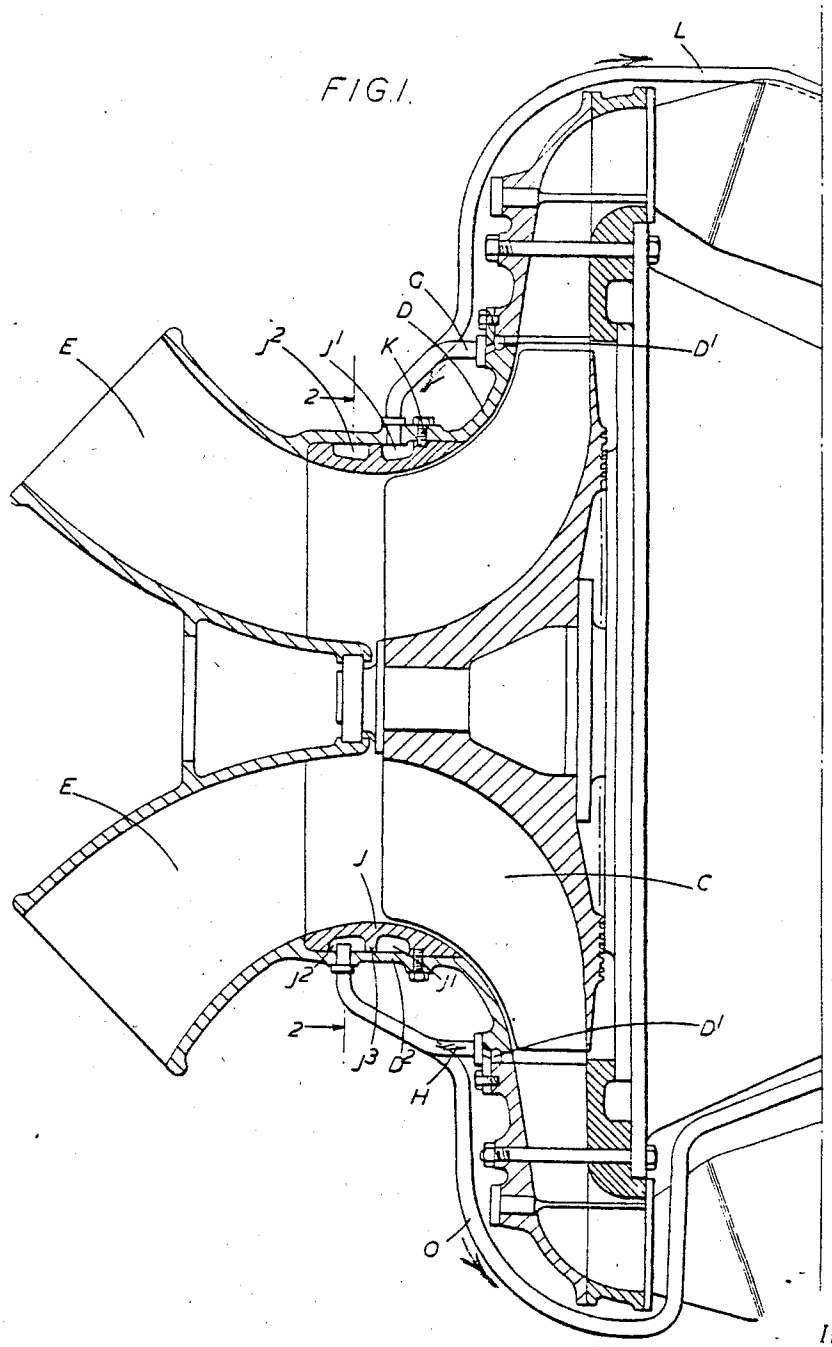
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TURBO-COMPRESSOR PROPULSIVE APPARATUS

Filed Jan. 16, 1945 4 Sheets-Sheet 1

FIG. 1.



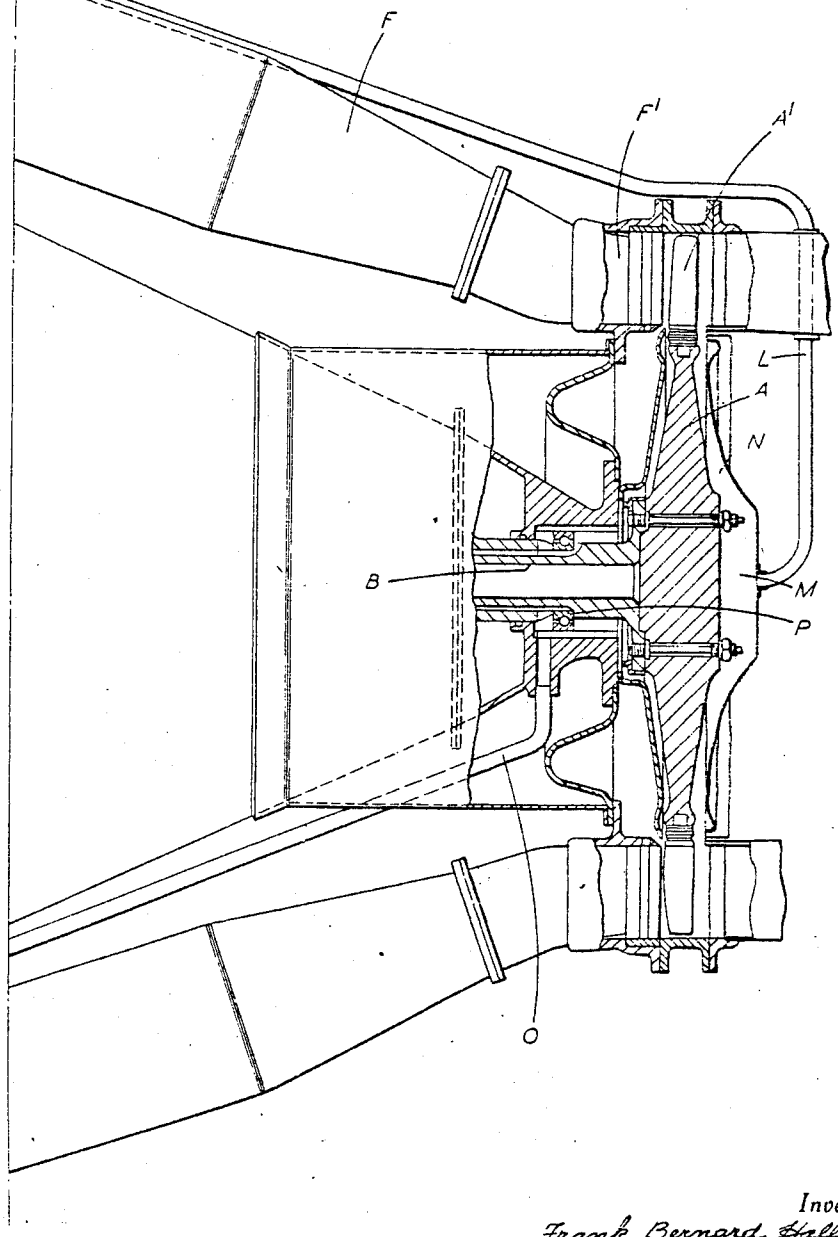
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TURBO-COMPRESSOR PROPULSIVE APPARATUS

Filed Jan. 16, 1945 4 Sheets-Sheet 2

FIG. 1a.



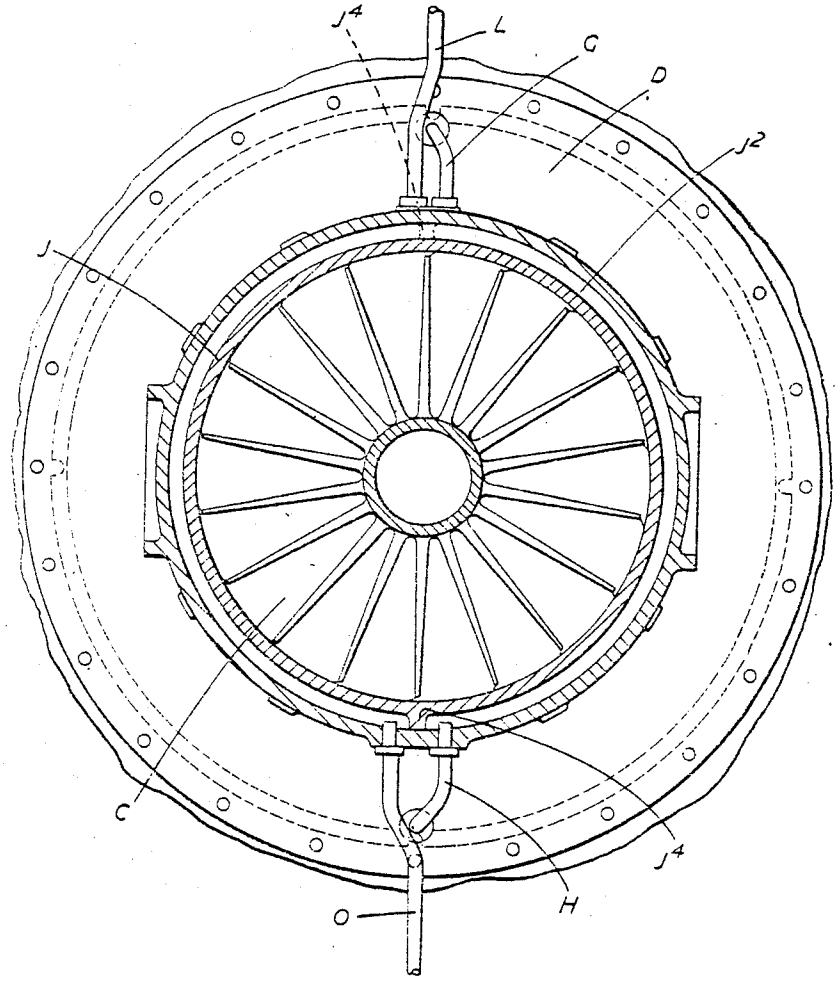
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TURBO-COMPRESSOR PROPULSIVE APPARATUS

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FIG. 2.



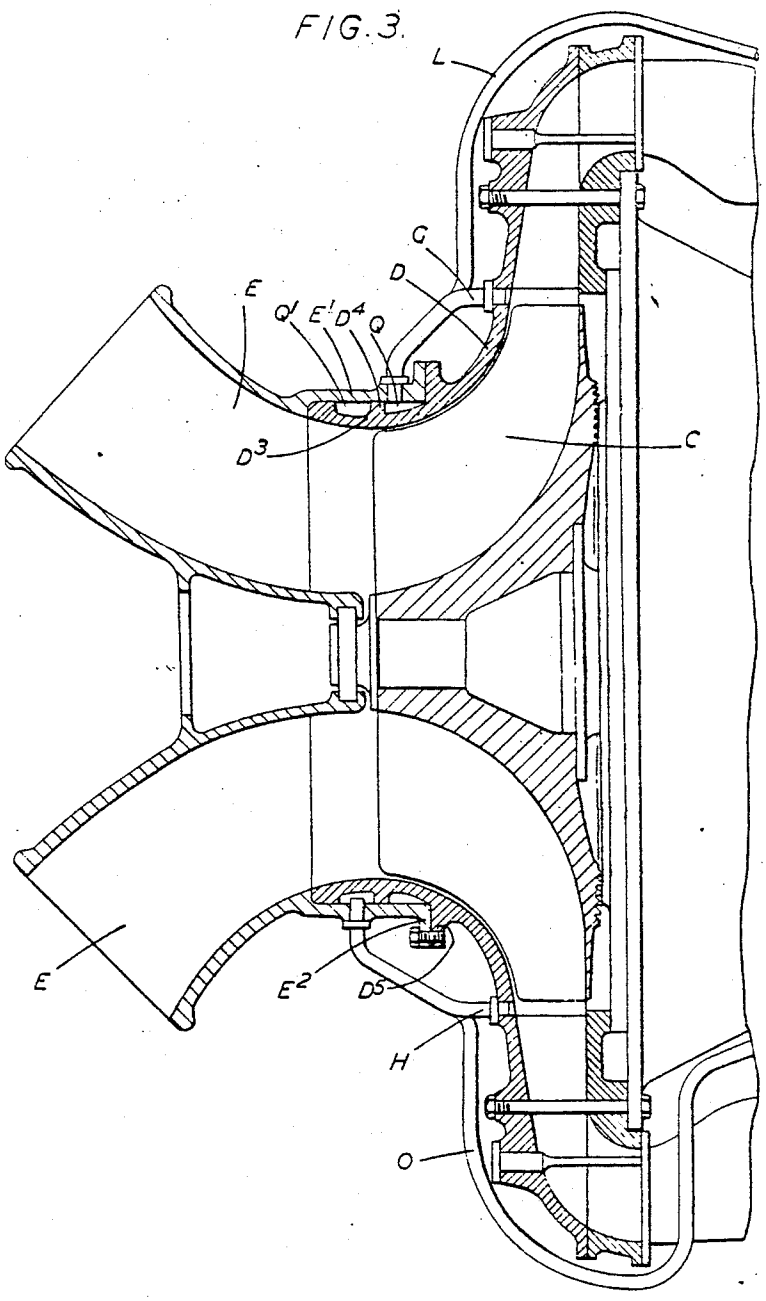
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TURBO-COMPRESSOR PROPULSIVE APPARATUS

Filed Jan. 16, 1945 4 Sheets-Sheet 4

FIG. 3.



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UNITED STATES PATENT OFFICE

2,399,865

TURBO-COMPRESSOR PROPULSIVE APPARATUS

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Application January 16, 1945, Serial No. 573,118
In Great Britain January 21, 1944

6 Claims. (Cl. 230—209)

This invention relates to turbo-compressor propulsive apparatus and has for its object to provide means whereby cooling of the bearings and disc of the turbine may be effected by the flow of air taken from the compressor.

In a known way by which this cooling is carried out the air drawn from some point in the compressor at which the air will be delivered at a pressure sufficient to ensure an adequate flow for the purpose, is led directly to the turbine bearing or to the turbine disc or to both of these. In such an arrangement in order that pipes and passages of reasonable size may be provided for the air, the supply must come from a place in the compressor where the pressure will be such that its temperature will be substantially above that of the surrounding atmosphere. This is due to the fact that in any compressor the temperature of the air passing through the compressor increases with the pressure and the cooling effect obtained with air drawn directly from the compressor is much less than is obtainable with an equivalent weight of air at atmospheric temperature. Hence the temperature difference between the air thus supplied and the maximum allowable temperature for the turbine bearing is not sufficient to permit of effective cooling. Moreover the higher the speed and duty of the turbo-compressor propulsive unit, so much the less becomes this temperature difference.

According to this invention air for cooling the bearings, and if desirable also the disc of the turbine is taken from the compressor and is cooled after leaving the compressor and before it reaches the part or parts to be cooled. This cooling of the air thus drawn from the compressor is effected by the air which flows through the intake to the compressor. Conveniently the improved arrangement may comprise in combination one or more chambers or passages in the wall of the air intake or like part of the compressor, a pipe leading to each of such chambers through which air at a pressure created by the compressor flows into the chamber wherein this air will be cooled by the air flow to the impeller of the compressor, and a pipe or passage leading from each such chamber through which the air after it has been cooled in the chamber is led to the part or parts to be cooled thereby. Each air cooling chamber is constituted by an annular space formed in the wall of the casing or like part through which the air flows to the compressor. In this chamber is a partition which so divides the space that air led into the chamber on one side of the partition is caused to flow circumferentially throughout the space to an exit on the other side of the partition. The annular air cooling chamber or passage may be formed by a separate member which when inserted into the casing of the air intake or like part of the compressor and fixed in place constitutes on one side of the member a part of the smooth wall of the air passage and at its other side encloses an annular space constituting the cooling chamber. Pipes lead to and from this chamber and through them flows the air which after cooling in this chamber is led to the turbine bearings or the turbine disc, or to both the bearings and the disc.

In addition to the partition mentioned above which extends across the annular space constituting the cooling chamber and causes the circumferential flow of the air through the chamber, it is convenient to divide the whole space so as to form at least two separate cooling chambers by one or more partitions which run circumferentially. Each of these chambers has its own pipes leading into and from it and through one pipe the air under pressure comes to the chamber from the point in the compressor where it is tapped off, and through the other pipe the cooled air flows away to the parts to be cooled by it. It is preferable to tap off the air supply for these cooling chambers from separate places in the compressor.

It will be appreciated that by arranging the cooler for the compressed air which is to cool the bearings or disc of the turbine in the manner indicated above it is possible to avoid loss of efficiency such as would tend to occur if a cooler were disposed where it would introduce a drag or resistance to the air flow through the propulsive unit. In the present arrangement the cooler will cause some rise in the temperature of the air flowing into the compressor, but as the heating effect on this air is small when considered in terms of the large air flow into the compressor, this effect is really negligible.

The accompanying drawings illustrate by way of example two alternative constructions which may be used in carrying the invention into practice. In these drawings,

Figures 1 and 1a show a longitudinal sectional elevation of a turbo-compressor propulsive apparatus with one arrangement according to this invention for effecting the cooling of the air prior to its delivery to the rotor of the turbine and the bearings adjacent to the turbine.

Figure 2 is a transverse section on the line 2—2 in Figure 1 looking in the direction of the arrows.

Figure 3 is a longitudinal sectional elevation

similar to Figure 1 and showing an alternative construction of the cooling chambers for the air.

Referring to Figures 1, 1*a* and 2, the turbine A is connected through the shaft B to the impeller C of the compressor which rotates in a casing D into which lead the twin intakes E. The air delivered by the compressor C flows through at least one combustion chamber to the blades of the turbine. In the construction shown the combustion chamber is constituted by a number of separate tubular chambers F into each of which fuel is supplied and the hot gases from all these chambers pass into a common annular chamber F^1 and the gases then act on the blades A^1 of the turbine rotor A. Air from the delivery side of the compressor and thus under pressure is tapped off through holes D^1 in the wall of the casing D and is led by pipes G and H to cooling chambers. These chambers are formed by the construction of an annular member J which is inserted and fixed in the intake of the wall of which it forms a part around the eye of the impeller C. This annular member J may be said to somewhat resemble a sleeve with its inner surface smoothly curved to carry on the contour of the intake and casing D about the eye of the impeller. On its outer side the member J is provided with two parallel annular recesses or grooves J^1 and J^2 which are separated by a rib J^3. At a suitable place in each groove J^1 and J^2 is a partition J^4 which runs transversely across the groove and thus converts it into an elongated and annular chamber as apparent in Figure 2 where it may be seen that these transverse partitions are situated at diametrically opposite places in their respective grooves. The sleeve member J fits into a part D^2 of the casing D which has a substantially cylindrical internal formation to receive this member which when it is fixed in place by studs K or otherwise completes the formation of two elongated and annular chambers in the wall of this part of the casing D. The pipe G delivering air under pressure from the compressor runs into the annular chamber J^1 and the pipe H runs similarly into the chamber J^2. From the chamber J^1 a pipe L takes the air which has been cooled in the chamber to a space M on the rear side of the turbine rotor and between the face of the rotor disc and a fixed enclosing disc N. The pipes G and L respectively enter and leave the chamber J^1 at opposite sides of the partition J^4 so that the air going into the chamber through the pipe G has to flow through the whole length of the chamber to the pipe L through which it passes away to the turbine. As this air traverses the chamber J^1 it will be cooled by the cold air which is drawn in through the intakes E by the impeller C. A pipe O runs from the annular chamber J^2 to the bearing P which is situated near the turbine and carries the shaft B. The pipe H which conveys compressed air into the chamber J^2 enters the chamber at one side of the partition J^4 and the pipe O leaves from the other side of this partition so that the air must flow throughout the length of the chamber and thus be cooled before passing to the bearing.

In the case of the pipes H and O which pass through the wall of the casing part D^2 at the lowest part of the annular chamber J^2 it is desirable that the end of each pipe should project, as shown in Figures 1 and 2, a short distance into the chamber so as to prevent moisture which may condense in the chamber from being carried over with the air.

Turning to the construction shown in Figure 3, it will be seen here that the annular cooling chambers are formed by making the intakes E separate from the compressor casing D. The intake is provided with a part E^1 which is substantially cylindrical on its inner surface so that it can be engaged with a part D^3 of the casing which is adapted to fit within the intake part. The inner surface of the casing part D^3 forms with the inside of the intake E the necessary smooth contour for the air flow to the impeller C when the intake has had its part E^1 pushed on to the casing. This casing part D^3 on its outer side is formed with two annular grooves Q and Q^1 which are separated by the annular rib D^4 and these grooves thus form the annular cooling chambers when the intake is in position. The interengaging parts are provided with flanges E^2, D^5 which butt up against each other and are connected by studs as shown. The air is led into and flows from these two annular cooling chambers through the pipes G and L, and H and O in the same way as described above with respect to the construction shown in Figures 1, 1*a* and 2.

The pipes G and H through which the compressed air flows to the cooling chambers may be led off from other points in the wall of the compressor casing, as for instance at places clear from and less near the impeller.

In propulsive apparatus of the type to which this invention relates it is essential that air employed for cooling the turbine bearing be free from foreign matter such as particles of dust and excess moisture. The present arrangement enables such foreign matter to be excluded since the construction makes it possible to effectually clean the interior of the cooling chambers before assembly, and the passing over of moisture can be prevented.

What I claim as my invention and desire to secure by Letters Patent is:

1. Turbo - compressor propulsive apparatus comprising in combination a turbine, a shaft driven by this turbine, a compressor coupled to this shaft, a casing enclosing the compressor with an intake passage thereto through which air is drawn by the compressor, a bearing for the said turbine driving shaft adjacent to the turbine, means for delivering to this bearing and also to the turbine air which has been compressed by the compressor for the purpose of cooling these parts, said parts including at least one chamber a wall of which forms a part of the intake passage to the said casing enclosing the compressor, at least one passage through which air is delivered by the compressor into this chamber, and at least one passage through which the air after passing through and being cooled in this chamber is led to a part which is to be cooled thereby.

2. Turbo - compressor propulsive apparatus comprising in combination a turbine, a shaft driven by this turbine, a compressor coupled to this shaft, a casing enclosing the compressor with an intake passage thereto through which air is drawn by the compressor, at least one annular chamber around this intake passage with a wall of the chamber formed by a part of the wall of the passage, means by which air from the compressor is delivered into this chamber, a bearing for the said turbine driving shaft adjacent to the turbine, and means by which air which has passed through the said annular chamber and been there cooled is delivered to and exercises a cooling effect on the said bearing and on the turbine.

3. Turbo - compressor propulsive apparatus comprising in combination the parts as set out in claim 2 in which the annular chamber around

the air intake to the compressor has therein a transverse partition with the passage through which air is delivered by the compressor opening into the chamber on one side of this partition and the passage by which the air which has been cooled in the chamber leaves it leading from the other side of this partition so that the air must travel throughout the circumferential length of the chamber.

4. Turbo - compressor propulsive apparatus comprising in combination the parts as set out in claim 2 in which at least one cooling chamber for the air around the intake passage to the compressor is constituted by two interengaging parts which when assembled on the one hand together provide the smooth wall of the air intake and on the other hand enclose between them at least one annular space through which passes the air to be cooled.

5. Turbo - compressor propulsive apparatus comprising in combination a turbine, a shaft driven by this turbine, a compressor coupled to this shaft, a casing enclosing the compressor with an intake passage thereto through which air is drawn by the compressor, two annular chambers around this intake passage with a wall of each chamber formed by a part of the wall of the passage, a partition extending transversely across each chamber, means by which air from the compressor is delivered separately into each chamber and at one side of and near the said partition therein, a bearing for the said turbine driving shaft adjacent to the turbine, means by which air which has passed through one of the said annular chambers and been there cooled leaves that chamber from near the side of the partition therein opposite to that at which the air entered the chamber and is led to the said bearing, and means by which air which has passed through the second of the said annular chambers and been there cooled leaves that chamber from near the side of the partition therein opposite to that at which the air entered the chamber and is led to the turbine which is cooled thereby.

6. Turbo - compressor propulsive apparatus comprising in combination the parts as set out in claim 5 in which the two cooling chambers for the air around the intake passage are constituted by two interengaging parts which when assembled on the one hand provide the smooth wall of the air intake passage and on the other hand enclose between them two annular spaces through each of which passes the air to be cooled.

FRANK BERNARD HALFORD.