N° 3235 A.D. 1901

*Date of Application, 14th Feb., 1901*

*Complete Specification Left, 14th Nov., 1901—Accepted, 13th Feb., 1902*

PROVISIONAL SPECIFICATION.

# "Improvements in or relating to Liquid Cooling Apparatus for Explosion Engines or other Purposes",

I, WILHELM MAYBACH, Engineer, of Cannstatt, Kingdom of Würtemberg, in the German Empire, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in or relating to cooling apparatus for explosion engines or other purposes and has for its object to provide means by which the liquid to be cooled may be divided up into thin layers of equal cross section and thus readily and evenly cooled.

According to one method of carrying out this invention a drum of any convenient material is constructed, covered at each end by a netting. The netting may be of wire or strip preferably of metal and may be woven or composed of two layers of parallel strips crossing one another.

In the meshes thus formed between the wires are inserted tubes, the ends of which are left open, whilst the spaces between the ends and the wires which support them are closed by soldering or other convenient means.

The apparatus thus constructed forms a drum filled with horizontal tubes open at each end, the interior of the drum being divided up into a number of horizontal and vertical passages of equal cross section.

The liquid to be cooled is allowed to enter at the upper end of the drum passing through it by means of the vertical and horizontal passages, transversely to the tubes and not, as has heretofore been the practice, in the longitudinal direction of the same.

By using strip or wire for the netting of the same cross section throughout the tubes may be arranged exactly parallel to one another so that the spaces between them are all of equal cross section; also the tubes are readily put in place and by putting a considerable tension if necessary upon the wires or strips forming the netting, derangement of the tubes may be prevented. This arrangement of the tubes so as to leave passageways between them of narrow and equal cross section enables the liquid passing through the passages to be rapidly and evenly cooled.

In using a cooler of this description for an explosion engine the cooling water may be made to pass through the narrow passages surrounding the tubes, while the tubes are left open to the atmospheric air and a draught created through them by artificial means if desired.

Any cooling medium may of course be used in place of air if desired, and the apparatus used for cooling any liquid other than that of water.

The inside faces of the side members of the frame may be dished or recessed so that a passageway is formed between them and the sides of the tubes nearest them so that liquid may be allowed to circulate on the outside of these tubes. The liquid will readily circulate through the vertical passages and will of course fill the horizontal passages through which it will flow more slowly, but owing to the slower flow here the liquid in these passages will be brought to a lower temperature than that in the vertical passages so that it will gravitate out of these passages and flow down through the vertical passages with the rest of the liquid.

[*Price 8d.*]

It is obvious that the netting may be arranged to form a square, triangular or other shaped mesh, tubes of a shape corresponding to that of the mesh being employed.

In some cases it may be desired to so construct the netting that each mesh may be of greater diameter in one direction than in the other to receive tubes of oblong cross section; each tube of such cross section may be provided in its interior with partitions which serve to strengthen the sides of the tube so that they may be made of thin material best adapted to conduct the heat from the liquid to be cooled and also serving to conduct the heat from the sides of the tubes to the air circulating through them. This arrangement does not allow of the same number of horizontal passages as the former arrangement, but dispenses with the necessity of forming a good many joints whilst at the same time the horizontal passages are not of so much importance as the vertical passages.

It will be understood that the partitions within the tubes of oblong cross section may take any form and the tubes themselves may be set obliquely in the frame so that their cross section is not strictly oblong, if desired.

Again in some cases it is desirable that the passages at one end of the drum should be of greater cross section than at the other end. This may be effected by using a thicker wire or wider strips for the web of the netting on that side at which it is desired the passages should be widened.

Dated this 14th day of February, 1901.

BOULT, WADE & KILBURN,
Agents for the Applicant.

## COMPLETE SPECIFICATION.

### "Improvements in or relating to Liquid Cooling Apparatus for Explosion Engines or other Purposes".

I, WILHELM MAYBACH, Engineer, of Cannstatt, Kingdom of Würtemberg, in the German Empire, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention realtes to improvements in or relating to cooling apparatus for explosion engines or other purposes and has for its object to provide means by which the liquid to be cooled may be divided up into thin layers of equal thickness and thus readily and evenly cooled.

According to one method of carrying out this invention a drum of any convenient material is constructed, covered at each end by a netting. The netting may be of wire or strip preferably of metal and may be woven or composed of two layers of parallel strips crossing one another.

In the meshes thus formed between the wires are inserted tubes, the ends of which are left open whilst the spaces between the ends and the wires which support them are closed by soldering or other convenient means.

The apparatus thus constructed forms a drum filled with horizontal tubes open at each end, the interior of the drum being divided up into a number of horizontal and vertical passages of equal cross section.

The liquid to be cooled is allowed to enter at the upper end of the drum passing through it by means of the vertical and horizontal passages transversely to the tubes and not, as has heretofore been the practice, in the longitudinal direction of the same.

By using strip or wire for the netting of the same cross section throughout the tubes may be arranged exactly parallel to one another so that the spaces between

them are all of equal cross section; also the tubes are readily put in place and by putting a considerable tension if necessary upon the wires or strips forming the netting, derangement of the tubes may be prevented. This arrangement of the tubes so as to leave passageways between them of narrow and equal width or depth enables the liquid passing through the passages to be rapidly and evenly cooled.

In using a cooler of this description for an explosion engine the cooling water may be made to pass through the narrow passages surrounding the tubes, while the tubes are left open to the atmospheric air and a draught created through them by artificial means if desired.

In the accompanying drawings,

Figure 1 is a diagrammatic view illustrating one method of carrying out this invention with modifications;

Figure 2 is a plan of the cooler in part section;

Figure 3 is a diagrammatic view of a cooler showing other modifications;

Figures 4 and 5 illustrate details of construction; and

Figure 6 is a diagrammatic view of a complete cooler as usually constructed.

Like letters indicate like parts throughout the drawings.

This invention consists in constructing a cooling chamber in such a manner that fluids passed through it are divided into layers or streams of equal thickness, and has further reference to the method of constructing the chamber for this purpose.

To divide the chamber into intersecting passages flat-sided tubes are employed through which the cooling medium is passed and the tubes are spaced equidistant from each other so that the spaces between them form intersecting passages in the chamber of uniform width or depth.

For convenience the tubes are mounted in a frame or drum $a$, $a^1$, $a^2$ (Figure 1) which when closed at its ends, as hereinafter described, forms a chamber through which the fluid to be cooled is passed. The tubes $r$, in this case of square cross section, are mounted parallel to each other within the frame their open ends coinciding with the open ends of the drum.

To keep the tubes in place and equidistant from each other horizontal wires or strips $m^1$ and vertical wires or strips $m^2$ are secured across the open ends of the frame $a$, $a^1$ $a^2$ so that a mesh is formed at each end in which the ends of the tubes may be supported. It will thus be seen that the wires or strips $m^1$ $m^2$ serve to space the tubes as well as retain them in place so that the interior of the chamber $a$, $a^1$ $a^2$ is divided into vertical and horizontal passages $x$ and $y$ respectively.

To secure the tubes in place their ends may be soldered to the mesh formed by the wires $m^1$ $m^2$ so that the ends of the drum $a$, $a^1$ $a^2$ are completely closed by the soldered tubes and wires.

A pipe $e$ is provided at the upper end of the chamber $a$, $a^1$ $a^2$ and a pipe $f$ at the lower end. The upper and lower ends of the chamber are preferably raised and depressed respectively towards the centre of the chamber, where the pipes are secured, so that a space $u$ is formed at each end of the chamber within which the fluid entering or leaving the chamber accumulates and is distributed to, or collected from, the passages $x$, $y$ of the chamber. The sides $a$ of the chamber are preferably recessed on the inner side as shown at $w$ (Figures 1 and 2) so that the fluid admitted to the chamber can pass from the end of one passage $y$, adjacent to the wall, to the next passage.

Fluid entering the chamber say by the pipe $e$ is distributed in the space $u$ at the upper end of the chamber, over the whole of the passages $x$ through which it traverses, at the same time travelling more slowly through the passages $y$. As the fluid travels more slowly through the passages $y$ than the passages $x$ it is cooled more quickly in these passages and becoming colder than the fluid passing down the passages $x$, will also, after a short time again flow into the passages $x$, its place being supplied by fresh quantities of warmer fluid from

the passages $x$. The transverse passages $y$ thus cause an intimate mixture of the fluid and as all the passages are of the same width the fluid is divided into layers of equal thickness so that the whole is evenly cooled.

Having traversed the passages $x$ and $y$ throughout the chamber the fluid collects in the space $u$ at the bottom of the chamber from which it is carried off by the pipe $f$.

It will be seen that wires or strips may be arranged in many different ways so that various forms of mesh $m$ are produced in which correspondingly shaped pipes may be mounted. At the bottom on the left hand side of Figure 1 additional wires or strips $z$ are shown which cross the wires $m^1$ $m^2$ so that the mesh takes a triangular form adapted to receive tubes of triangular cross section.

On the right hand of Figure 1 another form of mesh $m$ is illustrated, constructed of wires woven in three different directions.

On the left hand side of Figure 3 vertical wires are shown crossed by only a few horizontal wires. The mesh thus formed is adapted to receive tubes $k$ of oblong cross section the walls of which may be made very thin and supported where necessary by struts $r^1$. In this form of apparatus the same number of vertical passages $x$ may be retained although there are necessarily fewer horizontal passages $y$. The passages $y$ however, are not of great importance and by using tubes of this form, the walls of which are supported by struts $r^1$, the walls, as stated, may be made very thin so that more rapid cooling is effected. The struts $r^1$ in addition to supporting the walls of the tubes also serve to conduct heat collected by the walls to the cooling medium which further accelerates the cooling of the fluid passing between the tubes. Another advantage in this construction is that by having only a few transverse passages a considerable number of joints are dispensed with. This construction again may be modified by arranging the wires obliquely, as shown on the right hand side of Figure 3 the tubes being made to take a corresponding shape. For tubes of this modified construction the partitions or struts $r^1$ may, if desired, take the form shown in Figure 5 and in fact any convenient arrangement of struts may be used for the tubes $k$.

The wires or strips in all cases may be either laid across each other or woven together and if desired, considerable tension may be put upon them so that the tubes are kept rigidly in place before soldering, thus ensuring uniformity in the width of the passages between the tubes.

Figure 6 shows the usual form of cooler used for explosion engines, the mesh in this case being similar to that on the right hand of Figure 1.

Obviously other means may be employed for retaining the tubes in position although owing to the small space between the tubes a mesh formed by stamping is not found practicable as buckling and other difficulties occur. A mesh of any kind however, may be dispensed with and the tubes maintained in place by enlarged portions on the ends of the tubes acting as distance pieces to maintain each tube at its required distance from its neighbour. The tubes in this case may be soldered or otherwise secured directly one to the other so that the ends of the drum $a$, $a^1$ $a^2$ are closed as before whilst the cooling medium has free passage through the tubes.

For motor cars the cooling device is conveniently mounted at the forward end of the vehicle where it is exposed to draught created by the passage of the vehicle through the air and as the tubes are arranged to lie with their ends facing the direction in which the vehicle travels the air which serves in this case as the cooling medium has free passage through them.

In some cases it may be desired that the spaces between the ends of the tube at one end of the drum $a$, $a^1$ $a^2$ shall be greater than those at the other end of the drum. In this case a wider strip or thicker wire may be employed at one end of the drum to form the mesh by which the tubes are supported, or if the tubes themselves are provided with enlarged end pieces it is only necessary that

one end piece of each tube shall be larger than the other, care of course being taken to put the larger end pieces all on one side of the drum.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

1. In apparatus for cooling fluids the combination with a chamber of a number of flat-sided tubes for the cooling medium arranged parallel to and equidistant from each other within the chamber so that the latter is divided into intersecting passages whereby fluid passing through it is divided into layers of equal thickness substantially as and for the purpose described.

2. In cooling apparatus for cooling fluids the combination with a chamber of a number of flat-sided tubes for the cooling medium crossing the chamber in one direction, means for maintaining the ends of the tubes at one end of the chamber equidistant from each other and means for similarly spacing the tubes at the other end but with wider intervals so that fluid passing through the chamber transversely to the tubes is divided into layers of evenly increasing thickness substantially as described.

3. In cooling apparatus for cooling fluids the combination with a drum of a number of flat-sided tubes within the drum and enlarged ends to the tubes whereby they are maintained at the required distance apart and connected together so that they close the ends of the drum substantially as and for the purpose described.

4. In cooling apparatus for cooling fluids the combination with a drum or frame such as $a$ $a^1$ $a^2$, of a number of flat-sided tubes within the drum for the cooling medium and a mesh at each end of the drum formed of wires or strips secured to the drum and separating the tubes which are secured to them all substantially as and for the purpose described.

5. The complete cooling device for fluids substantially as described and illustrated in the accompanying drawings.

Dated this 14th day of November 1901.

BOULT, WADE & KILBURN,
Agents for the Applicant.

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A.D. 1901. Feb. 14 N° 3235.

MAYBACH'S Complete Specification.

(1 SHEET.)

Fig. 1.

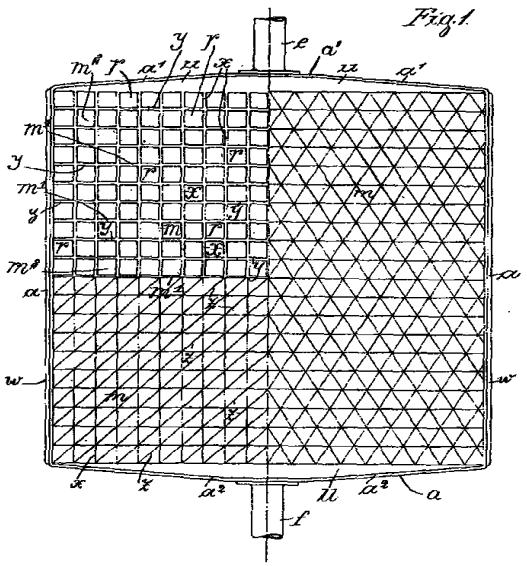
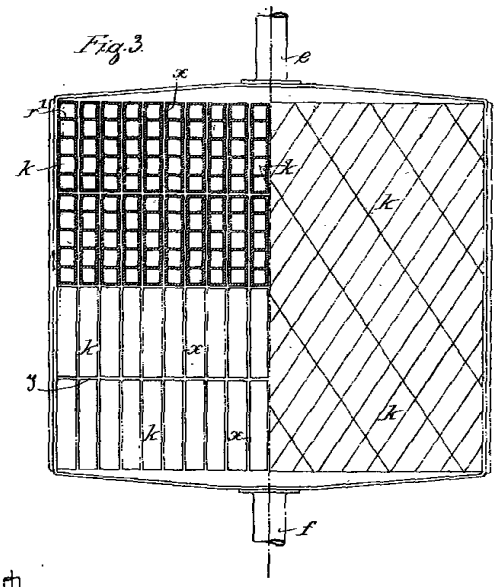


Fig. 3.



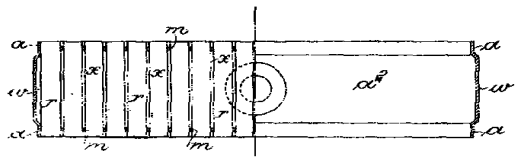


Fig. 2.

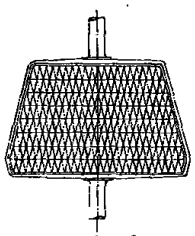


Fig. 6.

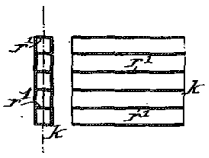


Fig. 4.

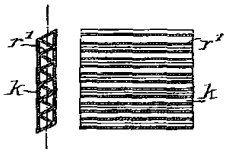
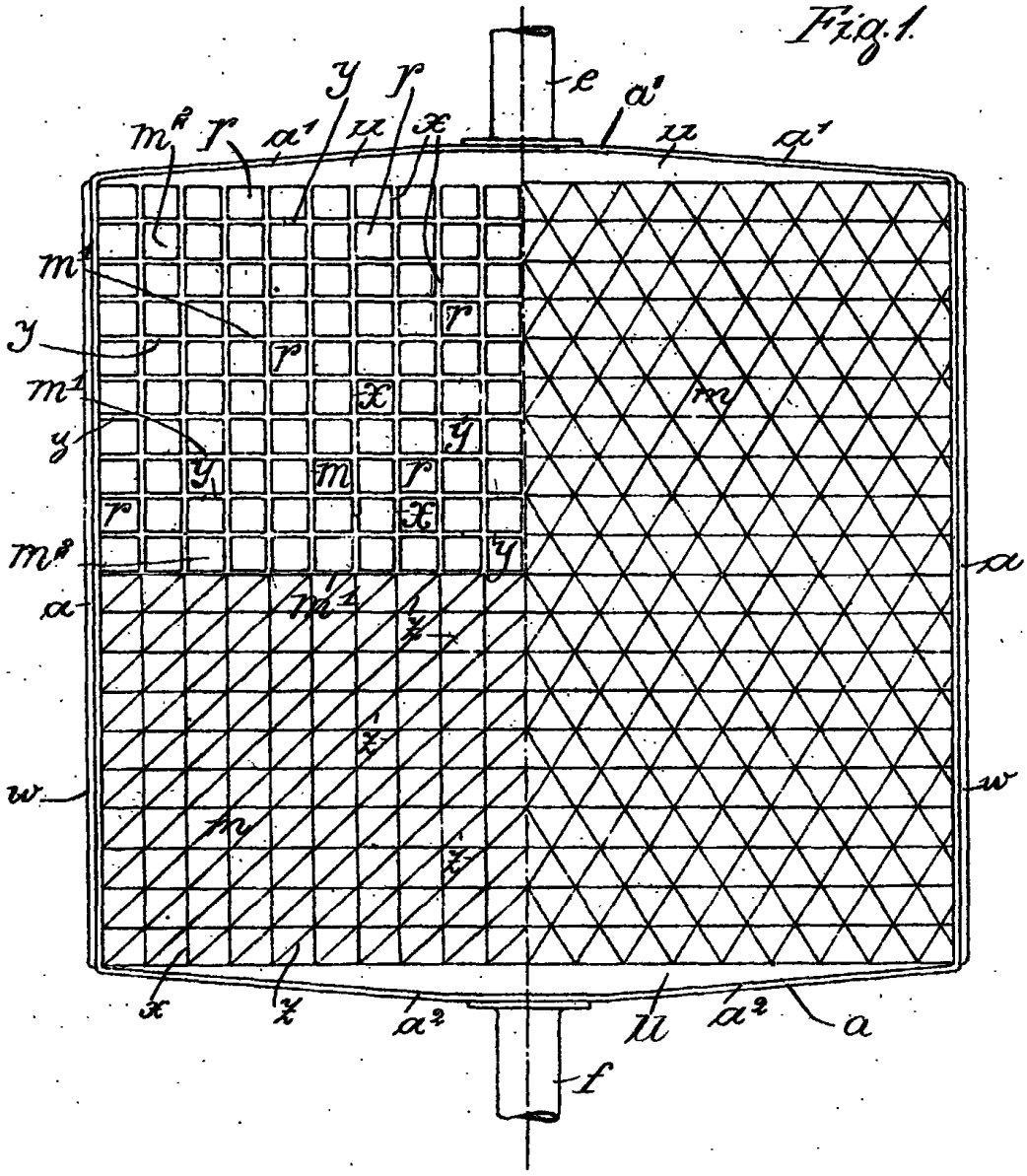


Fig. 5.

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.



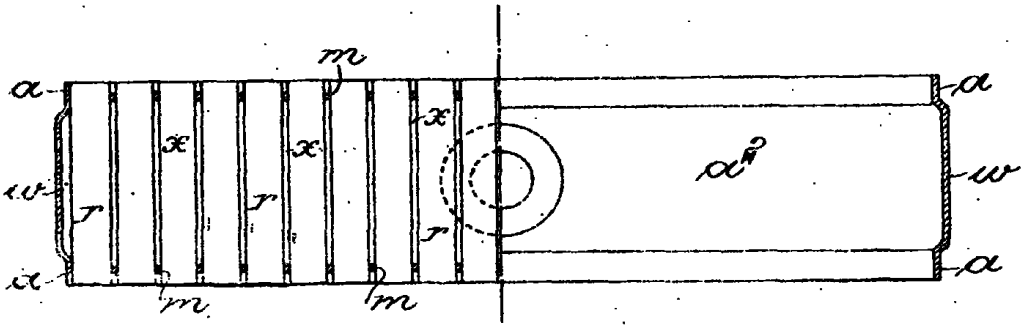
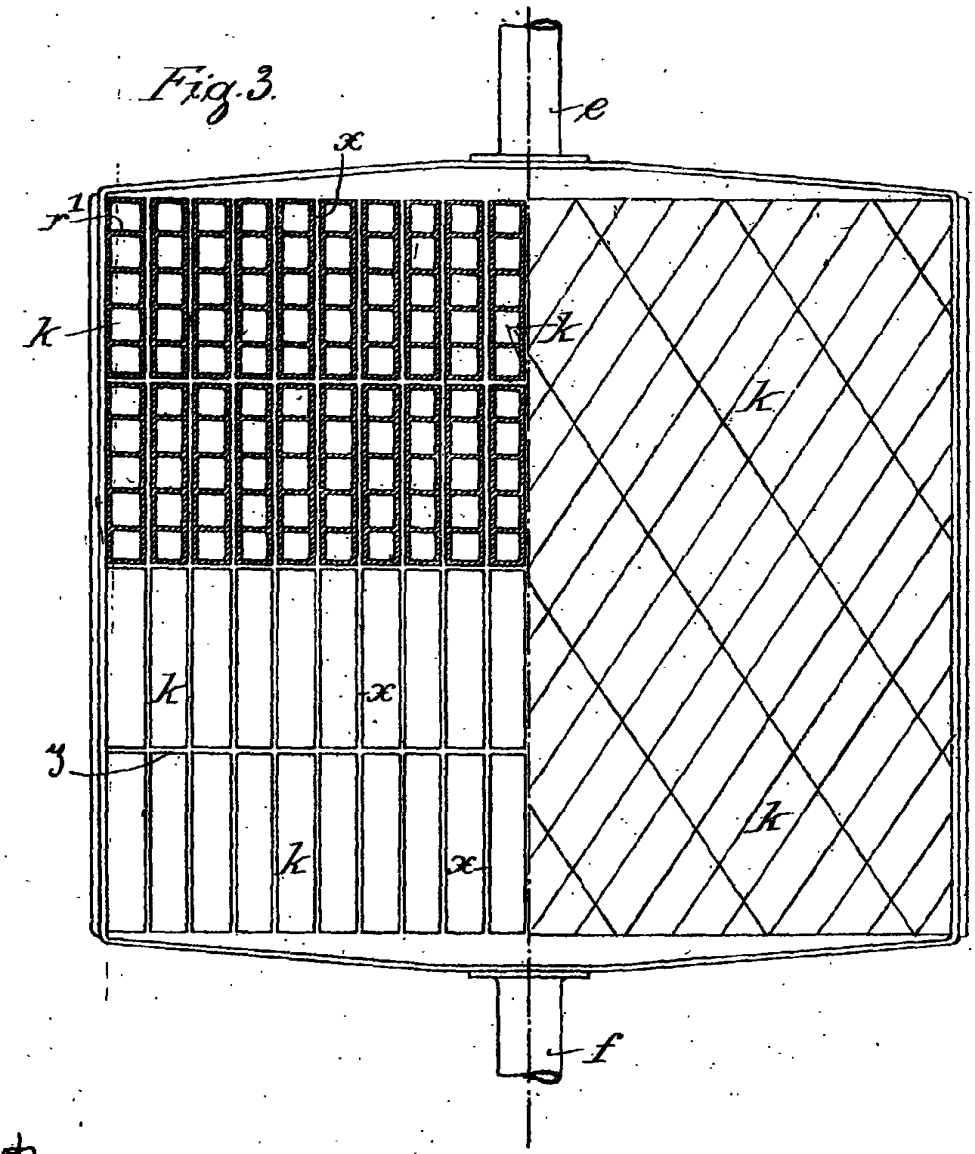




Fig. 2.

Fig. 3.



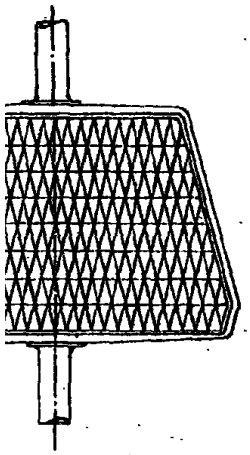



Fig. 6.

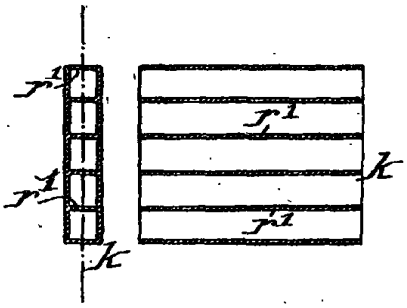



Fig. 4.

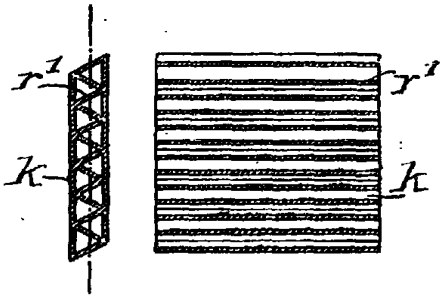



Fig. F.

[This Drawing is a reproduction of the Original on a reduced scale.]



Malby&Sons, Photo-Litho.