Memorandum on Copper Conservation Project for Use in Your Wednesday Talk

51-3

Schenectady, July 23, 1951

Mr. W. A. Sredenschek:

Because copper in most of our products has at least doubled in cost since design decisions were made while aluminum has increased relatively little and because, in the long range, aluminum promises to become more plentiful while copper more difficult to obtain, we decided to aggressively examine the practicability of using aluminum instead of copper for our electrical conductors. We first established that our program would be based upon sound dollar economy, where aluminum will stay because of relative cost even though copper should temporarily become readily available.

An interesting application is for the interpole coils of the generator used in the Diesel locomotive. These coils are edge-wise wound of copper ribbon approximately 1/8" x 1". The coil then in the form of a "spring" must be provided with insulation between each turn and some additional insulation overall at points which come in contact or are adjacent to the core or the frame of the generator. Significant information follows:

Use of copper per coil	8.3 lbs.
Present cost per coil	$3.30
Coils per generator	4
Present production rate--generators per year	1,000
Copper consumption per year	33,000 lbs.
Copper dollars cost per year	$13,000

While the present facilities for producing aluminum in conductor sizes and grades have not been developed to any degree commensurate with that for copper, a study of the conductor needs with the aluminum suppliers indicates that electrical conductivity (considering higher resistance, lower weight, relative costs, etc.) should become available in aluminum at a cost of from 50 to 60 per cent when compared to copper.

When the study is first initiated, it runs into several retarding factors such as; "We have considered aluminum about every year for this and its use is always rejected for good reasons"; "The problem of making satisfactory low-resistance, non-corroding joints where it attaches to the copper has not been satisfactorily solved"; etc.

However, a more intense study begins to develop factors in its favor; for example, although to conduct the same current with the same watts loss and the same heat rise in the same environment 60 per cent more aluminum would be required, the following factors are found to apply:

1) Anodized (aluminum oxide) coatings are readily put on aluminum. The raw material is sulphuric or other acid, water and electric current. These insulations have excellent adherence but are brittle. They are low cost and are readily applied by high production processes.

2) They are applied as a "plating" excepting somewhat in reverse; that is, as soon as an area "plates" over with the oxide it becomes insulating and plates no more. Therefore, the oxide penetrates very small crevices and leaves no pinholes. It is further true that only one thickness of the anodized coating can be applied. It is normally about .0005" in thickness but, our laboratory has found, can be varied considerably by varying the temperature of the bath at application.

3) In anodizing, the coil would be pulled apart slightly very much as a spring is opened so that it quickly and economically receives the coating throughout.

4) Since the insulation is only .0005" rather than the present .010" , approximately 10 per cent additional aluminum area can be added.

5) A study of the mounting of the coil indicates that the size can probably be increased slightly in other directions to account for a total of 33 per cent area increase.

6) This would mean that the aluminum would operate at higher temperature for which, in fact, the aluminum oxide is ideally suited. The anodized coating will stand temperatures up to the melting point of the aluminum.

7) Examination of the present coil discloses that it is completely surrounded by various insulating coatings intended for electrical insulation from ground but which, in effect, thermally isolate the present winding. This insulation includes fiberglass, mica, paper, and tape. By providing

this overall insulation only at such locations where the core or the frame is adjacent, portions of the winding can probably be left entirely open to facilitate cooling as is, in fact, done in some other models where copper is so used. This might carry away enough heat to provide satisfactory operation.

8) Another interesting point, however, is that the blower blades which draw air through the motor have been reviewed by our fan specialists who advise that by the use of modern curved blades instead of the present straight ones a considerably larger volume of air will be drawn through the motor even with the same power so that, if need be, this added factor may be called upon to promote the successful use of aluminum.

9) Satisfactory joints are being made between aluminum and copper providing proper procedures are carefully followed. The materials can be spot welded, flash welded, fusion welded, soldered, and secured by several satisfactory mechanical arrangements. In addition to this, Herb Schnell is now investigating a new material which it is said will soon be available and that is a sheet having aluminum on one face and copper on the other, which will simplify this type of joint.

Based upon the above it seems reasonable to achieve a saving on this one job of 33,000 lbs. of copper, and based upon 60 per cent cost, a saving of $5,000 cash annually. In addition, we now have labor in insulating these coils to the extent of $5 per coil at shop cost. It seems entirely reasonable that this may be reduced to $1.50 saving another $3.50 per coil for a total of $14,000.

This is only one example. We noted similar examples in the Control Division; for example, the attached partial coil.

L. D. Miles

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