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METHOD FOR MAKING AIR COOLED CYLINDERS

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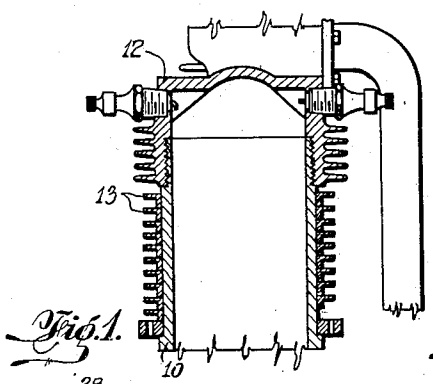


Fig. 1.

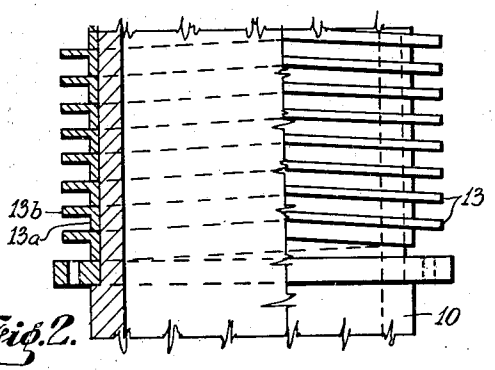


Fig. 2.

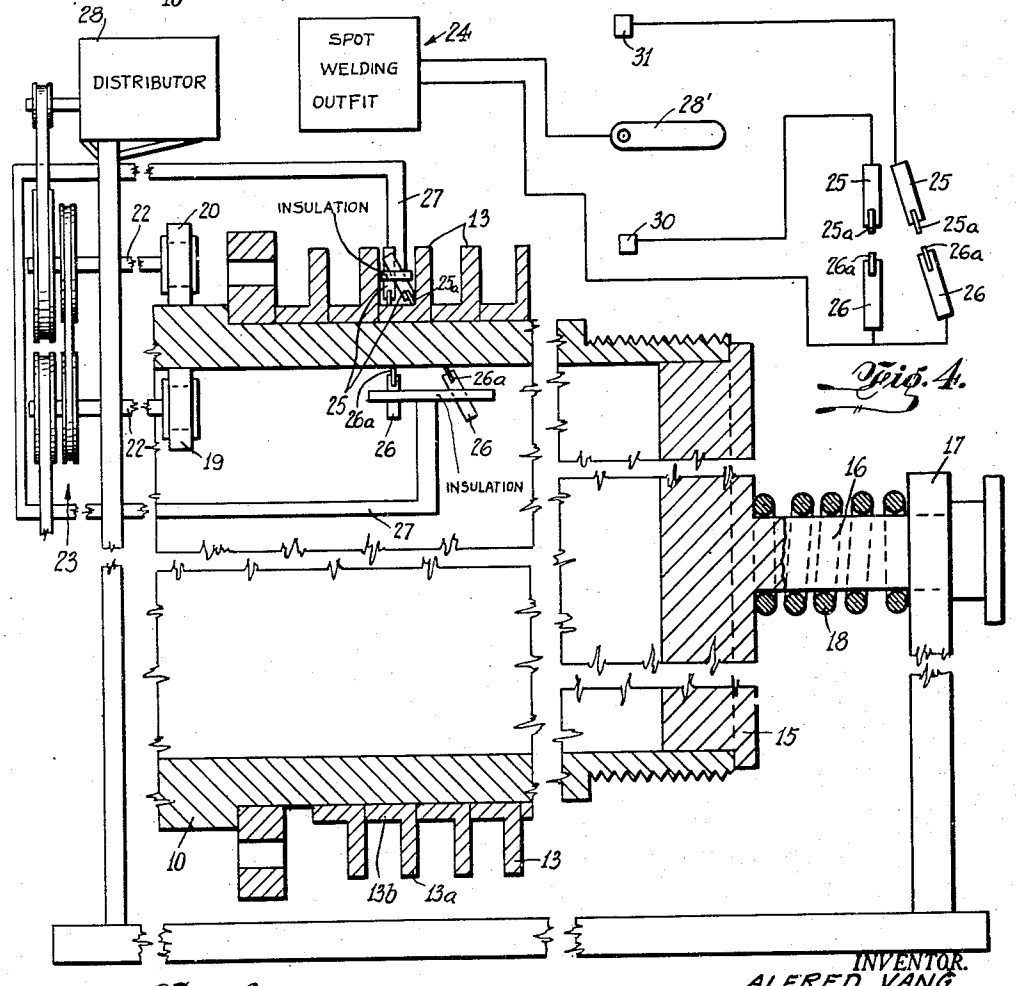


Fig. 3.

Fig. 4.

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METHOD FOR MAKING AIR-COOLED CYLINDERS

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2 Claims. (Cl. 219—10)

This invention relates to new and useful improvements in a method for constructing air-cooled cylinders for engines, refrigerator systems, heating systems, and other purposes. Thus, it may in like manner be applicable to any hollow object to which it is desired to impart the characteristics of my invention.

While this specification will be directed to an internal combustion engine, this should not be viewed as a limitation of the invention, but rather as an example and illustration.

The main advantage gained with respect to an engine resides in greatly increasing the thermal efficiency of the radiating system in said engine. This is very important because it then becomes possible to increase the horsepower of air-cooled engines without any increase in weight. It is rather obvious what this will do in aviation. It will increase speed, flying distance, load carrying ability, and improve other characteristics of the airplane.

It may here be pointed out that with an increased thermal efficiency of the radiating system of the engine, it becomes possible to operate the engine at a higher compression. Of course, more fuel will be consumed and more heat will be liberated. The extra consumption of the fuel will increase the horsepower of the engine. The higher temperatures will not, however, be detrimental because of the more efficient radiating system.

Fundamentally this new method for constructing an air-cooled cylinder consists in closely spot welding fin material of great thermal conductivity directly upon the steel cylinders of the engine. Preferably, this fin material will be aluminum, as this material has a great conductivity constant at high temperatures. Other materials may also be used, such as copper. At relatively lower temperatures copper is a better conductor of heat, but at the high temperatures proposed for the improved engine, aluminum will be ideal.

In order to properly understand this invention some consideration should now be given to the phenomenon of heat transmission. Heat is propagated from one place to another by conduction in which the heat passes from one body to another, or even from one part of a body to another by actual contact. The accepted theory of heat conduction is that the warmer molecules of the body impart heat to the colder ones. The transfer of heat is not static but an active condition in which each molecule is absorbing and radiating heat at the same time. The hotter molecules radiate more heat energy than they absorb, and the colder ones absorb more than they radiate. The result is that there is a tendency for equalization of temperature, but even after the equalization of temperature has been reached the process of radiation and absorption continues.

When bodies are in physical contact with each other, as distinguished from molecular connection, there is always a film between the bodies which have great heat resistant qualities. This film may be one of oil, oxide, or other foreign impurities. It is a generally accepted theory that film of this nature accounts for 90% of the difference in temperatures between contacting bodies which are at different temperatures and which are undergoing the transfer of heat from the hotter to the colder one, and in which a sufficient time has passed and yet the temperatures have not been equalized.

Bearing in mind the phenomenon of heat transmission, we are now ready to consider the prior methods and constructions of air-cooled cylinders. In one of these old constructions the fins were forged or by any other method made integral with the steel cylinders themselves. This method has long been discarded since steel is a relatively poor conductor of heat in relation to such metals as copper and aluminum. Even though the steel fins were integral with the steel cylinders, the thermal efficiency of the radiating system was poor, tending to cause the cylinders to become red hot and consequently requiring a cutting down of the number of explosions in a time interval and the pressures of these explosions. Engines having radiating systems thus constructed were consequently heavy in relation to the horsepower they produced.

An improved method was subsequently developed in which copper fins or fins of other good conducting materials were shrunk on to the steel cylinders. This construction, however, also embodied numerous inherent defects. In the first place the contact between the fins and the cylinder was poor, even though very tight. An objectionable film, such as previously pointed out, always existed. This film in itself cut down the conduction of heat from the cylinder to the fins. Another important defect was that when the cylinder and fins became heated they would expand different amounts, and under certain conditions the fins would actually become loose and this, of course, further impaired the efficiency of thermal radiating system from the cylinder. While engines of this type developed more horse-

power than the previous types, they were soon further improved.

The latest improvements prior to the instant invention, included the actual welding or brazing of a binder material to the cylinder, and welding or brazing of fins to the binder material. This construction was a great deal better than the prior construction, but it is not at maximum efficiency. The use of the binder material cuts down the efficiency of the radiating system since it acts in the nature of a composite wall. While the welding or brazing process theoretically places the molecules in molecular contact with each other, it is known that the maximum radiating efficiency is not obtained because of the composite nature of the wall thus produced, which cuts down the conductive qualities. Obviously the molecules are not in tight connection with each other and the formation of a composite wall thus interferes with the free transfer of heat between them.

The reason that prior constructions made use of a binder was that no commercial method was known for directly welding fins of aluminum or other highly conductive material on to the steel cylinders. Spot welding of dissimilar metals was known, but the usual spot welding would not suffice in this case because, then only, points of the dissimilar metals would be in molecular connection, while the remaining area would merely be in physical contact with each other.

We may now understand the present invention by realizing that it covers a method for actually welding fin material of great thermal conductivity, such as aluminum (and others) to steel cylinders. The new and improved method essentially consists in an arrangement by which the spot welding may be so closely arranged that the weld will be substantially 100% continuous. It is only done at spots, but these spots contact and overlap each other, thus producing the continuous weld. In this way a spot welding method is used for continuously welding the fin material to the cylinders.

The invention further proposes to characterize the new method by use of spot welding electrodes and an arrangement for relatively moving these electrodes along the fin material and the cylinder, and to rapidly spot weld during this motion.

Still further, the invention proposes to arrange the fin material in the nature of a strip and to feed it spirally on to the cylinder, and during this feeding operation to move the spot welding electrodes relative to the fin material and the cylinder to accomplish the close welding of these materials.

With the above and other objects in view, this invention consists of the novel features of construction, combination, and arrangement of parts, hereinafter fully described, claimed, and illustrated in the accompanying drawing, forming part of this application, and in which similar characters of reference indicate corresponding parts in all views, and in which:

Figure 1 is a sectional view of one of the cylinders of an air-cooled engine, embodying this invention.

Figure 2 is a fragmentary enlarged detailed view of a portion of Figure 1, but with a front portion of the cylinder being illustrated.

Figure 3 is a sectional view of the cylinder shown in Figures 1 and 2, but illustrated in conjunction with means for constructing the cylinder with the fins in accordance with this invention.

Figure 4 is a schematic view of the welding outfit used in this invention.

In Figure 1, reference numeral **10** indicates generally the steel cylinder of an internal combustion engine. This cylinder is shown provided with a cylinder head **12**. The cylinder is also provided with fins **13** for assisting in radiating the heat of combustion. The invention relates especially to the application of these fins **13**.

In Figure 2 a detail is disclosed of the fins **13**. It should be noted that they are formed from a strip of material wound helically on the cylinder **10**. This strip of material is substantially of L-shape in transverse cross section, so as to have an arm portion **13***a* which engages against the outside diameter of the cylinder **10** and a radially projecting arm portion **13***b* from which the heat radiates freely. The invention particularly proposes that the fins **13** be made of aluminum or other material of great thermal conductivity. The invention relates to the welding of the fin material **13** to the steel cylinder **10**.

In Figures 3 and 4 a detail has been shown of the means for welding the fin material in position. The cylinder **10** is rotatively supported by an end disc **15** which is engaged in one end thereof. This end disc is mounted on a shaft **16** rotatively supported in a standard **17**. A spring **18** urges the disc **15** into the end of the cylinder **10**.

A pair of friction rollers **19** and **20** frictionally engage opposite points upon one side of the cylinder **10**. Specifically, the friction rollers **19** and **20** are located inside and outside of the cylinder **10**. These rollers are mounted on the shafts **22** of a drive system **23** which is designed so that the cylinder **10** will be slowly turned.

A spot welding outfit **24**, having a gang of electrodes **25** and **26** located inside and outside of a wall area of the cylinder **10**, is arranged to closely spot weld the fin material **13** to the cylinder. The electrodes **25** and **26** have contact rollers **25***a* and **26***a* for engaging the work, and are supported by a support frame **27**. One of the electrodes is disposed in the corner of the fin and one of the opposed electrodes is offset so that a line joining the two substantially passes through the corner portion of the fin. This support frame **27** is resilient material so that the electrodes **25** and **26** may be properly pressed against the work being welded. The electrodes **25** and **26** are connected up with a distributor **28** which is driven by the drive means **23**, so as to work simultaneously with the turning of the cylinder **10**. The distributor **28** has a rotating arm **28'**, which engages the contacts **30** and **31** in succession to close the electrical circuit to the individual electrodes of the gang of electrodes so that they work one pair at a time. The details of the spot welding outfit will not be given in this specification as it forms no part of the invention and any type of outfit may be used. The type recommended would be like that disclosed in my invention covered by the U. S. Patent No. 2,287,544, issued June 23, 1942, and entitled "Electric welding of metals and the uniting of dissimilar metals."

The operation of the device is as follows:

The fin material **13** may be drawn off from a supply spool, or supplied in any other desirable way. It is helically wound on the cylinder **10** in the manner illustrated in Figures 2 and 3. It may be closely spot welded as it is helically wound on the cylinder, or it may be subsequently spot welded after it has been placed in position.

The spot welding operation must be carried out as follows: The gang of electrodes **25** and **26** is

started at one end of the fin material 13. The cylinder 10 slowly rotates and the gang of electrodes move longitudinally along the helical formation. During this motion the electrodes individually spot weld points of the fin material and the cylinder. These points must be very closely spaced together. In fact, they must be so closely spaced that they overlap. This welding operation may be carried on in one operation, or the spot welding may be carried on in more than one operation. When the latter system is used the spot welding initially is not spaced so closely, but then a second series of spot welding is done in between the points of the first group of spot weldings. In this way the fin material 13 is closely spot welded, in fact, so closely spot welded that it is substantially 100% welded to the cylinder 10.

It is pointed out that the fin material 13 is directly welded to the cylinder 10. There is no intermediate third material to form a binder between them. As pointed out in my prior patent the spot welding operation breaks through the film on the contacting surfaces of the materials being spot welded. Thus the objectionable film which hinders the conduction of heat is broken up, and the molecules of the fin material will be in molecular contact with the molecules of the cylinder. When this is so, there will be free conduction of heat from the cylinder 10 to the fins 13.

It will be found that the thermal efficiency of the radiating system of the cylinder when constructed in accordance with this invention will be some 27% higher than with the past prior construction. Because of this, the engine may be designed to produce more horsepower per unit of weight. The advantages of this have already been discussed in the object portion of this specification.

It is obvious that slight changes may be made in the form, construction, and arrangement of the several parts, as shown, within the scope of the appended claims, without departing from the spirit of my invention, and I do not, therefore, wish to limit myself to the exact construction and arrangement shown and described herein.

The apparatus disclosed herein forms the subject matter of my application, Serial No. 513,885, filed December 11, 1943.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. A method for providing hollow steel cylinders with fins, said method comprising helically winding metallic strip material of L-shaped cross section on and around the exterior face of the cylinder, the base of the strip of each turn being applied flat against said face, and applying high frequency, high voltage current to a turn and a cylinder between a point at the inside corner of the strip and the point where the shortest line passing substantially through the outside corner intersects the inner face of the cylindler.

2. A method for providing hollow steel cylinders with fins, said method comprising helically winding metallic strip material of L-shaped cross section on and around the exterior face of the cylinder, the base of the strip of each turn being applied flat against said face, and applying high frequency, high voltage current to a turn and the cylinder between a point at the inside corner of the strip and the point where the shortest line passing substantially through the outside corner intersects the inner face of the cylinder; the application of said current being intermittent and at points progressively along the turns to form a series of spot welds, so closely spaced as to substantially overlap.

ALFRED VANG.