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U.S.A. - Deposito domanda di brevetto No. 189.486 del 23.4.1962 per: "Dispositivo raccoglitore di energia raggiante ecc."

Elenco documenti allegati:

- un certificato ufficiale di deposito
- una copia descrizione e disegni come depositati.

U.S.A. - Brevetto No. 189.486 del 23.4.1962 per: "Dispositivo raccoglitore ecc."

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APPLICANT: FRANCIA, GIOVANNI OF GENOA, ITALY

INVENTION: RADIATION COLLECTOR, MORE PARTICULARLY SOLAR RADIATION COLLECTOR

DRAWINGS	EXTRA CL'S	FILING FEE	TRANSACTION	ATT'Y DK.
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SUGHRUE, ROTHWELL, MION AND ZINN
MUNSEY BLDG.
WASHINGTON 4, D. C.

14 MAG 1962

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MAY 4 1962

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"Radiation collector, more particularly solar radiation collector"

ITALY, filed May 5, 1961 the right of priority of which patent application is claimed.

Sughrue, Rothwell, Mion & Zinn, Munsey Bldg. Washington 4, D.C.

a law firm consisting of Richard C. Sughrue, Gideon Franklin Rothwell, John H. Mion and Donald E. Zinn 18590

18th April 62

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This invention relates to devices for collecting radiation, more particularly from the sun, of the type including a black body.

It is known that each total absorber for radiation is referred to as black body. However, the thermal balance between a source of radiation and the black body absorbing it a certain distance apart, generally occurs at a temperature of the black body which is much lower than the temperature of the source.

This is due to the fact that the solid angle of incident radiation at a point on the black body, which is the solid angle according to which the source is seen from that point, is generally very small with respect to the solid angle within which the energy is again emitted by the same point, the solid angle coinciding in fact with a semisphere or a half-space.

Since, as is well known, radiation is proportional to the fourth power of temperature, the width of the solid emission angle compared with the width of the solid absorption angle explains the differences in temperature between the source and black body.

Theoretical considerations investigated by applicant and experiments carried out heretofore show that it is possible to collect the radiation emitted by any source up to the source temperature.

Starting from this assumption this invention provides a collector for radiating energy comprising a black body, having the characteristic feature that it moreover comprises an absorber for the emitted energy adjacent the black body extending towards the source in such manner that the black body is capable of absorbing the radiation from the source and emitting energy from its radiated surface substantially in the direction of the incident radiation only.

The invention shall now be described with reference to the accompanying drawings which show by way of an example the principle and some embodiments of an apparatus suitable for industrial use.

Fig.1 is a diagrammatical representation of the distribution of radiation emitted by a conventional black body,

Fig.2 is a diagrammatical representation of a black body provided with an absorber according to this invention,

Figures 3, 4, 5 and 6 show diagrammatically various embodiments of the invention,

Fig.7 is an axial sectional view of a collector,

Fig.8 is an enlarged sectional view of a detail of Fig.7.

Figs.1 and 2 show the substantial difference between radiation from a conventional black body and a similar body provided with an absorber according to this invention.

A black body 1 is formed with an opening 2.

The black body in Fig.1 collects energy emitted by the source 3 along the ray 4, and emits radiation in the direction of the source 3 and additionally in all directions of a half-space according to the known law.

By providing a black body as above at its opening 2 with an absorber for the emitted energy such as in the form of a tube 5, the walls of which are black to the emitted energy, the black body absorbs as before radiation from the source 3 along the ray 4, but emits energy substantially only within a narrow angle denoted by the arrows 6 at the outlet of the tube 5.

A ray 7 steeper than the rays issuing from the end of the tube 5 incides the wall of the latter tube which behaves in respect thereof as a conventional black body and fully absorbs energy, which it re-emits at a lower temperature in all directions including the direction of the black body 1. The rays re-emitted by the tube wall at the absorption point of the ray 7, less the portion returning into the black body and the portion succeeding in directly issuing from the tube 5, again incide the pipe walls, their energy being again totally absorbed and re-emitted in all directions.

An analytic investigation shows that, ultimately, most of the energy of the rays of type 7 returns into the black body 2, so that the energy actually lost by radiation is but slightly in excess of the energy of rays of type 6.

Distribution of temperature throughout the black body 1 and along the tube 5 is shown by line L in Fig.2; the temperature of the black body is denoted by T_o and the temperature at the inlet of the tube 5 by T_1 which is lower than T_o. The line L slopes down from T_1 to a T_n value at the outlet of the tube 5. The temperature T_n is slightly in excess of ambient temperature.

Analytically, line L but slightly departs from a parabola of the fourth order having its axis extending parallel with the direction of the ray 4.

The above described example shows the theoretical possibility of providing a limiting device for the solid emission angle, which does not absorb the incident radiation.

Assuming the source is a point infinitely remote, an infinitely long tube placed in front of a black body extending towards the source would lead to an arrangement which may be referred to as an absolute black body, namely, a body which is capable of absorbing the radiation up to the temperature at which it has been emitted.

It might be said that the tube 5 is obviously a flow tube for in-coming radiation and in addition conditions emitted energy till it becomes also a flow tube for the latter; this explains why at the limit, the source and absorber interconnected by one and the same flow tube, can be at the same temperature.

For instance, in the case of the sun with its incoming radiation at a solid angle of 0.0000678, a tube which is 20 to 30 times long its diameter would afford absorption with a satisfactory efficiency up to temperatures of the order of 1000°C without adopting concentration of energy.

The example shown in Fig.3 relates to an absorber for emitted energy carried out by means of a bundle 8 of tubes, such as hexagonal tubes 9 juxtaposed to form a honeycomb structure constituting the absolute black body to be aimed towards the sun.

With this arrangement high temperatures, but energy of low intensity can be reached; similarly to the embodiment described with reference to Fig.2 the tubes should be such as to behave as black in respect of emitted energy.

The said tubes can be transparent in respect of the in-coming radiation, whereby also radiation other than parallel with their axis can be absorbed.

Such absorber, though it is of the same geometry as the above described absolute black body, differs therefrom, in that it does not require to aim at the source but it cannot reach the temperature of the source, as in this case the tubes become transparent also towards re-emitted radiation.

Such tubes can be made of ordinary glass, mica or plastic, such as cellulose acetate for low temperatures and silicone resins for higher temperatures.

It is generally known that these substances absorb under proper conditions less than 1% of the sun radiation, while they can be considered opaque in respect of infrared rays emitted by a body at 400° to 500°C. Experiments carried out by applicant have shown that the substances in question are opaque in respect of the said rays, almost "black" in a physical sense of the word.

The large number of part reflections against the surfaces of the glass tube (up to 50 to 70 reflections) does not decrease the in-coming radiation, in that it does not alter the component along the direction of the axis of the tubes of the quantity of motion of the in-coming photons.

According to the modification shown in Fig.4 the absolute black body, which does not require to aim at the source, comprises a plurality of parallel plates 10 of a material which can be black in respect of both in-coming and emitted radiation or, as in the previous example, may be black in respect of emitted radiation and transparent in respect of in-coming radiation.

In both cases an absorber of the type shown in Fig.4 will afford a rather large efficiency up to temperatures of the order of 300°-400°C.

In practice the plates 10 shall be oriented so as to extend parallel with the plane in which the sun apparently moves, spaced by 1/10 to 1/50 the height of the plates.

According to the modification shown in Fig.5 an energy absorber comprises a truncated cone of 90° aperture having a reflecting surface 51 aiming by its axis at the sun, which concentrates in-coming rays 56 and reflected rays 57 along the said axis.

Bodies having flat circular surfaces 52 are situated within the truncated zone perpendicular to the cone axis, and equal in diameter the small cone base 53 to lef pass the in-coming radiation and limit emitted radiation.

A further set of flat black bodies 54 are arranged within the truncated cone 51, the set of bodies 52 and 54 forming a collector which together with the black body 55 constitutes an absolute black body which is capable of collecting radiation and reaching temperatures probably over and above 4500°C.

Up to 3000°C the flat bodies can be, as shown in Fig.6 in the form of tungsten wire mesh arranged in a truncated cone 61 in two sets, one set comprising for instance wires 64 extending parallel with the axis of the truncated cone situated in radial planes denoted by 64, the other set comprising wires 62 arranged in cross planes supported by wires 64 in the form of a spider web. A black body 65 is arranged coaxially with the truncated cone 61.

Such tungsten wire mesh acts as an absorber for emitted radiation. The wire arrangement in the mesh is such that the arrangement is transparent in directions of the incoming rays 66 and reflected, rays 67, and is opaque in the other directions.

According to a further embodiment (not shown) the aperture of the cone 51 is other than 90°, the bodies 52 being conical instead of flat, their conicity being such that the surfaces extend parallel with the rays 57.

In the embodiment shown in Fig.7, 17 denotes a frame having pivoted to its top 18 a cylindrical portion 19 of a collector 20.

A reflector 21 is arranged coaxially with the cylinder 19 and comprises two frusto-conical surfaces 22, 23. The bottom of the cylinder 19 at the end remote from the reflector is in the form of a metal plate 24 having a rough surface 25 such as a gramophone record surface, the said surface aiming at the reflector and acting as a black body.

The surface 25 of the plate 24 has abutting thereon a bundle of hexagonal parallel tubes 26 acting as an absorber (which should of course be of the selected absorption type, that is, transparent and black in respect of the in-coming and emitted radiation, respectively) arranged so as to fill the cylinder 19 completely.

One or a plurality of sets of spirally wound or serpentine-shaped tubes 27 are provided on the opposite side of the surface 25 of the plate 24 and establish a thermal contact with the plate 24 by means of welding material forming a body 28 or by any other known means. The body 28 is backwardly insulated by a heat insulation 31.

The set of pipes 27 are connected on one side with a pump 29 feeding fluid and on their other side with a receptacle 30 collecting the fluid having received the thermal energy while flowing through the tubes 27. The fluid can be drawn from the receptacle 30 for accomplishing any work, such as actuating a thermal machine or otherwise exploiting thermal energy.

The frame 17 and articulation 18 can be provided with an automatic mechanism for aiming the axis of the collector 20 at the sun.

A further use of the absorber for the emitted radiation described above is for heat-insulating purposes. For the absolute black body can be in a certain sense considered as a cold body. Such an insulation for extra high temperatures, when made of wires such as tungsten wires which can of course be supported by frames remote from the very hot region, will additionally afford the property of a very low thermal mass. With a proper shape thereof it can permit direct vision of the hot regions from the outside.

It will of course be understood that, the principle of the invention being left unaltered, embodiments and constructional details of the device can be widely varied from the examples described and illustrated without departing from the scope of this invention.

WHAT I CLAIM IS:

1. Radiation collector comprising a black body, and an absorber a for the emitted radiation adjacent the black body and extending towards the source in such manner that the black body is capable of absorbing radiation from the source and emitting radiation from its irradiated surface substantially only in direction of the source.

2. Collector as claimed in claim 1, wherein the absorber comprises a bundle of tubes of material black in respect of emitted radiation.

3. Collector as claimed in claim 2, wherein the absorber comprises a bundle of tubes of hexagonal cross sectional shape.

4. Collector as claimed in claims 2 and 3, wherein the absorber comprises a bundle of tubes of a material which is transparent in respect of the in-coming radiation and black in respect of emitted radiation.

5. Collector as claimed in claims 2 to 4, wherein the tubes have length 20 to 50 times their diameter.

6. Collector as claimed in claim 1, wherein the absorber comprises a set of black flat bodies perpendicular to the plane of the black body.

7. Collector as claimed in claim 6, wherein the flat bodies are of the order of 10 to 50 times high

the spacing thereof.

8. Collector as claimed in claim 5, wherein the absorber comprises a set of plates of a material which is transparent in respect of in-coming radiation and black in respect of emitted radiation.

9. Collector as claimed in claim 1, wherein the absorber comprises mesh of a wire withstanding high temperatures.

10. Collector as claimed in claim 1, comprising in combination a frame, a concave reflector articulated to the frame, a black body fixed at the bottom of said reflector an absorber in the form of a bundle of glass tubes arranged on the bottom of the reflector and abutting said black body and means adapted to subtract heat from the black body adjacent the said body on the opposite side of the absorber.

11. Collector as claimed in claim 10, wherein the black body is in the form of a metal plate having a rough surface, contacting the bundle of tubes.

12. Collector as claimed in claim 10, wherein the means adapted to subtract heat are in the form of tubes having a fluid flowing therethrough, arranged in thermal contact with the black body.

13. Collector as claimed in claim 1, comprising in combination a reflecting truncated cone, an absorber

in form of surfaces arranged within said cone and a cylindrical black body arranged axially within said cone, all made of a material withstanding high or very high temperatures.

14. Thermal insulation for a hot body comprising an absorber for emitted radiation from said hot body of the type comprising a plurality of tubes arranged to form a honey comb structure abutting the surface of the hot body.

15. Thermal insulation as claimed in claim 14 wherein the tubes have length 20 to 50 times their diameter.

Fig. 1

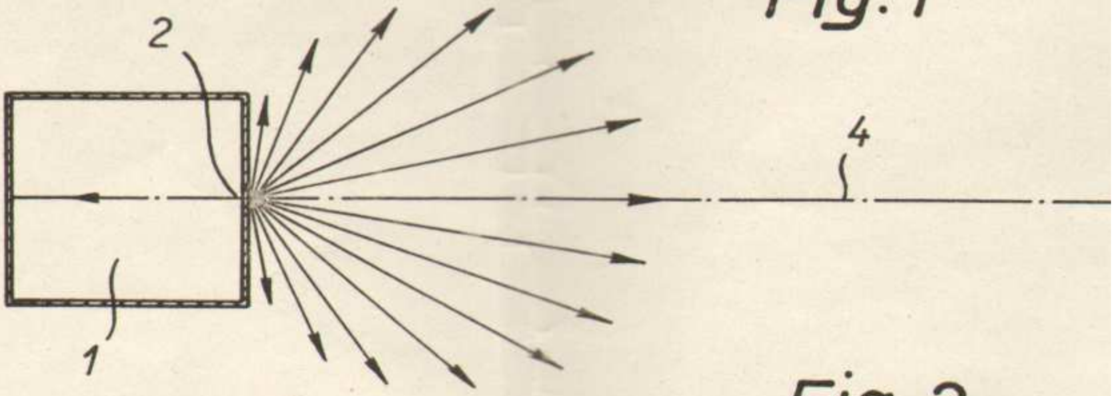

Fig. 2

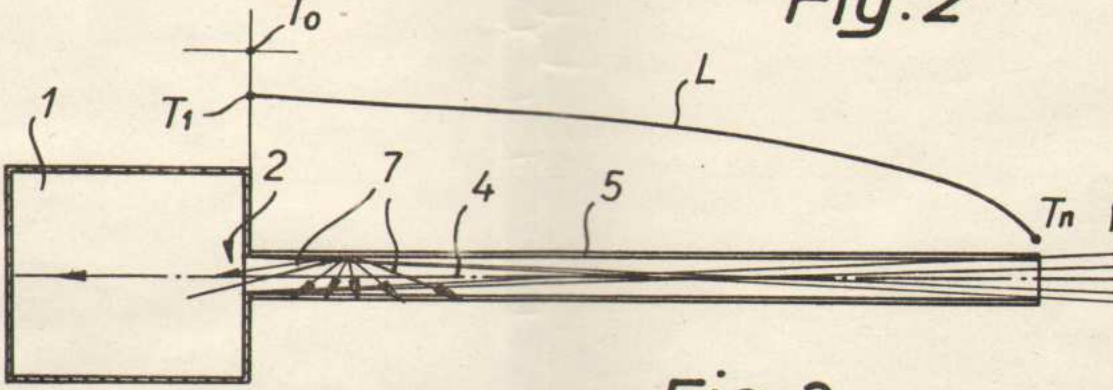

Fig. 3

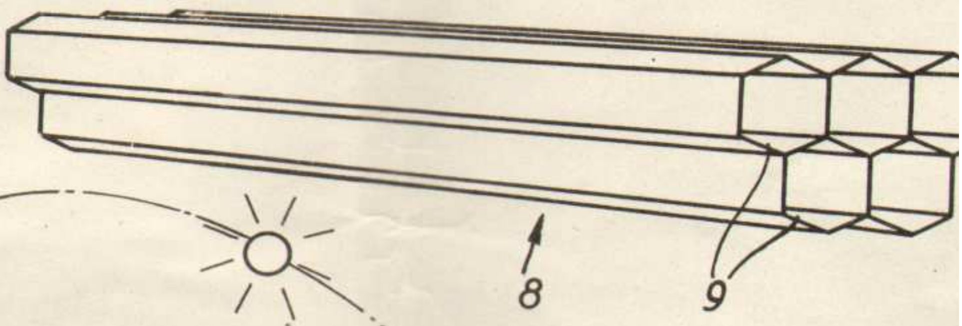

Fig. 4

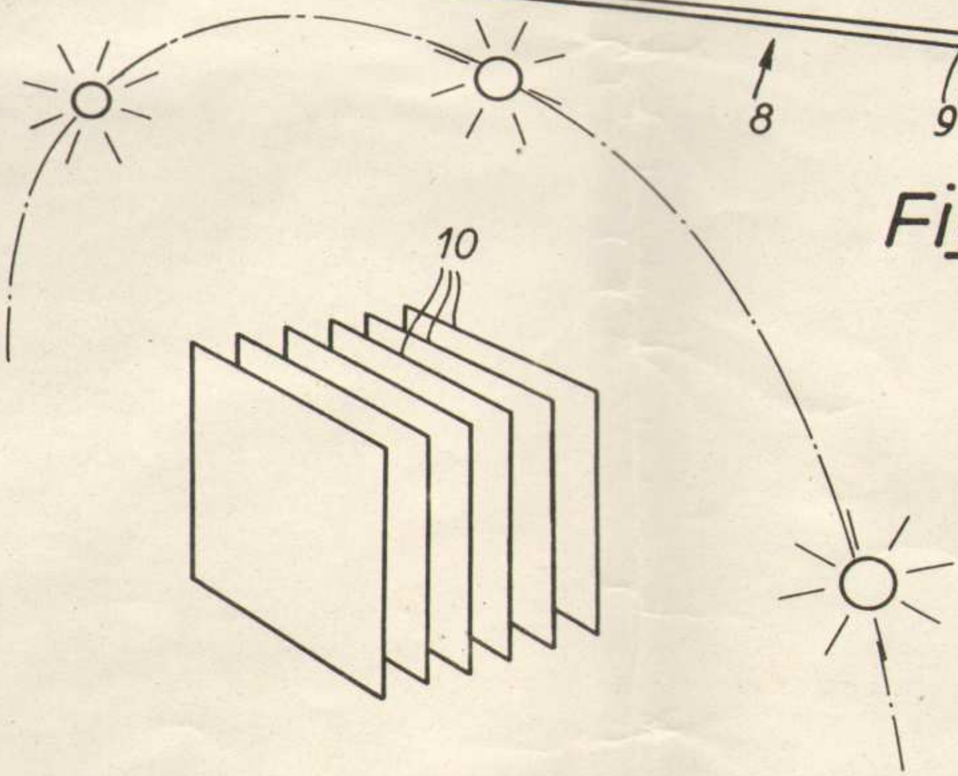

Fig. 5

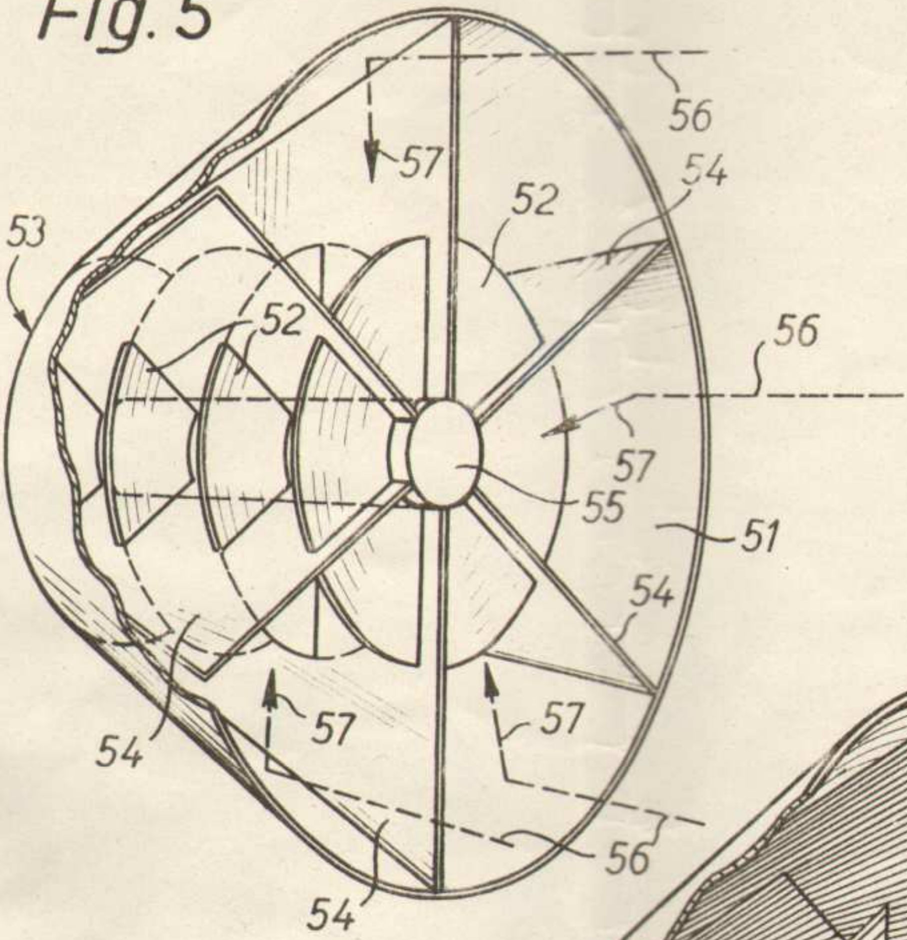
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Fig. 6

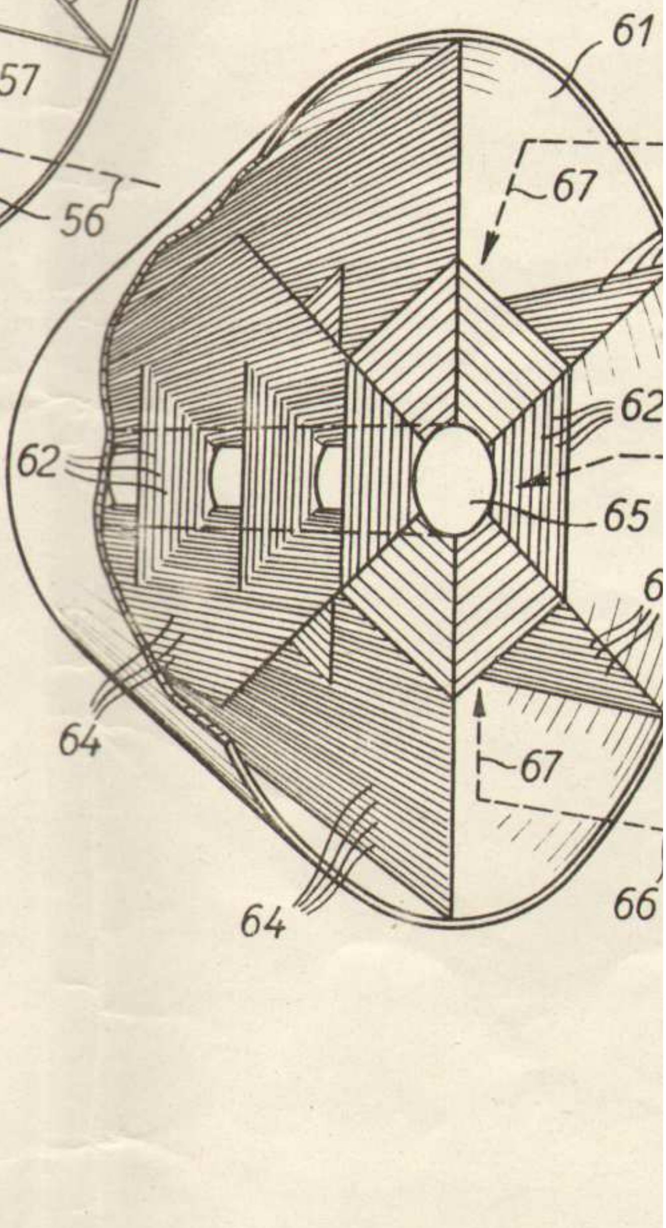
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Fig. 7

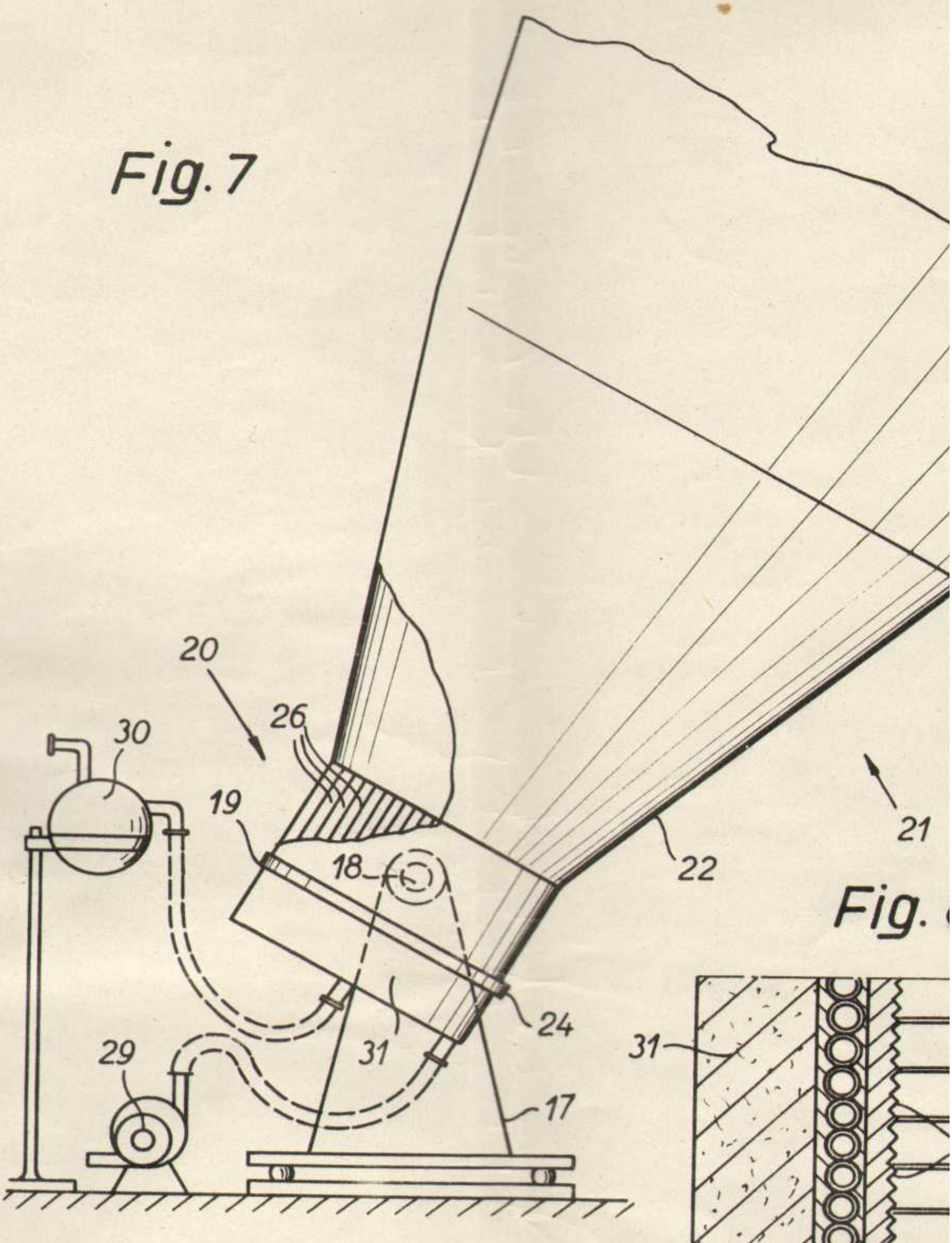

Fig.