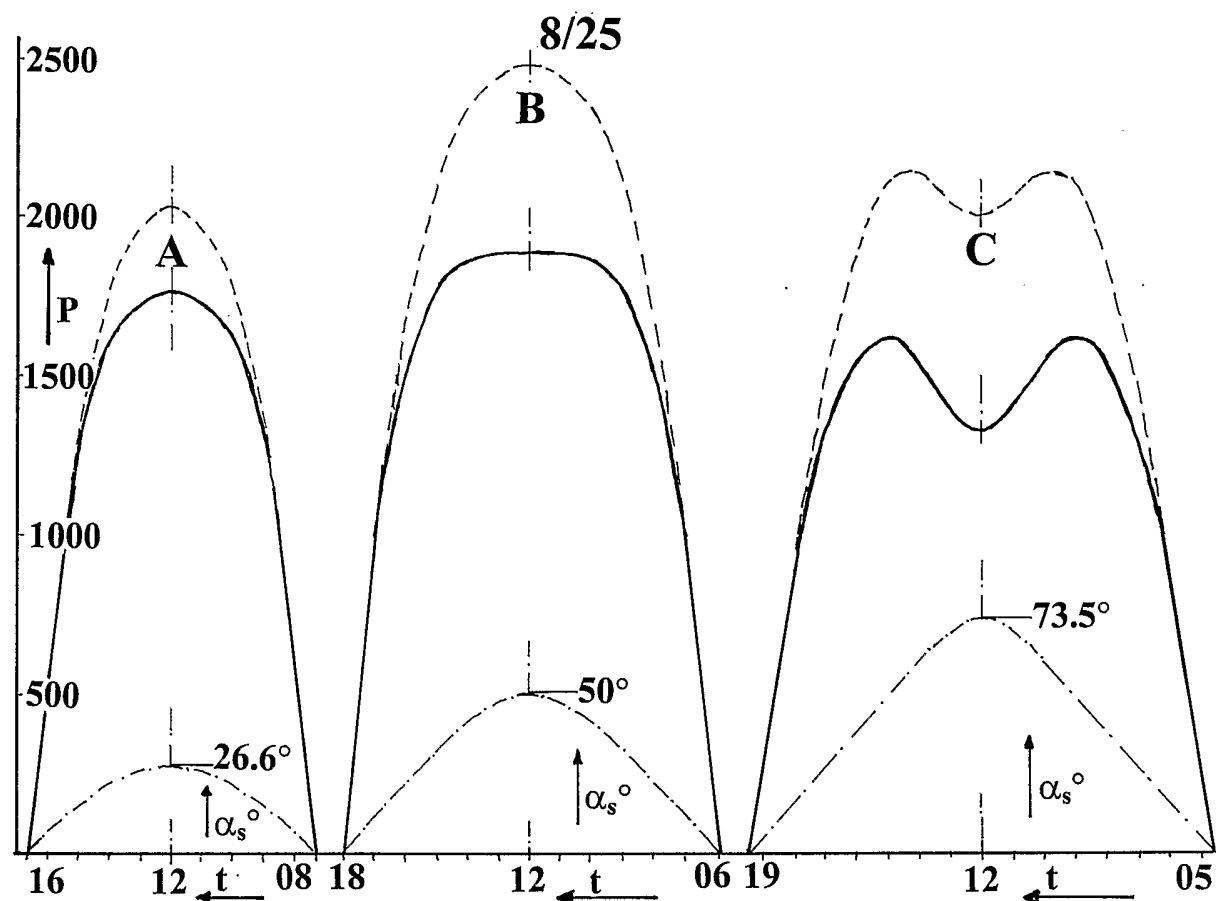
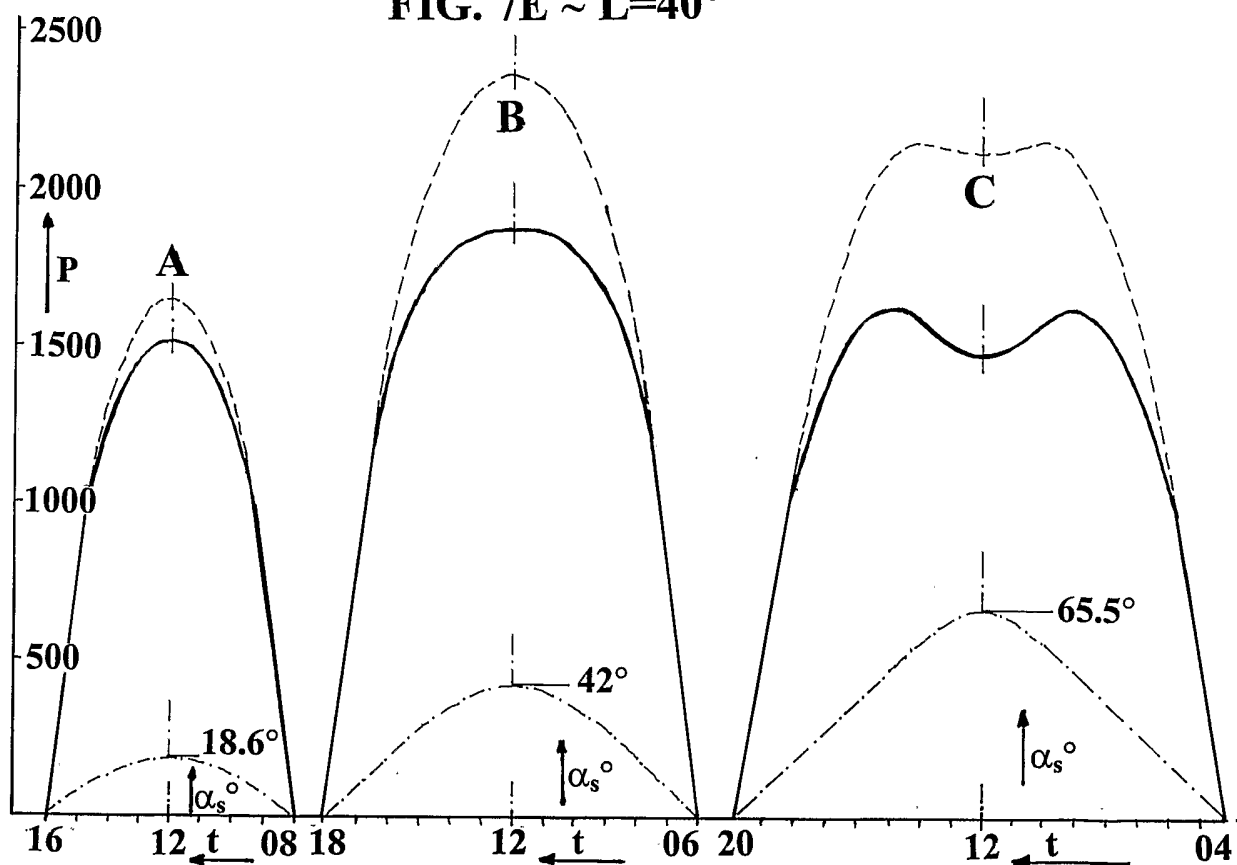
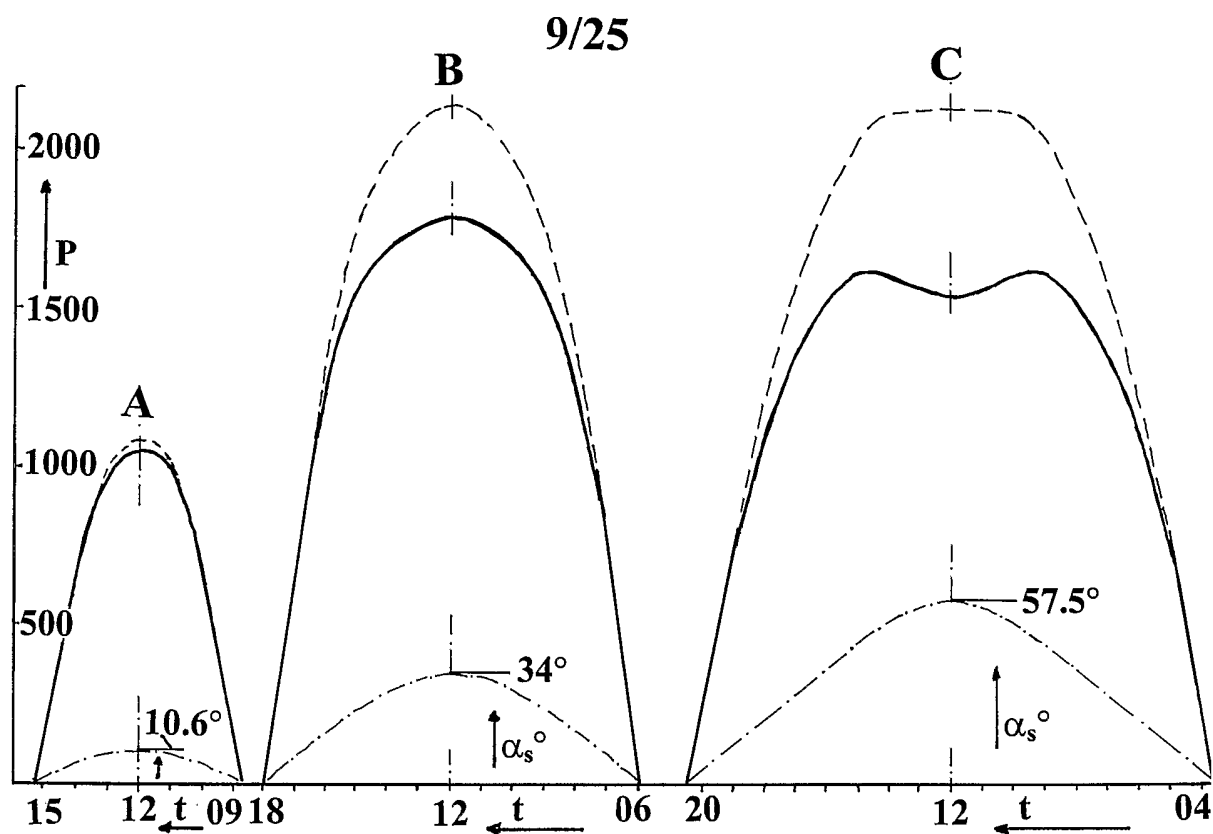
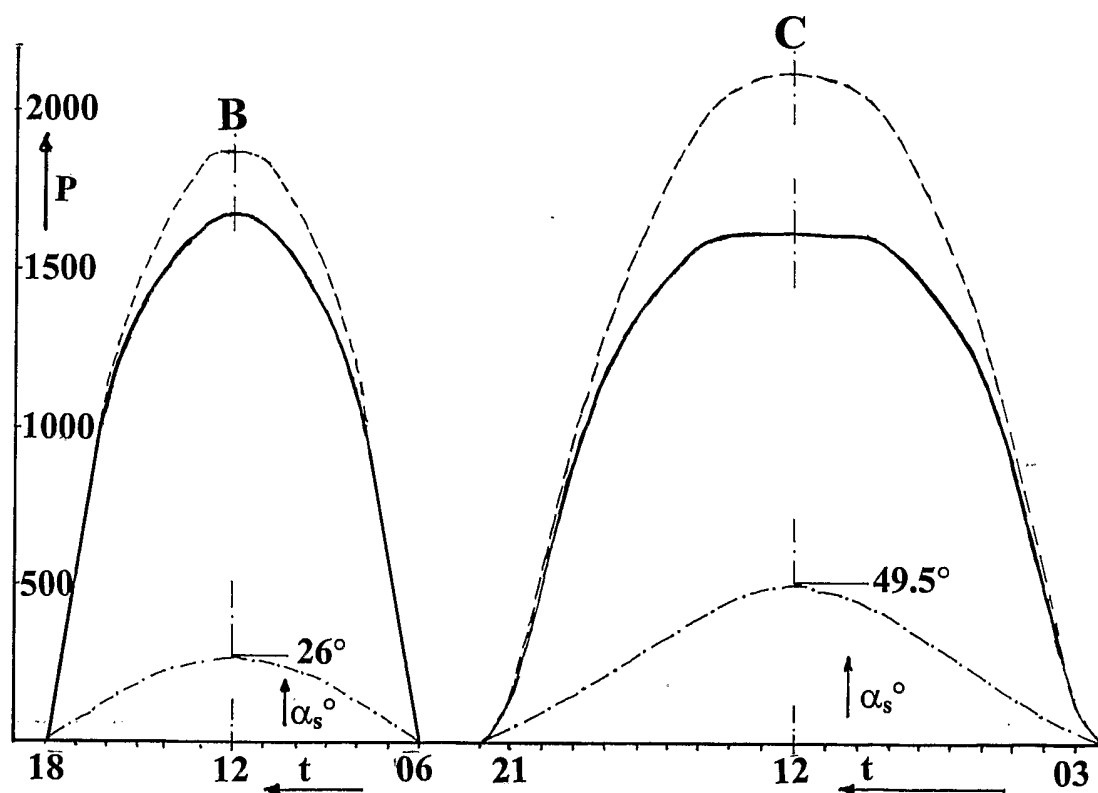


FIG. 7D ~ L=32°

FIG. 7E ~ $L=40^\circ$ FIG. 7F ~ $L=48^\circ$

**FIG. 7G ~ $L=56^\circ$** **FIG. 7H ~ $L=64^\circ$**

10/25

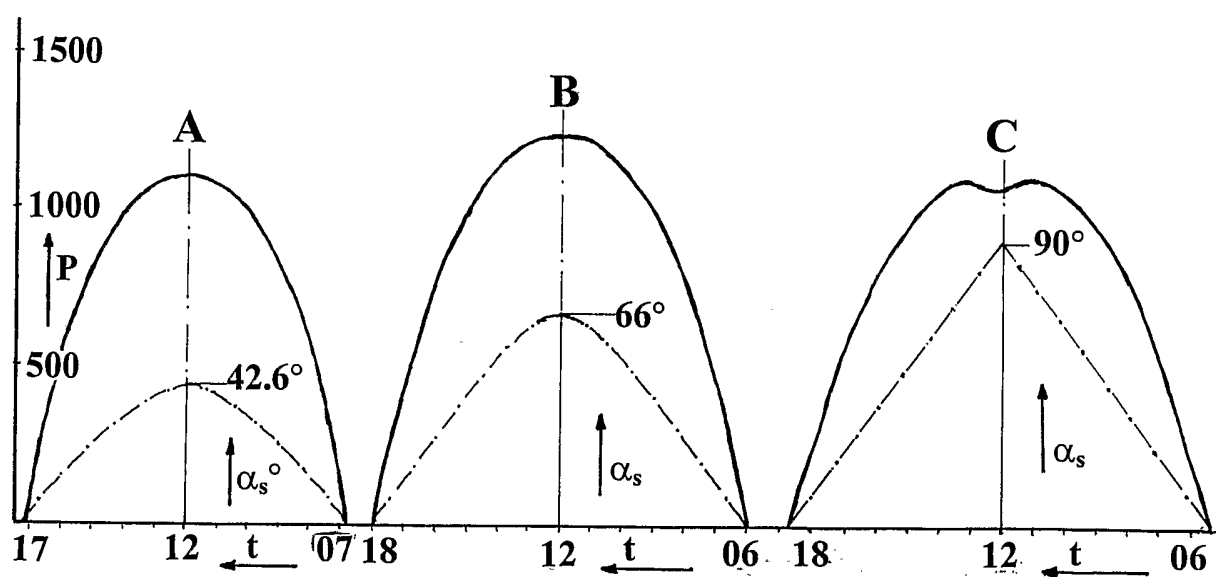
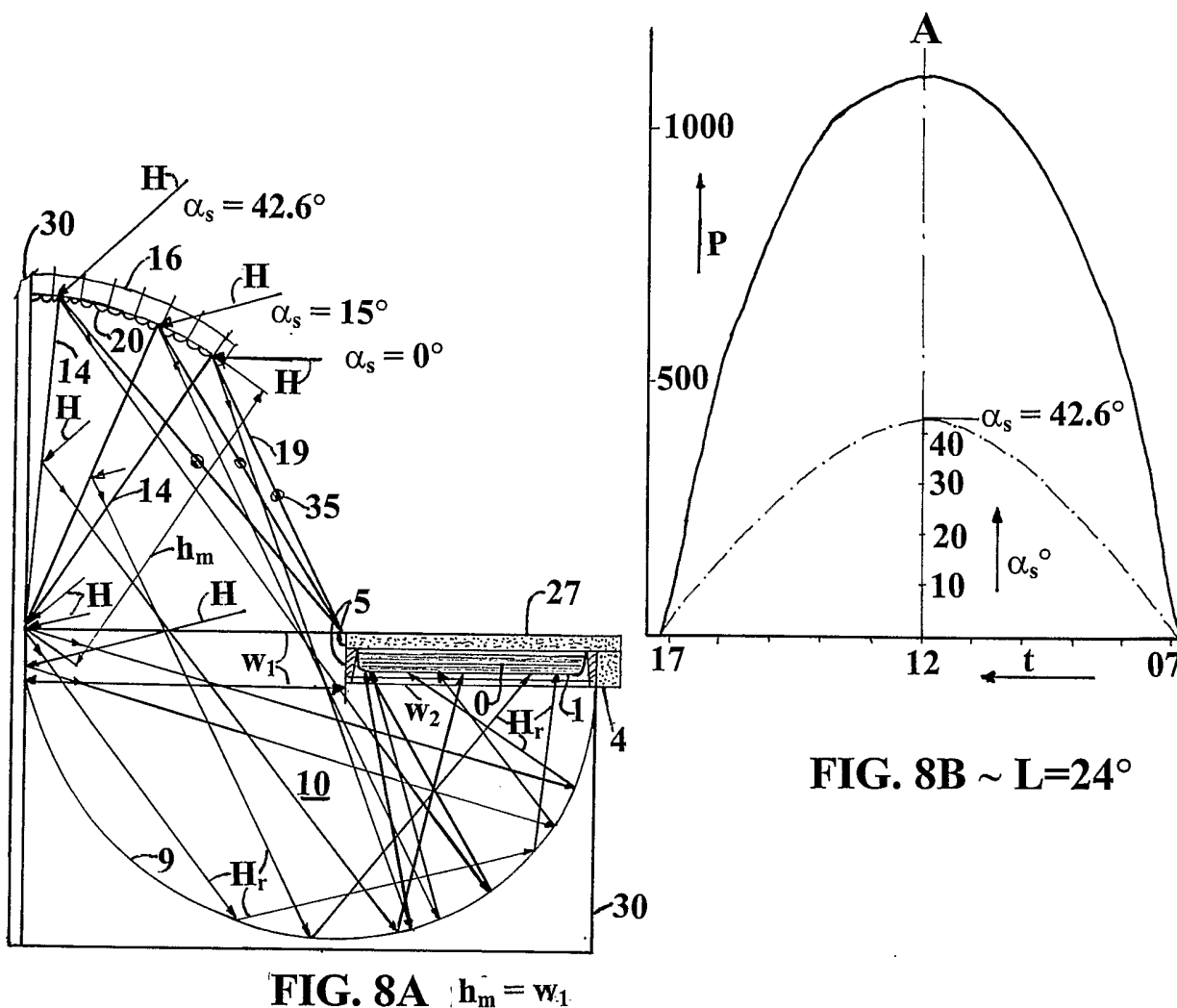


FIG. 8C ~ L=24°

FIG. 8D ~ L=24°

FIG. 8E ~ L=24°

11/25

FIG. 9A

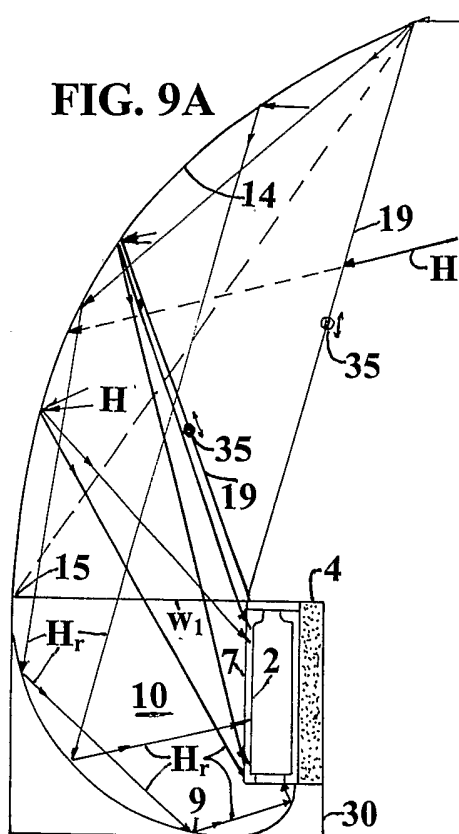


FIG. 9B

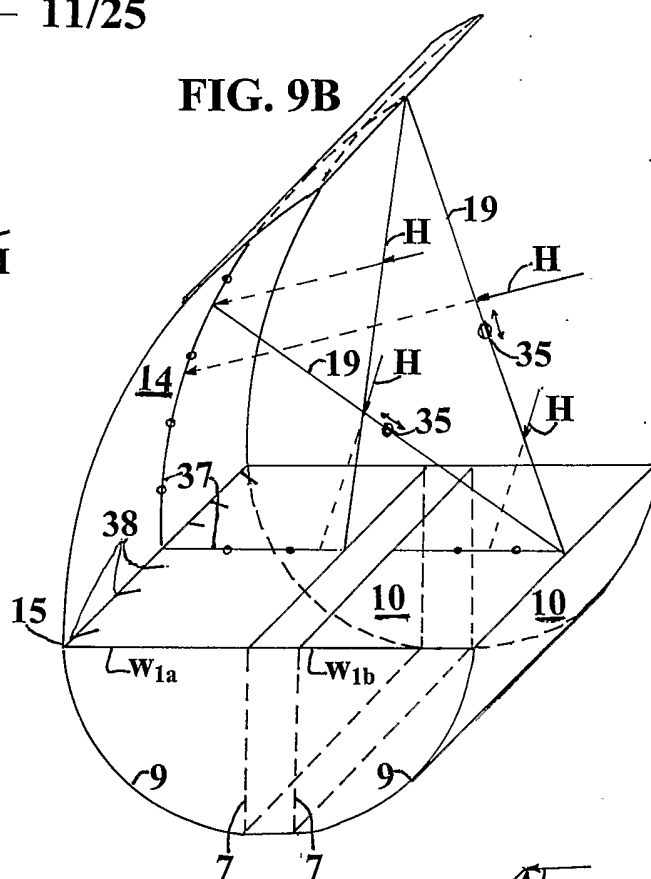


FIG. 9C

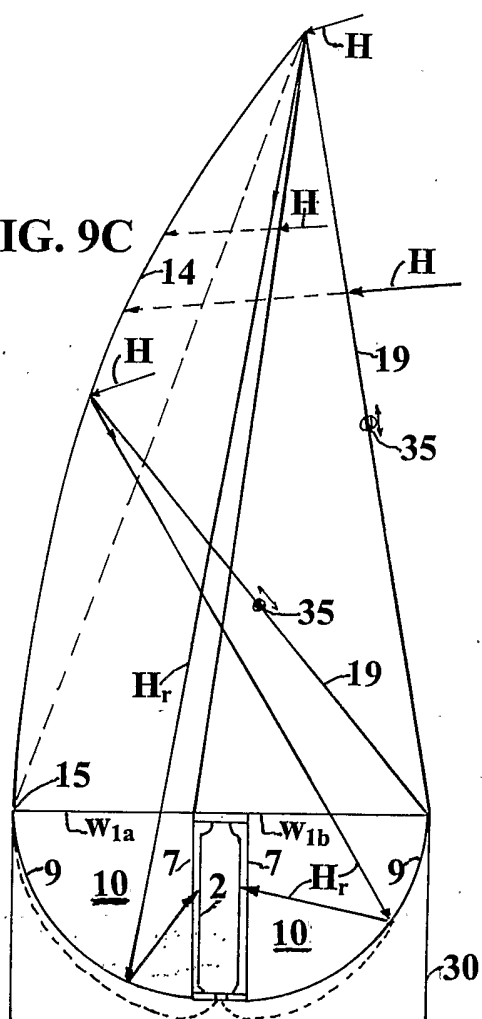
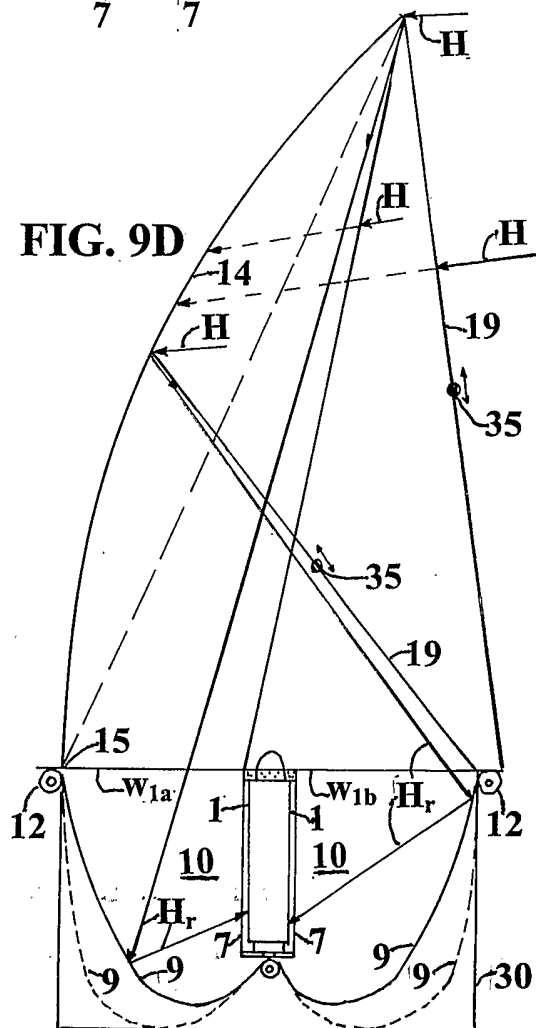


FIG. 9D



12/25

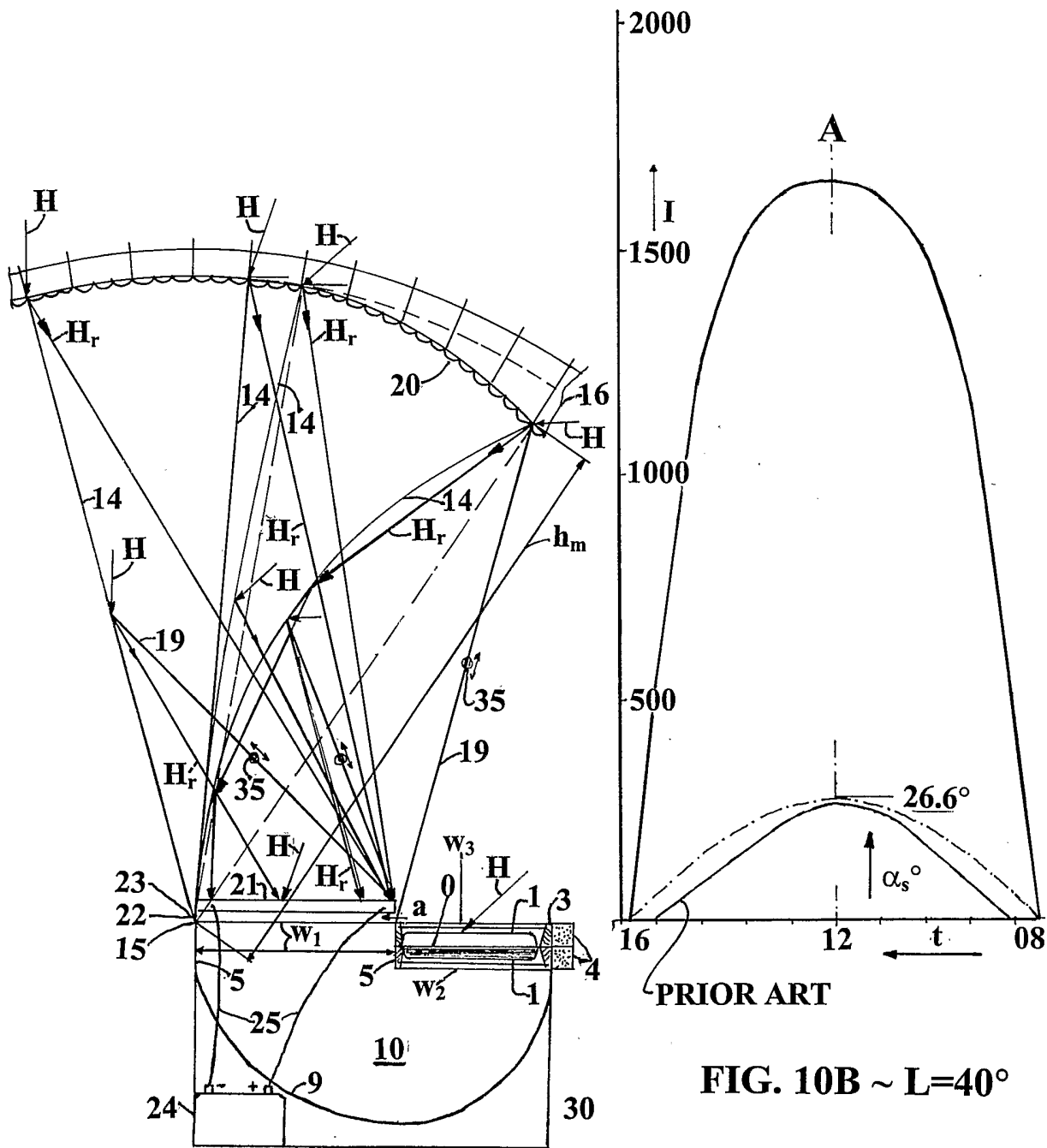
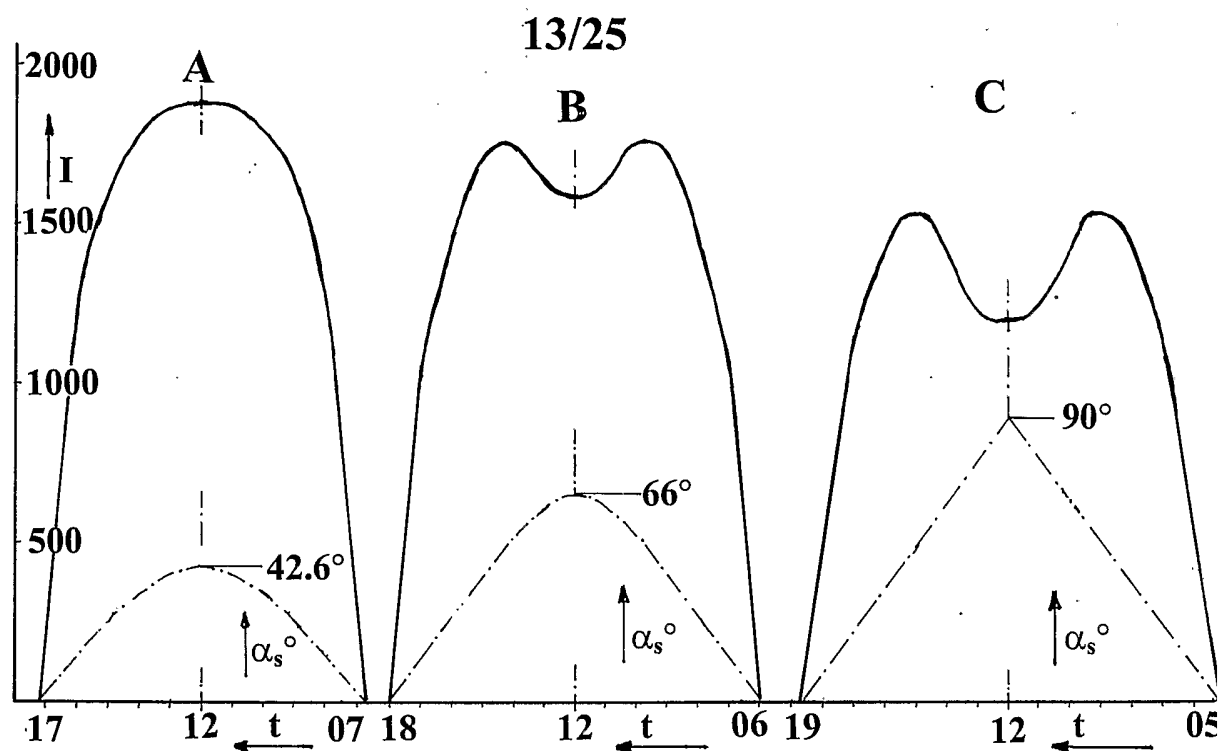
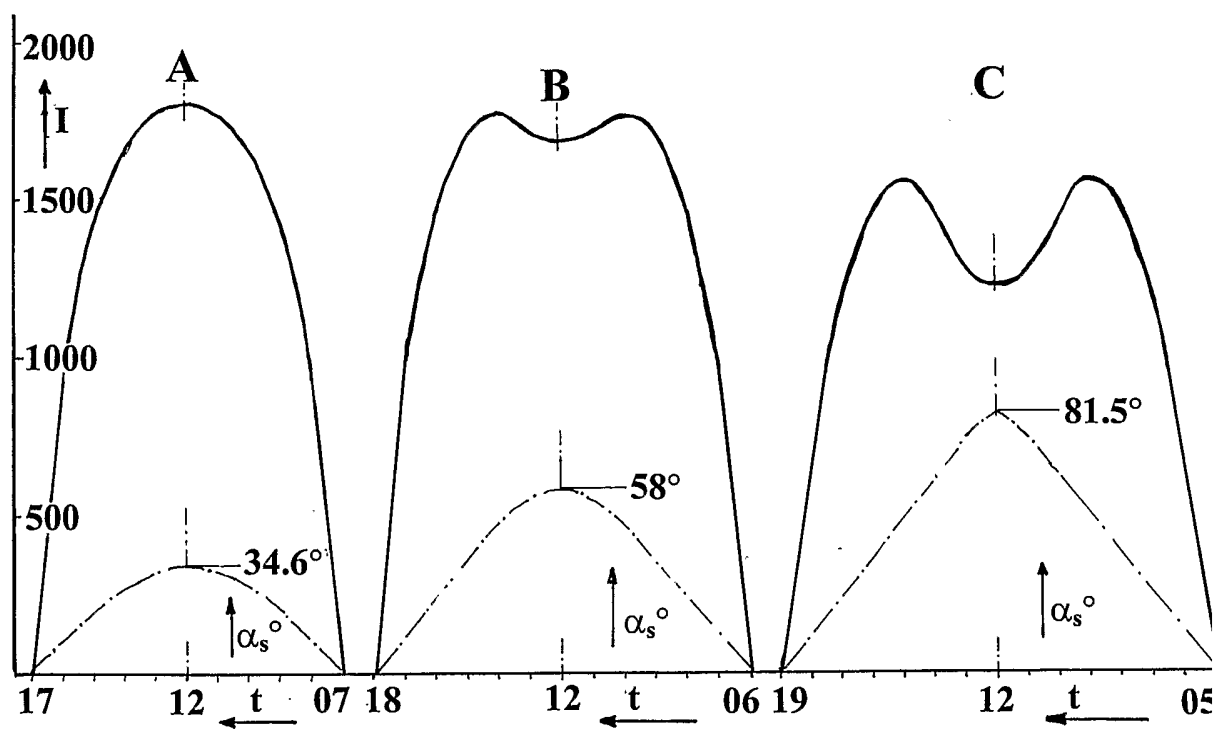


FIG. 10A $h_m = 3 \times w_1$

FIG. 10B ~ $L=40^\circ$

**FIG. 10C ~ $L=24^\circ$** **FIG. 10D ~ $L=32^\circ$**

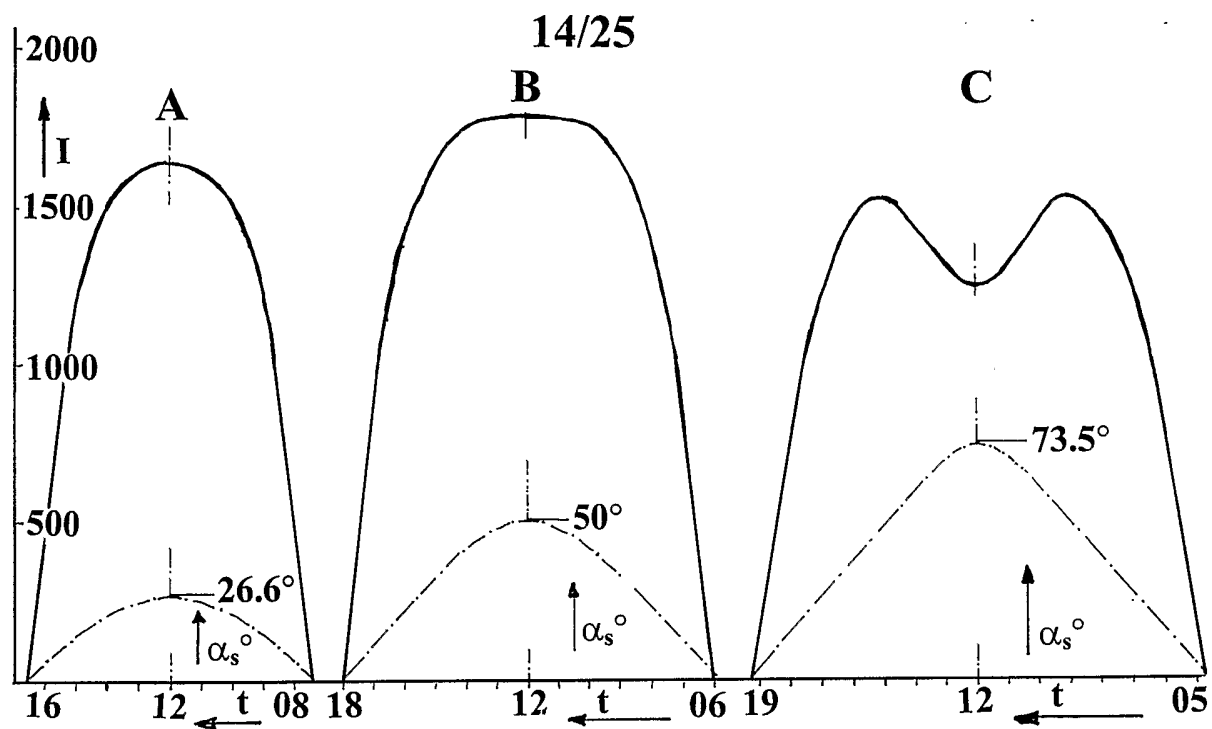


FIG. 10E ~ L=40°

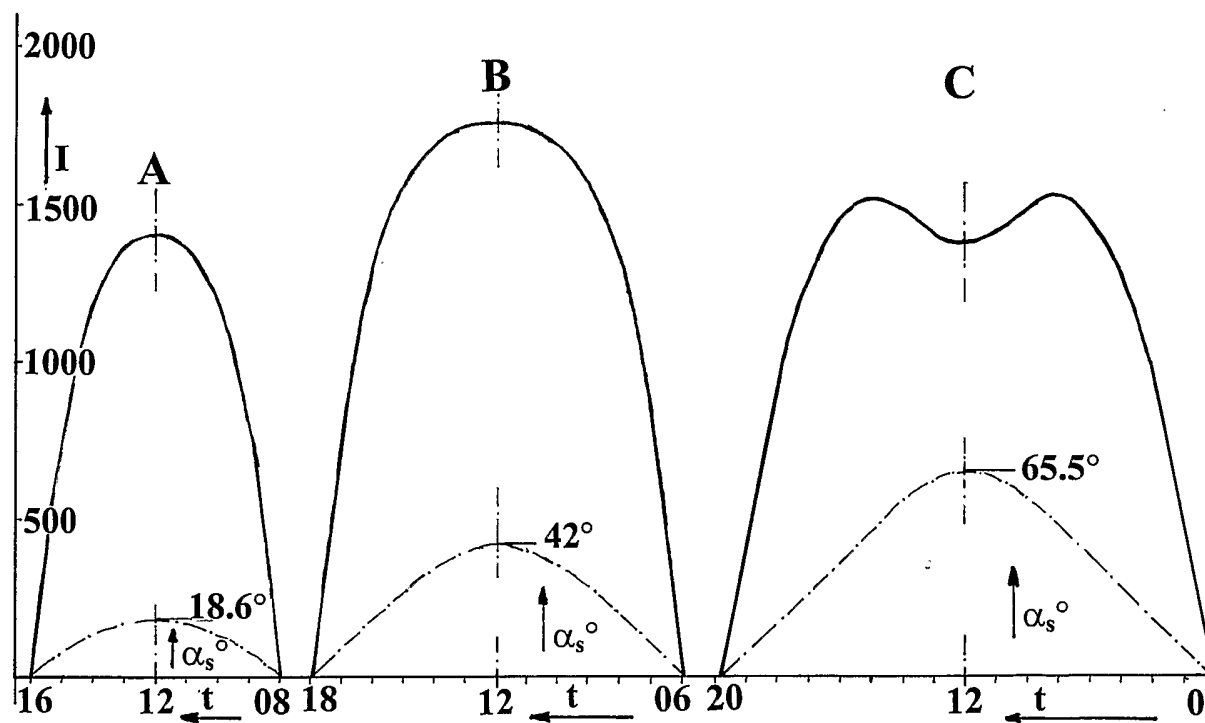


FIG. 10F ~ L=48°

15/25

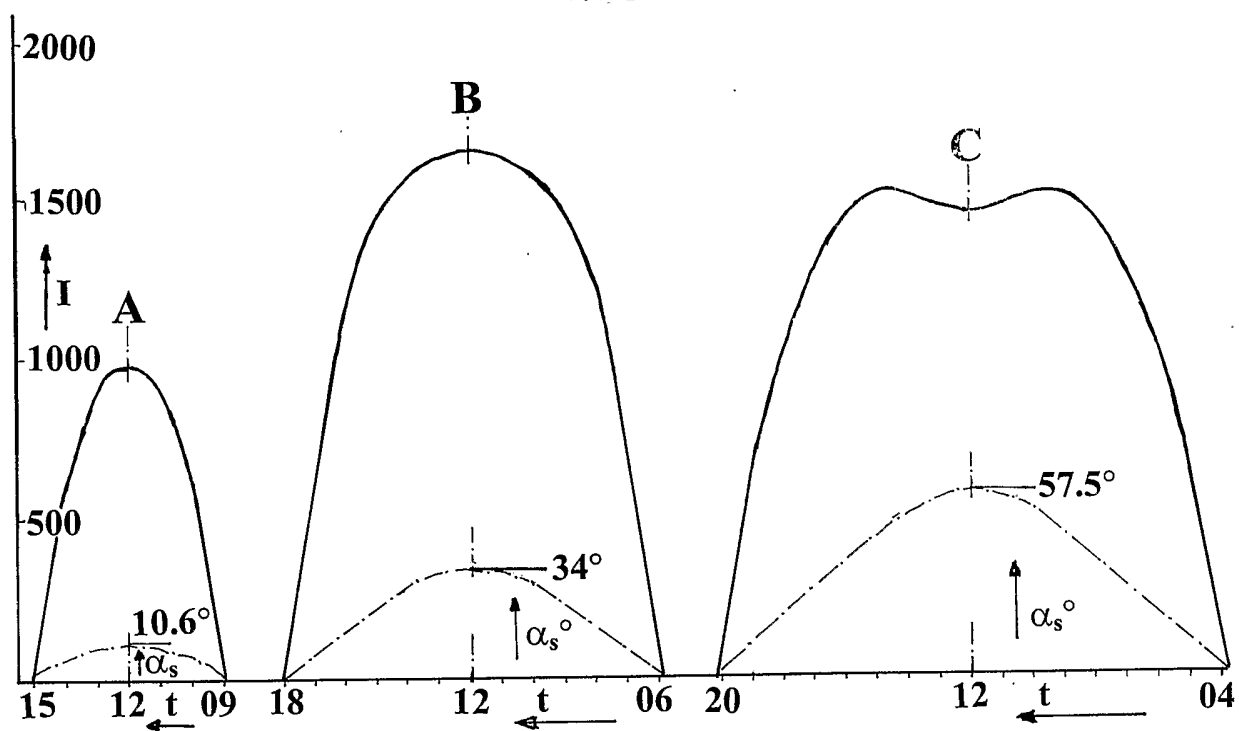


FIG. 10G ~ L=56°

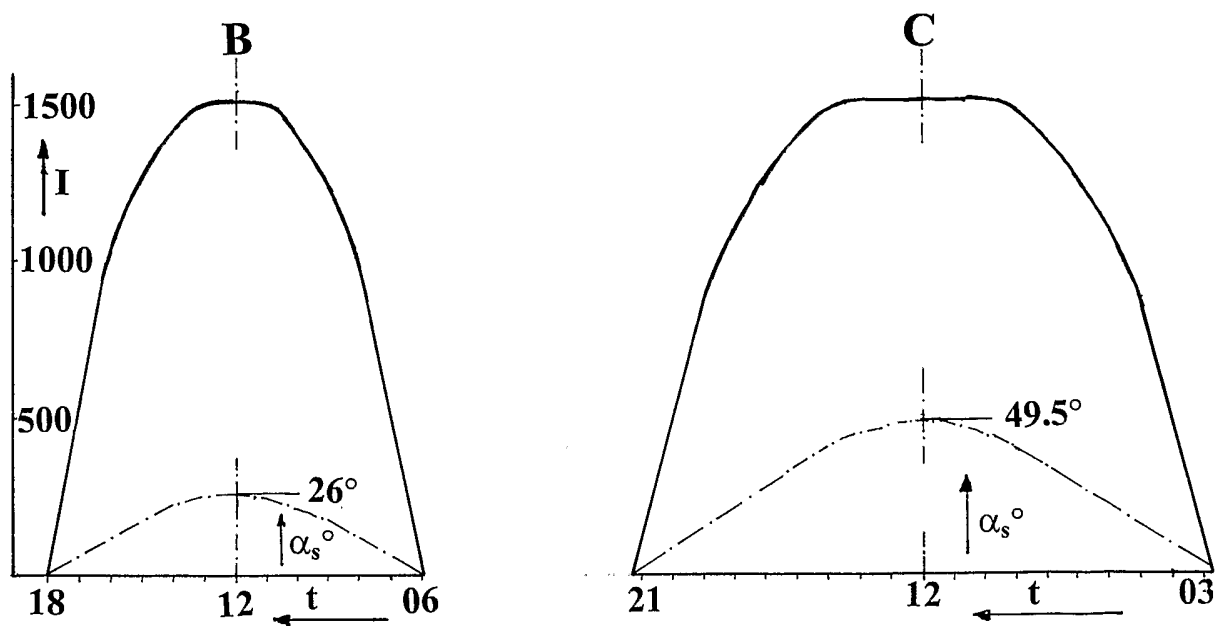
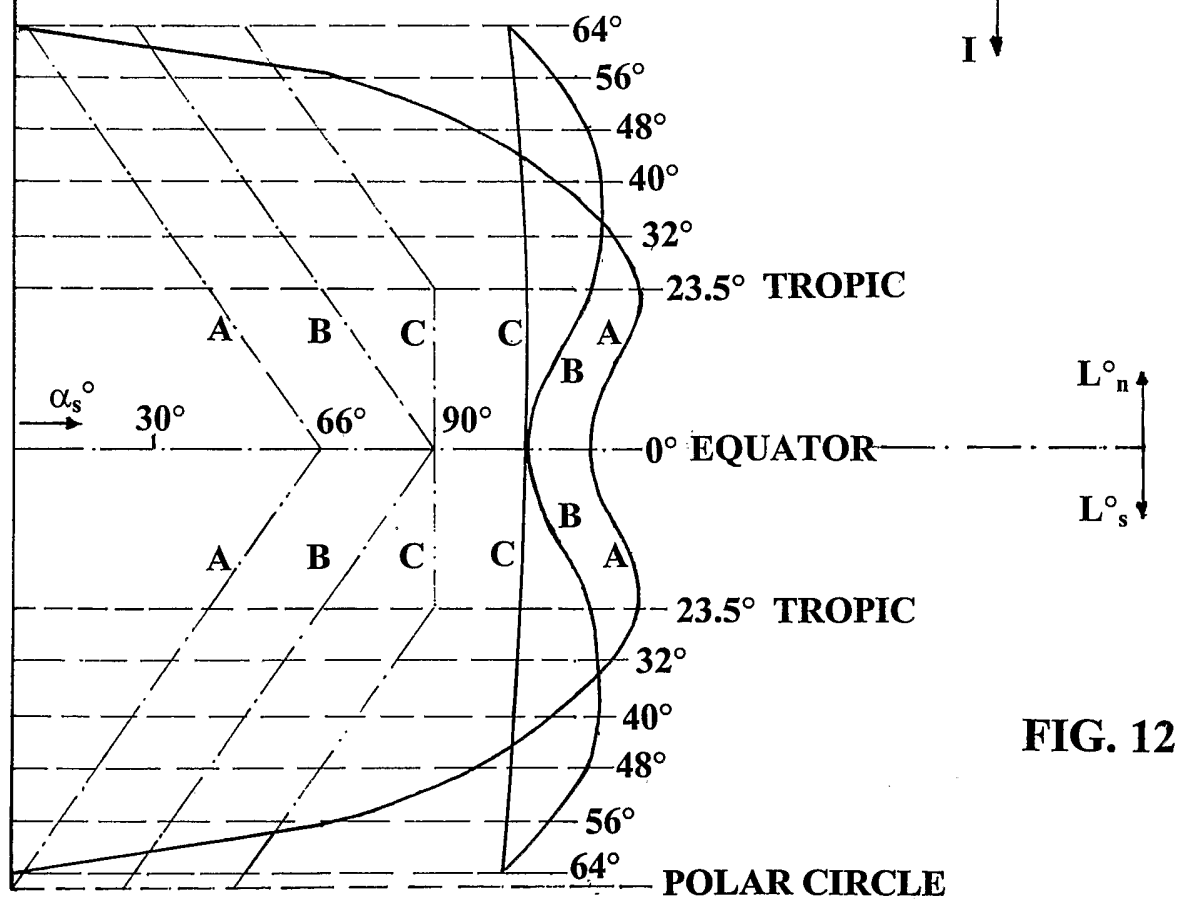
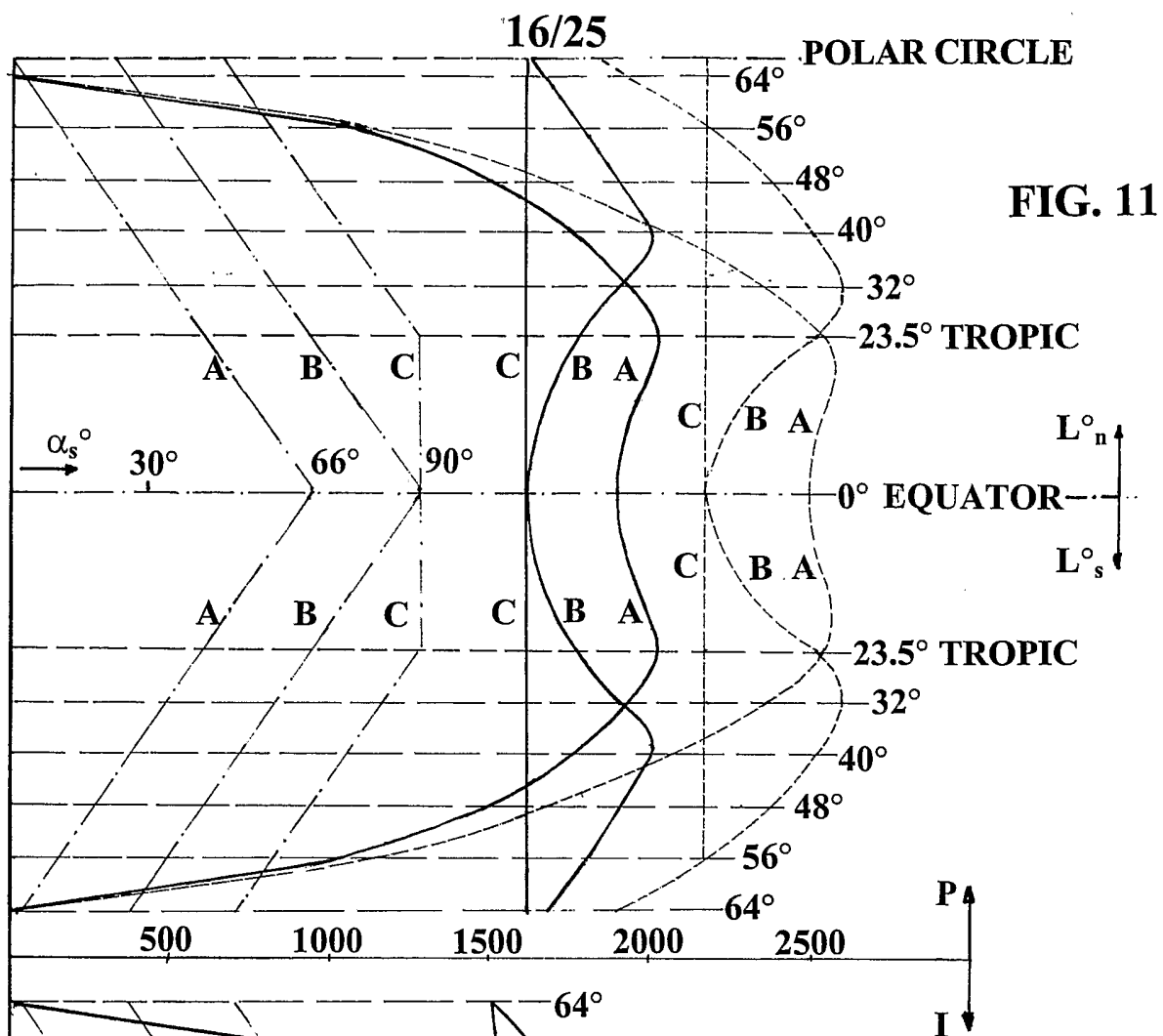


FIG. 10H ~ L=64°



17/25

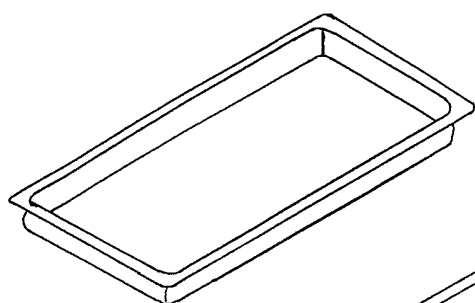


FIG. 13A

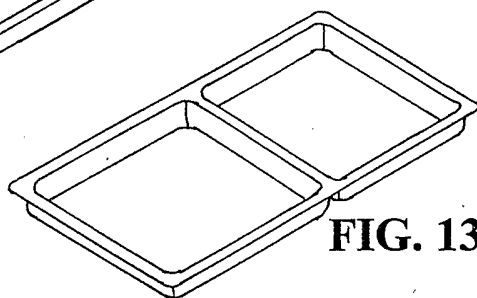


FIG. 13B

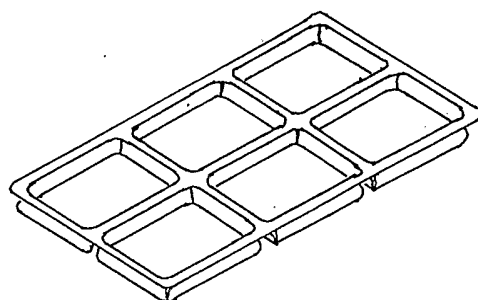


FIG. 13C

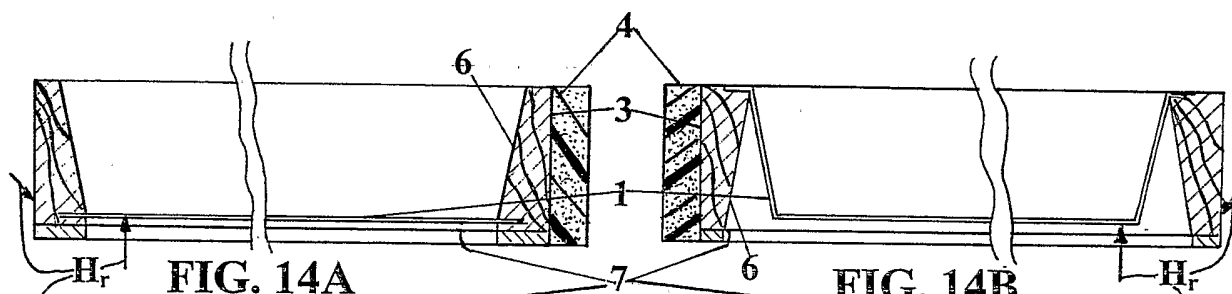


FIG. 14A

FIG. 14B

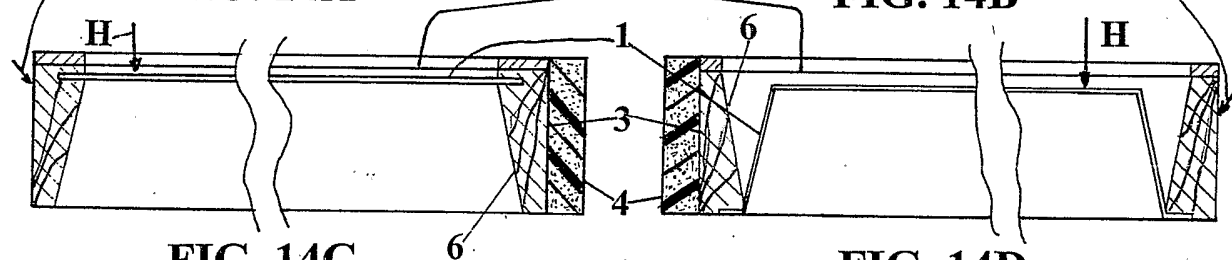


FIG. 14C

FIG. 14D

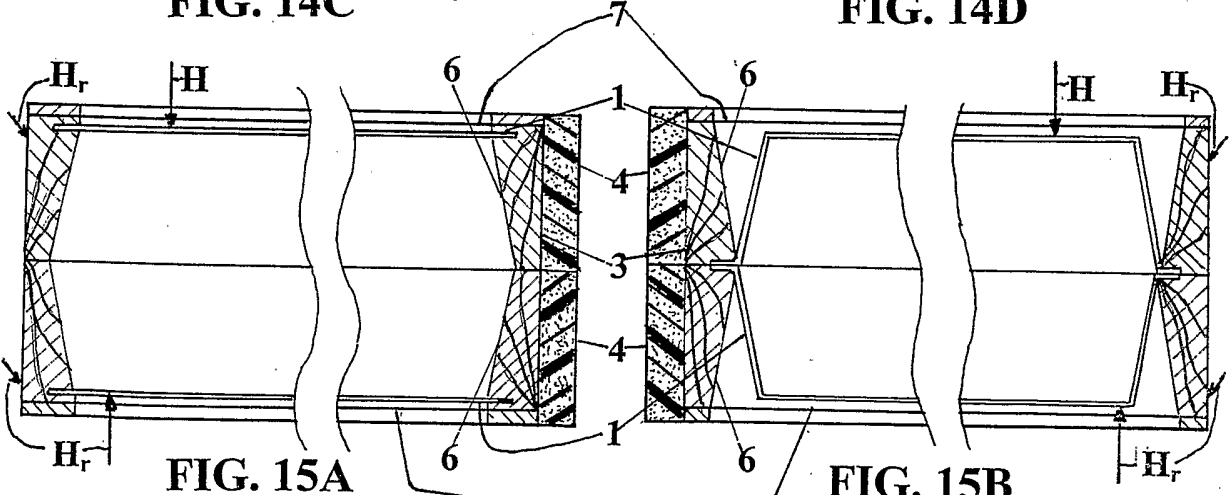


FIG. 15A

FIG. 15B

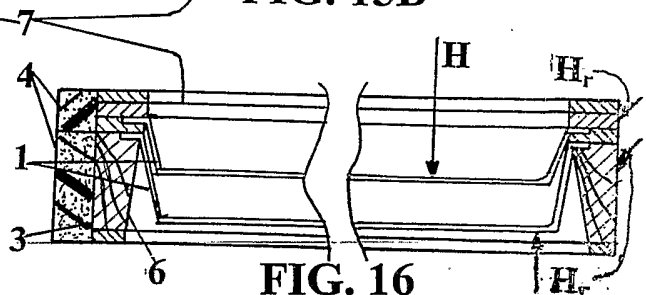


FIG. 16

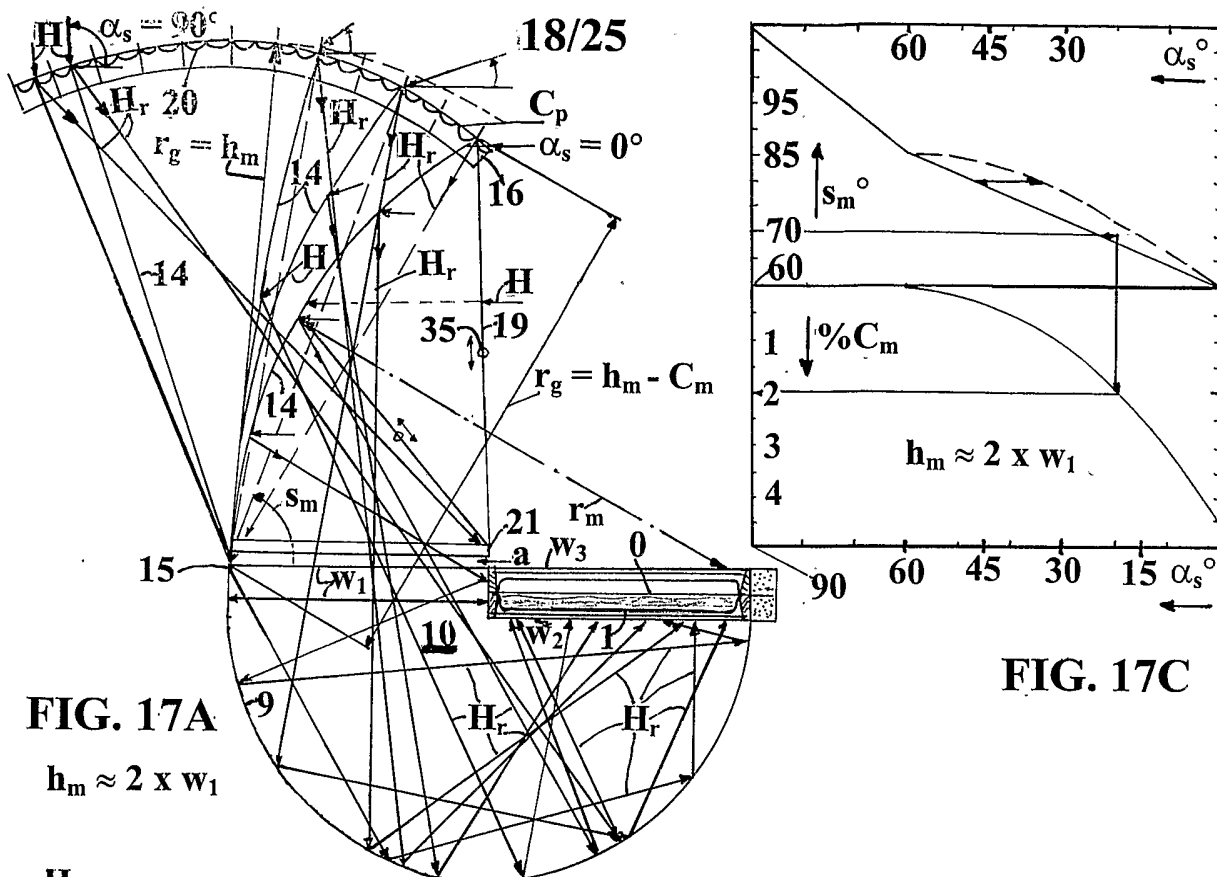


FIG. 17A

$$h_m \approx 2 \times w_1$$

FIG. 17C

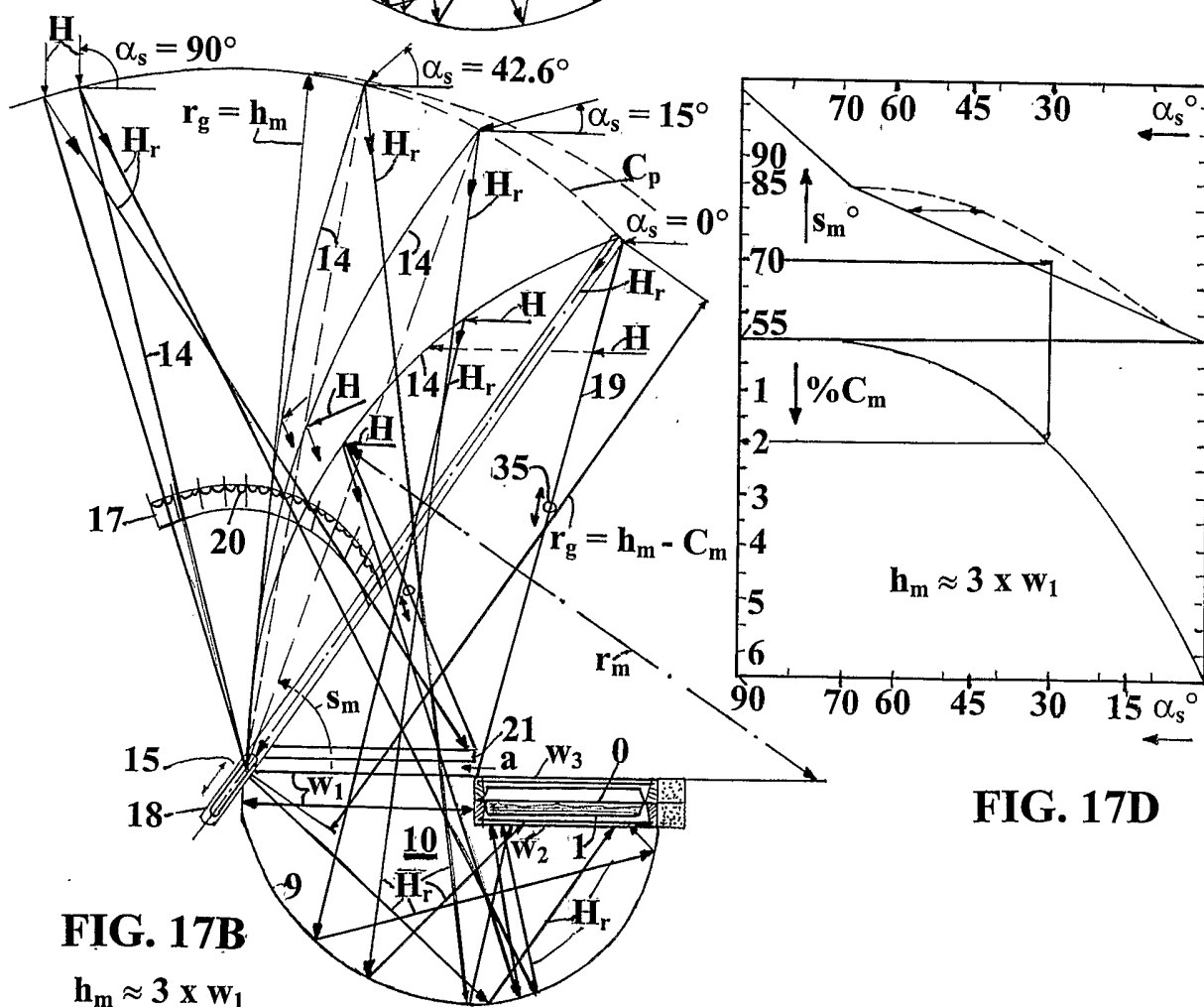


FIG. 17B

$$h_m \approx 3 \times w_1$$

FIG. 17D

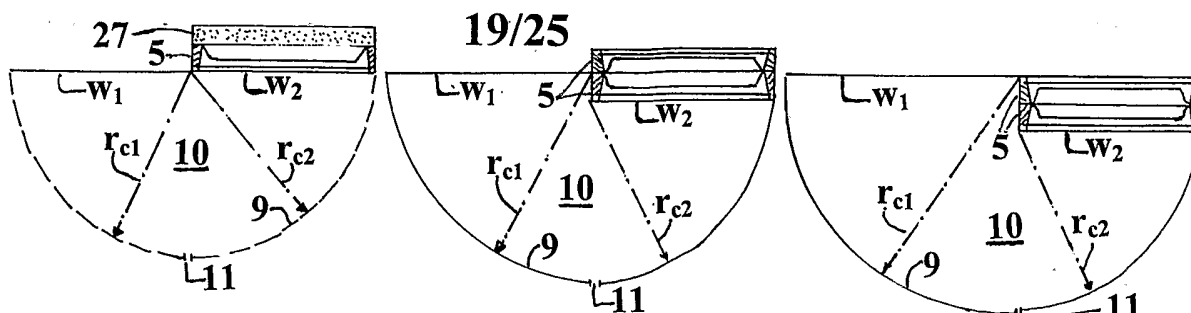


FIG. 18A, $r_{c1} = r_{c2}$

FIG. 18B, $r_{c1} > r_{c2}$

FIG. 18C, $r_{c1} \gg r_{c2}$

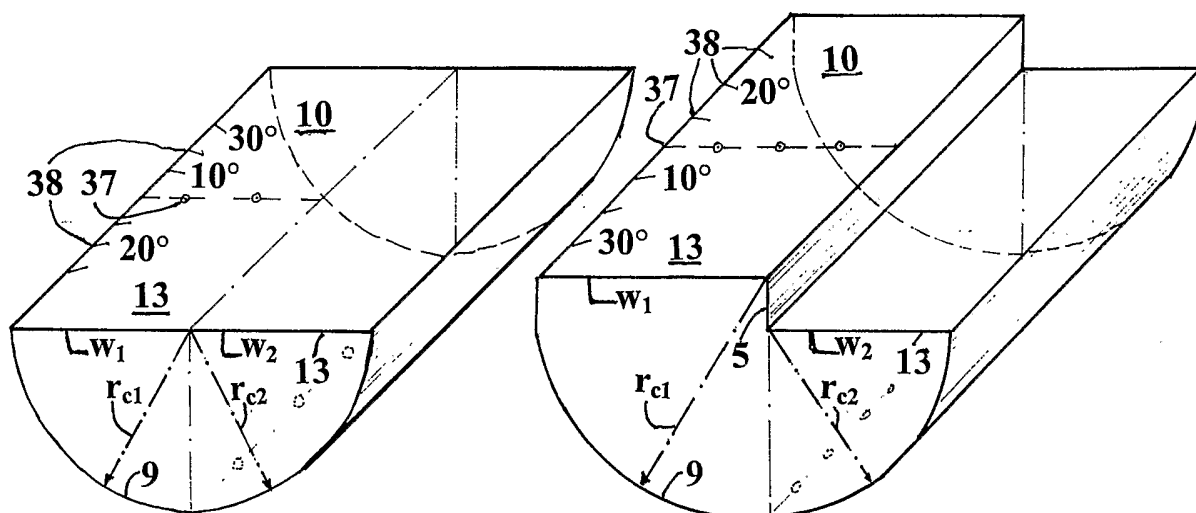


FIG. 18D, $r_{c1} = r_{c2}$

FIG. 18E, $r_{c1} \gg r_{c2}$

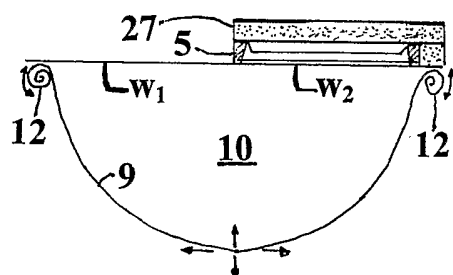


FIG. 18F

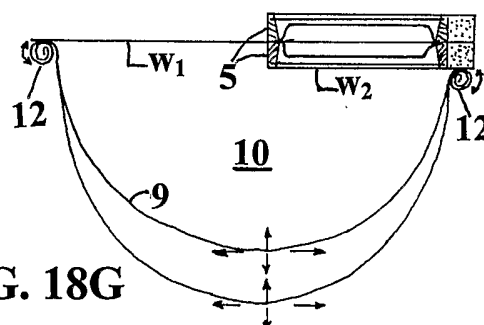


FIG. 18G

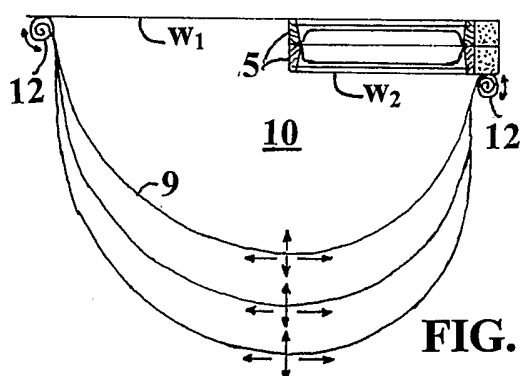


FIG. 18H

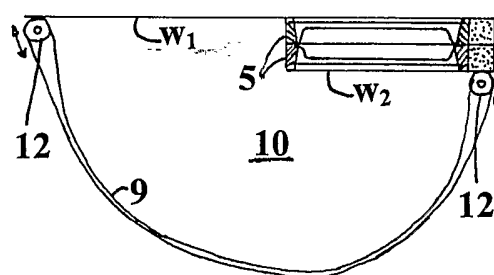


FIG. 18I

20/25

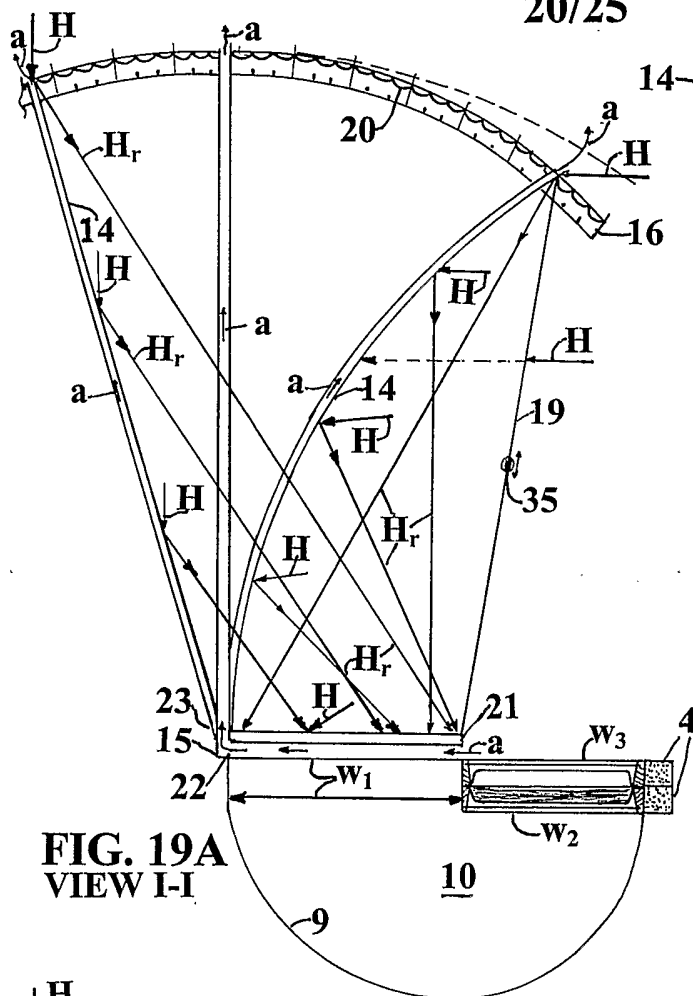


FIG. 19A
VIEW I-I

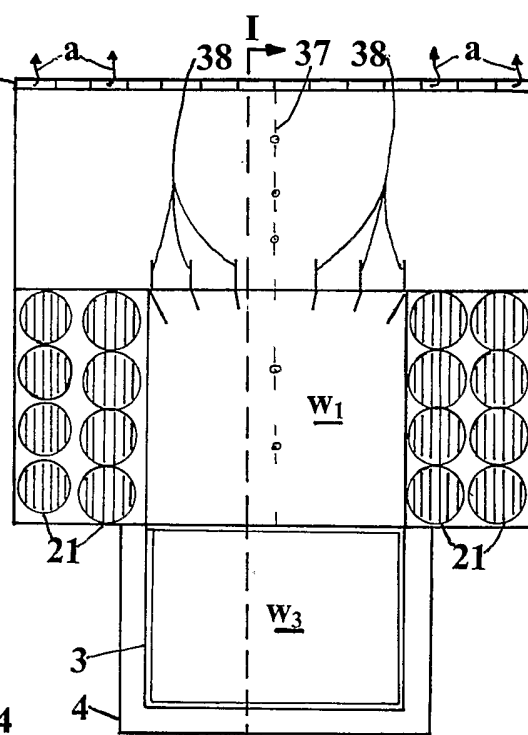


FIG. 19B
PLAN VIEW

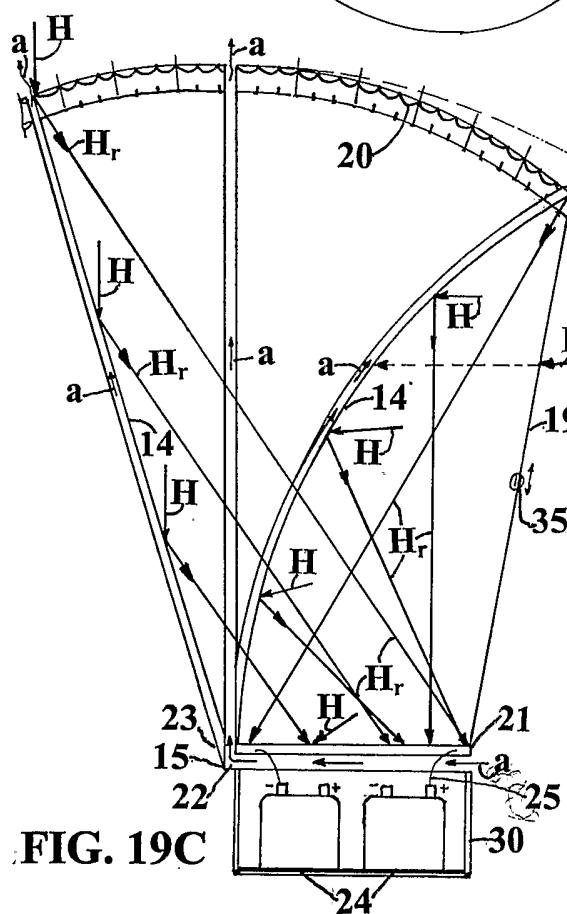


FIG. 19C

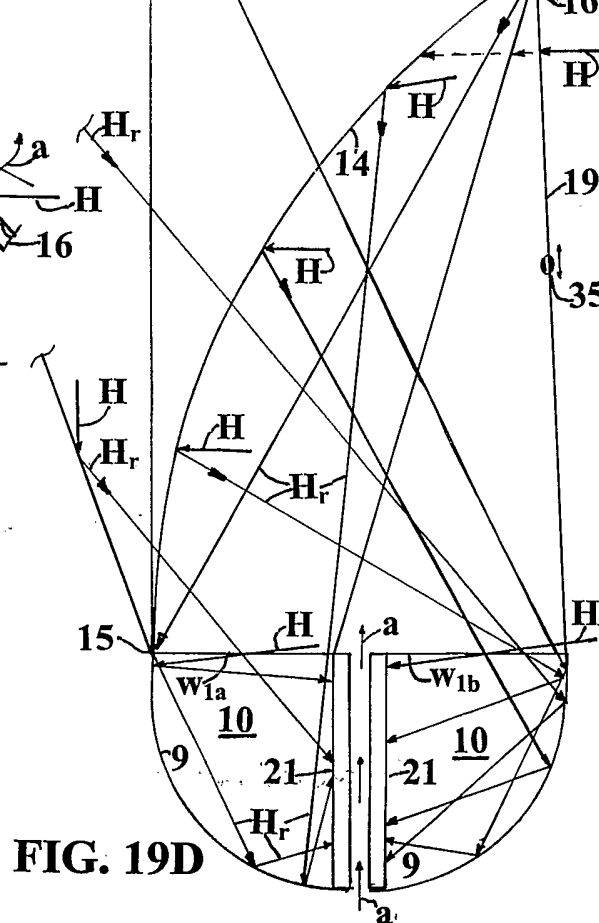


FIG. 19D

21/25

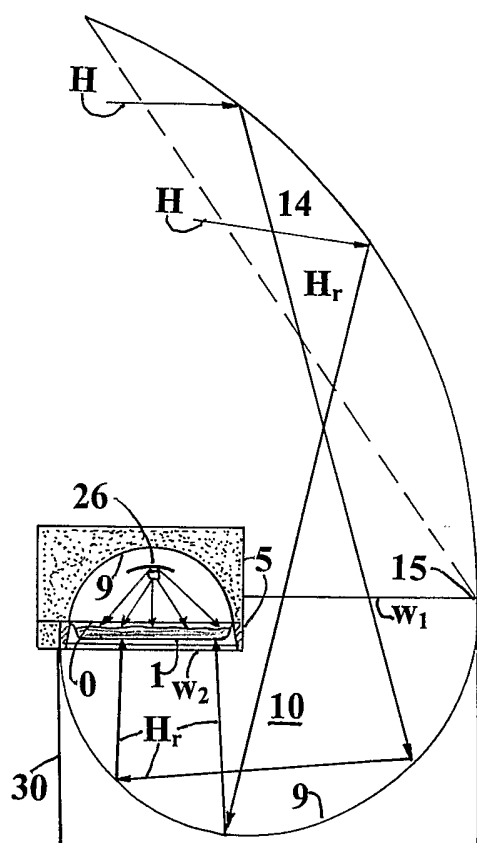


FIG. 20A

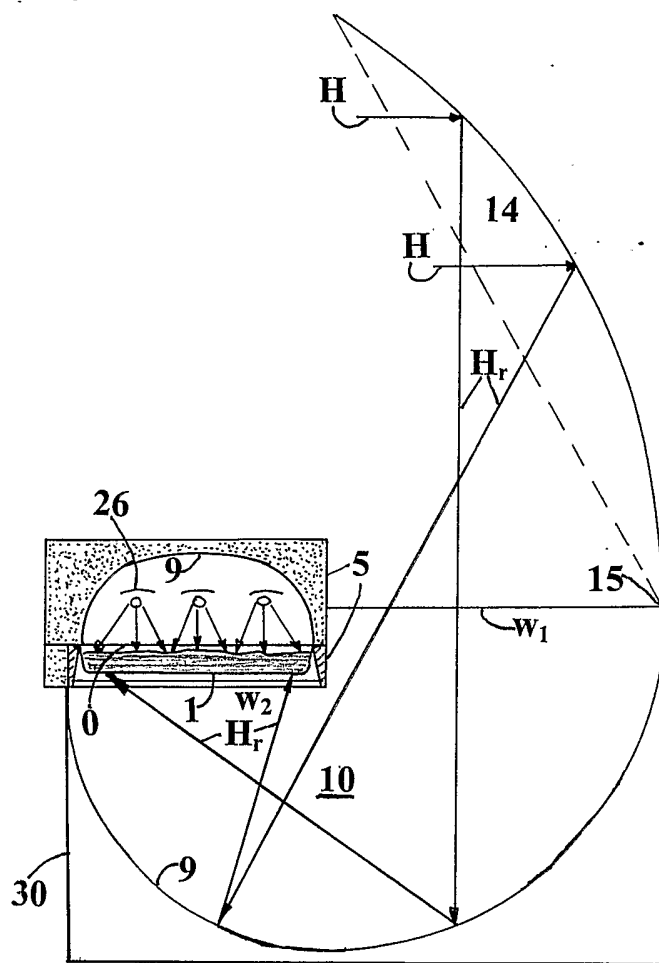


FIG. 20B

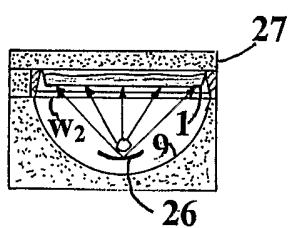


FIG. 20C

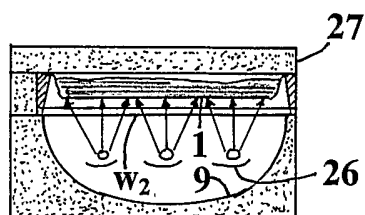


FIG. 20D

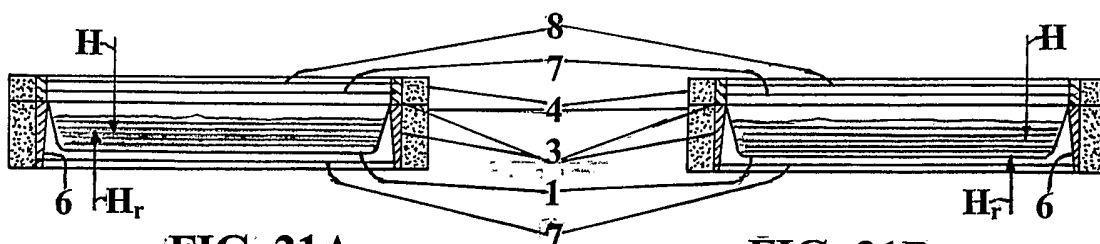


FIG. 21A

FIG. 21B

22/25

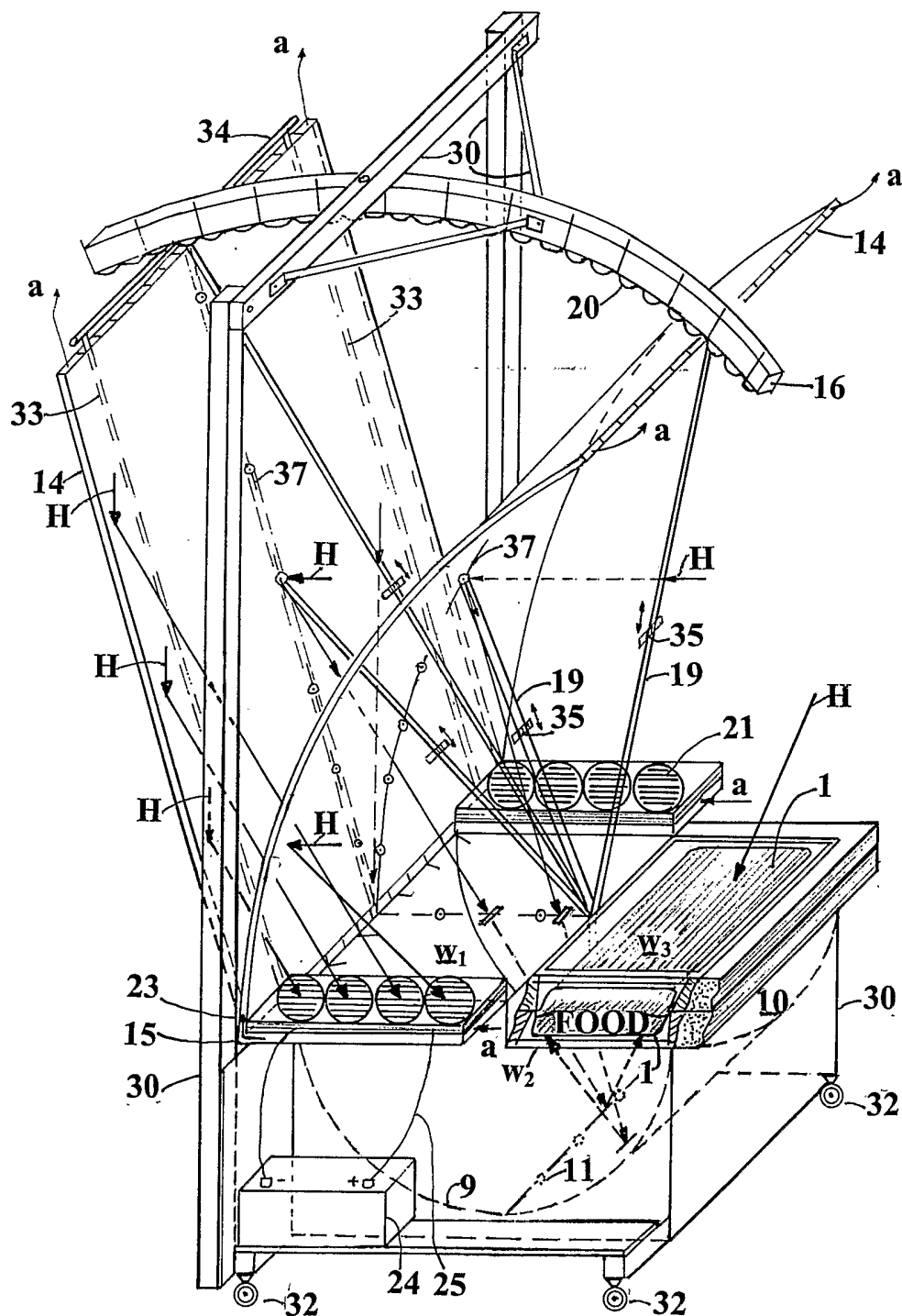
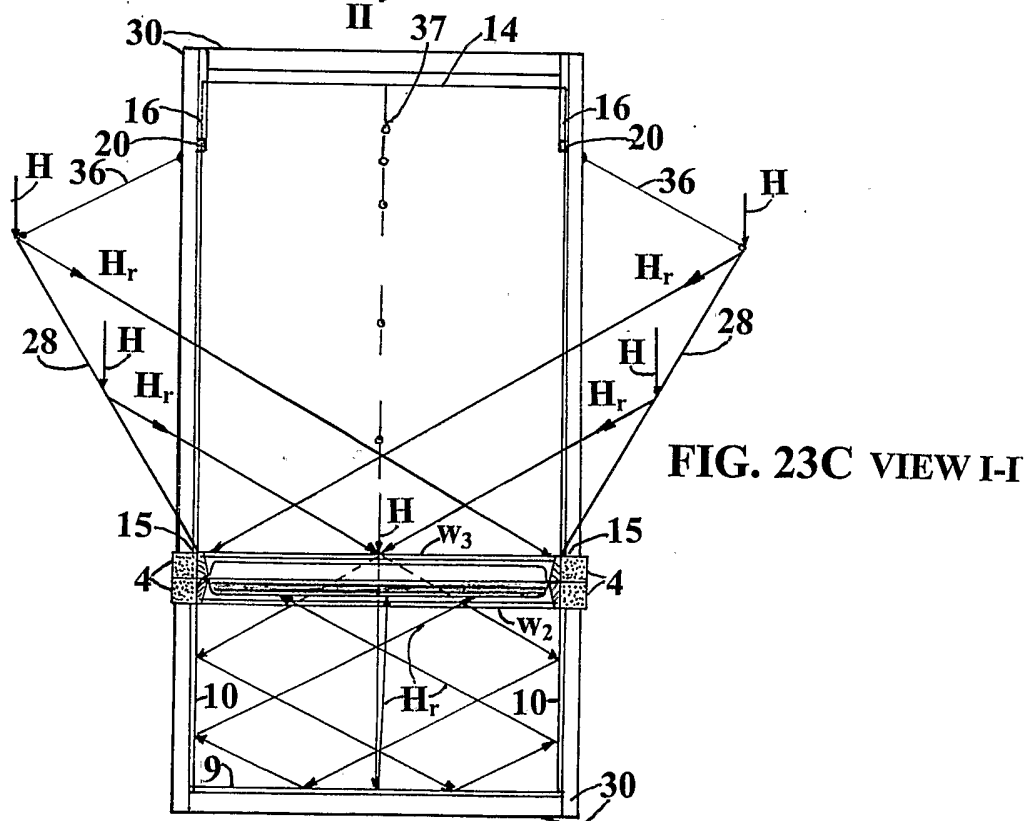
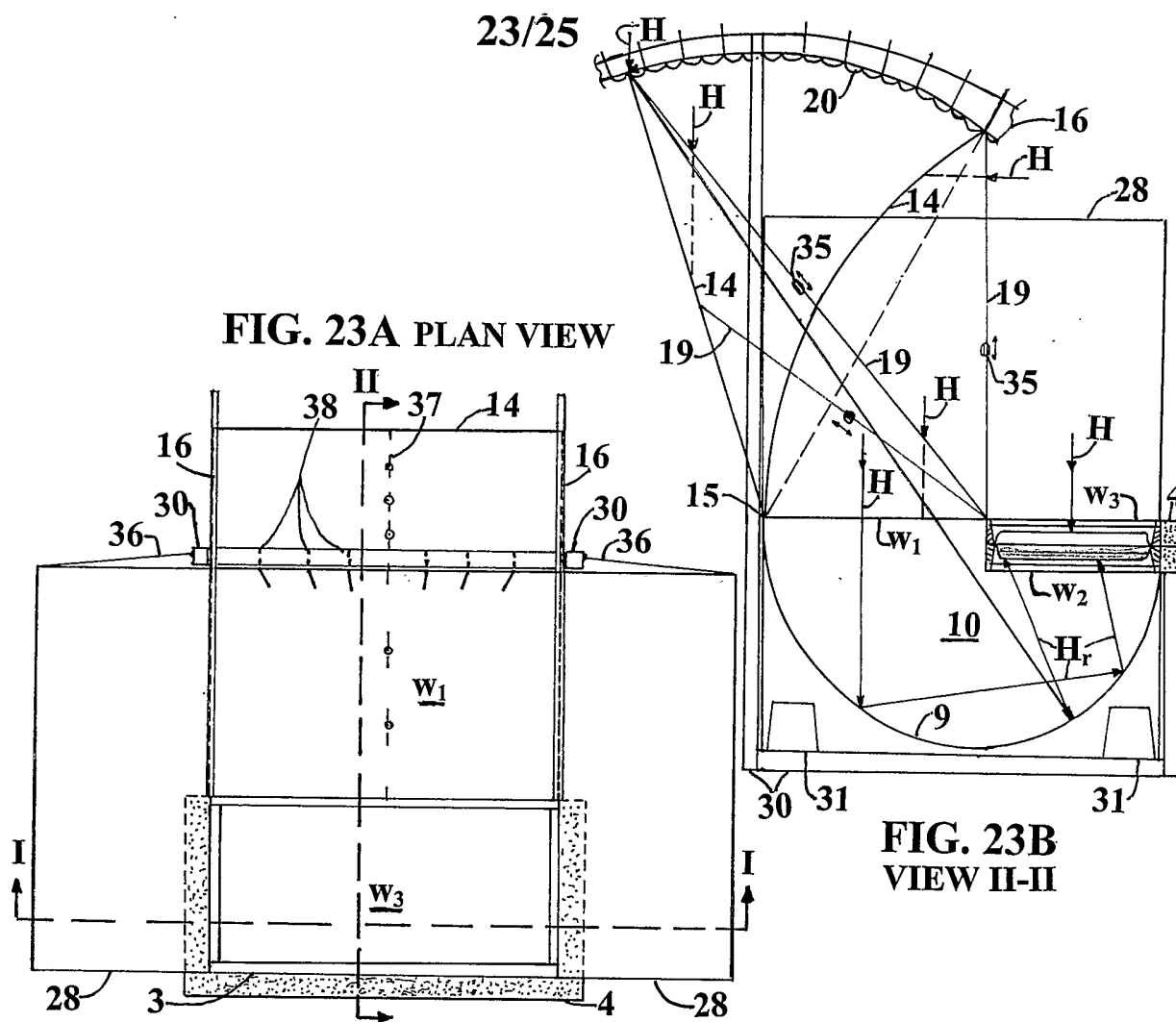


FIG. 22



24/25

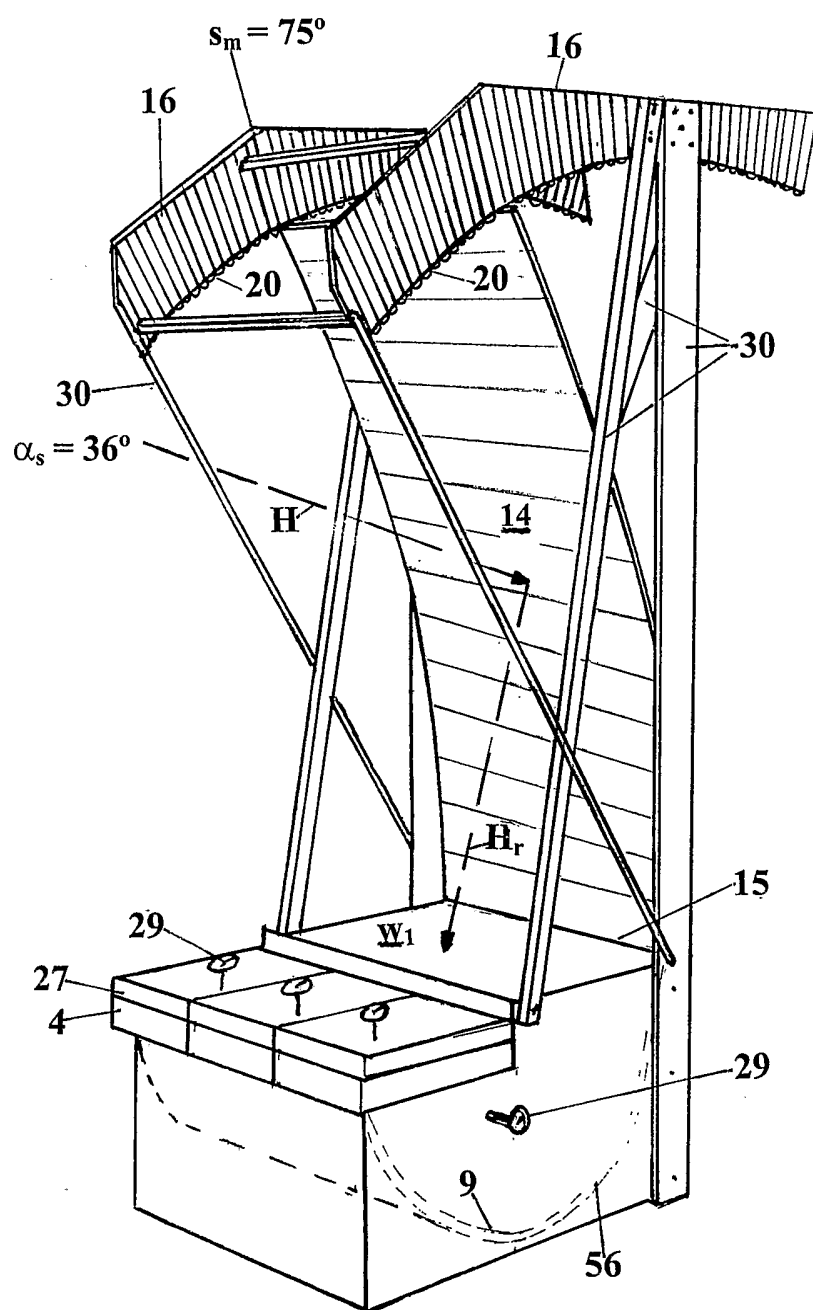


FIG. 24

25/25

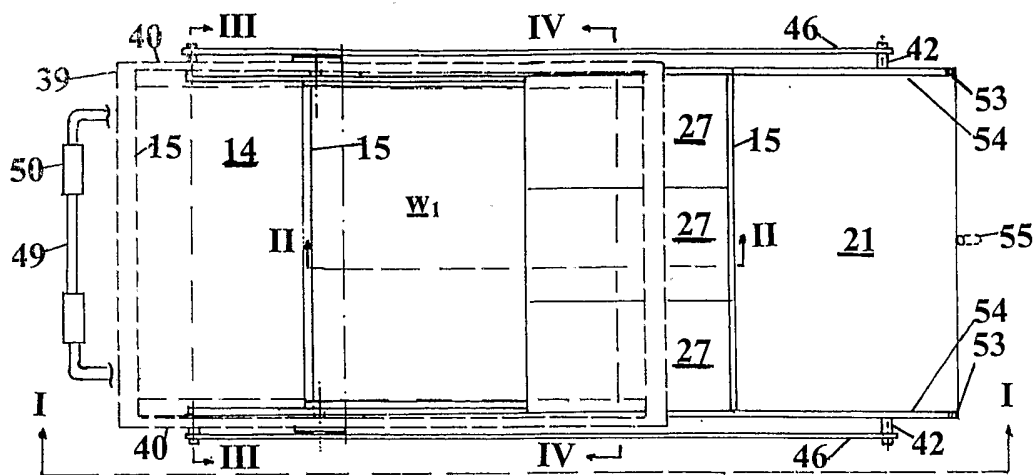


FIG. 25A PLAN VIEW

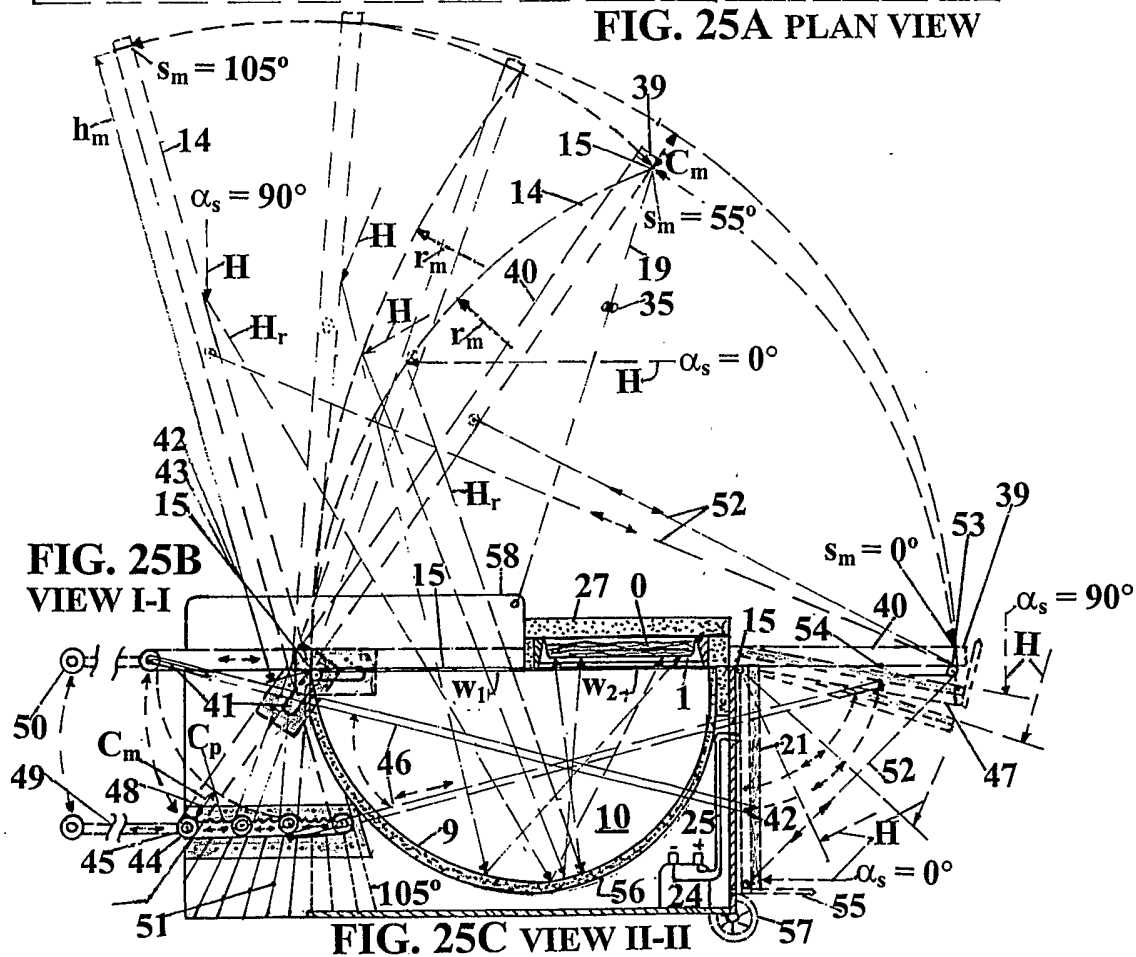
FIG. 25B
VIEW I-I

FIG. 25C VIEW II-II

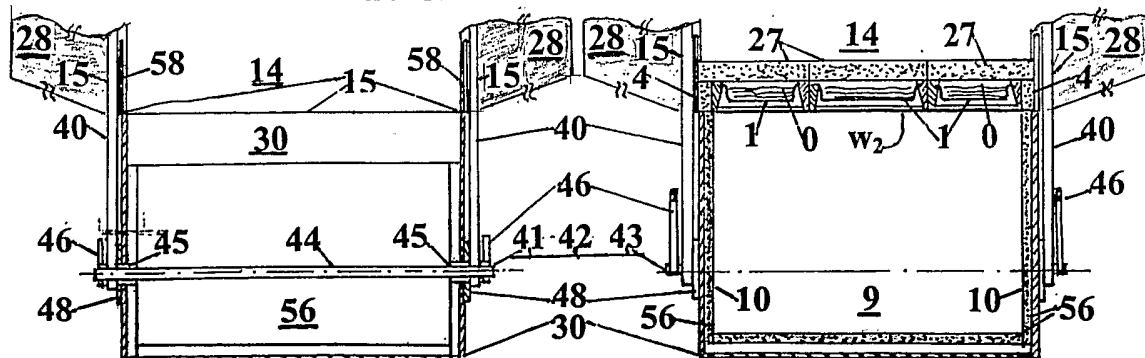


FIG. 25D VIEW III-III

FIG. 25E VIEW IV-IV