CONSERVATION OF CRITICAL MATERIALS

RADIO CORPORATION OF AMERICA
RCA LABORATORIES DIVISION
INDUSTRY SERVICE LABORATORY

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The conservation of critical material in the manufacture of receivers, tubes, and material required for installation can be approached from two separate and different viewpoints:

1. Reduce the use of critical material by reduction of the number of components, thereby reducing the performance and quality of the receiver;

2. Maintain quality and performance by redesigning components to take full advantage of any new non-critical materials not previously used. Where this is not possible, completely redesign the components and receiver to use the minimum amount of critical material, even though it may be necessary to add components.

RCA engineers are committed to following the second approach. We believe this is imperative in order to produce receivers of highest quality and performance. It is our viewpoint that it would be harmful to the industry to produce television receivers that would affect conservation of scarce materials at a sacrifice in quality.

We have made important savings of critical material and, at the same time, have continued production of high quality tubes and receivers. This is particularly important in that it permits keeping trained employes who will be needed to design and manufacture armed services equipment when needed.

The following tabulation is a summary of the savings based on production of 1,000,000 receivers. The first column shows savings in present production of 17-inch television receivers. The second column shows the material savings which we expect will result from the application of electrostatic focused kinescopes to these receivers.

Material	Pounds Material Saved Compared to Second Half 1950 Typical 16-17" Television Set #1 Pounds saved/ 1,000,000 sets, Present Production based on 17" TV set	#2 Pounds saved/ 1,000,000 sets - electrostatic focused 17" TV set
Alnico V* Speaker Saving based on 2.15 oz. magnet 8" table model speaker	72,000 pounds	72,000 pounds
Alnico V* Speaker Saving based on 3.16 oz. magnet 12" console speaker	135,000 pounds	135,000 pounds
Alnico V* Focus Magnet Based on 5 oz. magnets	-	310,000 pounds
Alnico V* Beam Bender	4,400 pounds	4,400 pounds
Steel in 12" Speaker	142,000 pounds	142,000 pounds
Brass in 12" Speaker	50,000 pounds	50,000 pounds
Zinc in Focus Magnet	-	310,000 pounds
Steel in Focus Magnet	-	500,000 pounds
Brass in Focus Magnet	-	22,000 pounds
Aluminum--Cup Over Back of Kinescope	62,000 pounds	62,000 pounds
Brass in Volume Controls	12,200 pounds	12,200 pounds
Copper-Shorting Band in Power Transformer	190,000 pounds	190,000 pounds
Copper Hook-up Wire	47,000 pounds	47,000 pounds
Copper--Leads on Paper and Ceramic Capacitors	11,850 pounds	11,850 pounds
Aluminum Shield	100,000 pounds	100,000 pounds

*Alnico V contains approximately 24% cobalt, 14% nickel, 8% aluminum, 3% copper and 51% iron.

The following tabulation summarizes the metal savings which are in effect in the manufacture of tubes and ferrite magnetic cores used in the manufacture of 1,000,000 television receivers. A typical 23-tube television receiver was used in these calculations.

Material	Savings per 1,000,000 Television Receivers.
Nickel	
(a) Nickel content in ferrite cores	12,400 pounds
(b) Nickel in receiving tubes and kinescopes	33,600 pounds
Copper in receiving tubes and kinescopes	33,000 pounds
Tin content in solder	50 pounds

The more important conservation steps that have been taken are as follows:

When it became known that practically all of the available cobalt would be required by the government for defense items, a study was immediately started to see what could be done to eliminate cobalt from our instruments. Alnico V magnets were used in focus magnets and speakers. (Alnico V contains 24% cobalt, 14% nickel, 8% aluminum, 3% copper, and 51% iron.) The average focus magnet contained 5 ounces of Alnico V, and the average speaker contained 2.5 ounces of Alnico V, or a total of 7.5 ounces per instrument.

The problem of reducing or eliminating cobalt used in speakers could be attacked by changing to an electromagnetic speaker to save the 2.5 ounces of Alnico V. To solve the problem in this way would have resulted in the addition of approximately 1 pound of copper for the field coil. Instead, it was considered more advisable to retain the Alnico V magnet, but to reduce its size as much as possible consistent with maintaining acceptable performance. A complete study and redesign of speakers was made with the result that the largest magnet now used is 1 ounce and the average is approximately 0.75 ounce. This redesign also resulted in a saving in the accompanying steel and brass parts, so that from the speaker standpoint, the savings are as follows:

Alnico V	- 70%	saving	compared	to	early	1950
Steel	- 35%	"	"	"	"	"
Brass	- 90%	"	"	"	"	"

This program is currently in effect and the speaker manufacturers are aware of it.

A reduction of Alnico used in the focusing magnet of the kinescopes is a slightly longer range change which is being very actively worked on. The focus magnet can be removed completely by continuing the use of electromagnetic focused kinescopes with electromagnetic focusing coil, or by changing to electrostatic focused kinescopes.

Electromagnetic focusing would require the use of a focusing coil with approximately 2 pounds of copper wire and with an adjustable D.C. current flowing in the coil. The D.C. power supply handling capacity would have to be increased in order to furnish this current. This in turn would require more copper and iron in the power transformer, or more electrolytic capacitors and selenium rectifiers which require aluminum. This program would obviously be impractical because, although it would save cobalt in the magnet material, it would use much more copper, aluminum and steel. It was therefore decided to change to electrostatic focusing. The change to the use of electrostatic focused kinescopes will cost slightly more per instrument because of the cost of the special components involved, but these special components do not involve critical materials.

The timing for introducing electrostatic focusing in production is determined by the availability of kinescopes, since the kinescope must be changed to permit this type of operation. The 17-inch rectangular sets (which is the largest item of production in the industry this year) will be changed to electrostatic focusing in the second quarter of 1951. By the end of the second quarter of 1951 it is planned to be completely changed over to electrostatic focusing on all sets.

The resultant saving is 5 ounces of Alnico V, approximately 5 ounces of zinc, and approximately 8 ounces of steel.

When we have completely changed over to electrostatic focusing, and assuming that we continue to average 0.75 ounce of Alnico V for the speaker, the total saving in Alnico V will be from 7.5 ounces to 0.75 ounce, or a saving of 90%.

Copper has become a very critical item; and we have effected savings in various ways. Our power transformers originally specified a shorting band 40 mils thick and approximately 2 inches wide. The specifications have been changed cutting the thickness in half, with a resultant saving of 0.19 pound per transformer. Hook-up wire has been reduced from 22 to 24 gauge, resulting in a saving of 33% in the amount of copper used. Certain screw machine parts which are used in the 45-rpm record changer and other places, and which were originally made of brass, are now made of steel.

Since RCA Victor does not manufacture all components, but purchases many parts that go into its instruments, changes in specifications of purchased components to save critical materials are made in cooperation with the various suppliers. Some of the changes which have been authorized are as follows:

- The cup over the end of the kinescope on the rear of the cabinet has been changed from aluminum to plastic.

- Shorter mounting bushings on some variable controls, saving approximately 10% of the brass in these controls.

- Reduction in the length of copper wire leads on paper and ceramic capacitors (20% copper saving).

- The use of copper clad steel wire instead of copper wire leads on wire-wound resistors and chokes.

- The use of Alnico 3 magnets (no cobalt required) for beam benders, instead of Alnico V magnets.

For future designs we are continuing to work in the direction of improved components and circuit efficiency, in order to further reduce the amount of materials used. Except for the power transformer, the deflection yoke is the largest component user of copper. Design work has been under way for some time to effect a saving here, and a design using only 50% of the usual amount of copper in the high-voltage coil and yoke appears promising. This in turn will still further reduce the amount of copper in the power transformer by an appreciable amount. The chassis size and depth can also be reduced in the future.

If these developments are entirely successful, we will be able to make additional important savings in steel, copper and transformer steel, over and above the savings shown in the above tabulation. We expect these developments will be completed by the end of April 1951, and we will then issue further information.

The conservation efforts and accomplishments given above relate to the metal content in television receivers. Another important component used in a receiver is the ferrite cores, used as a magnetic core material in deflection yokes, I-F coils, etc.

Nickel Oxide

Throughout the second half of 1950 our engineering organization has been engaged in an active program to conserve nickel oxide in

ferrites by changes in the chemical and metallurgical formulation of the ferrite. The following progress has been made to date.

1. A change in formulation from 13% to 10% NiO has been successfully developed, and after final tests on end products, will be effected in production in February 1951. This results in a reduction of approximately 23% in NiO content.

   This saving of approximately 23% in nickel oxide content results in a saving of 12,400 pounds of nickel in the nickel oxide, per 1,000,000 television sets produced.

2. Additional engineering and laboratory work to reduce our NiO consumption by another 50% is now in process and is expected to be effected in the second quarter. This is based upon a formulation using magnesium oxide to replace a certain amount of the nickel oxide, reducing the NiO content to only 5%.

   If we are successful in this further reduction to 5% nickel oxide, an additional saving of 20,000 pounds of nickel content in the nickel oxide will be made per 1,000,000 television sets.

Very active development programs have been persued to reduce the use of critical materials in the manufacture of tubes.

Nickel

Nickel, for years, has been an essential material of the electron tube industry. An intensive effort on the part of our engineering organization to conserve nickel and to substitute alternate materials, has brought outstanding results. The following substitution materials for pure nickel are now being used.

1. Carbonized Nickel-Plated Steel Strip

   After three years of intensive effort a new plate (anode) material has been developed and tested by RCA engineers to the point where it seems to meet all of the requirements of a substitute for pure nickel strip in tube manufacturing.

   This new material, known as S8S1, is produced by RCA. The raw material -- aluminum-deoxidized, cold-rolled steel strips, 10% nickel-plated, is coated with nickel oxide, which is then bonded to the strip, and carbonized.

2. Carbonized Steel Strip

In some applications a satisfactory carbonized strip can be made using the foregoing process of nickel-oxide coating and carbonizing, but using plain steel (without nickel plating) as the base material.

3. Nickel-Plated Iron Wire (Nipron)

Nickel-plated Armco iron -- a steel containing less than .05% carbon -- is now being widely used by RCA as a substitute for pure nickel wire in the manufacture of a significant number of electron tube components.

4. Stainless Steel Wire

We are now substituting 18-12 stainless steel wire with 18-8 stainless steel wire wherever possible throughout our operations. This permits a 33% saving in nickel content. In addition, we are now attempting the substitution of 18-8 stainless steel wire for nickel wire in certain non-critical tube components; such as getter loops.

Copper

The quantity of cooper used in tubes is relatively small as compared to circuit and component uses. Nevertheless, every effort has been made to conserve and substitute alternate materials wherever possible.

Our program for conservation and substitution of copper is as follows:

1. Receiving Types

Approximately 90% of our total copper requirements for receiving type tubes is for use as copper grid side rods which are used in about 10% of the receiving types produced. It now appears that, during the first quarter of 1951, we shall be able to effect a 30% reduction in our present usage of copper grid side rods through further usage of nickel-plated iron wires. Copper is also used in the lead wires which connect the elements of the tube to the base. It now appears probable that we can effect a saving of approximately 19% in the use of copper for this purpose by a reduction in the diameter of the leads used.

2. Cathode-Ray Tubes

The principal use of copper in cathode-ray tubes is in the

exhaust tubulation which is "pinched-off" upon completion of evacuation of the tube. A program for the substitution of glass for copper is under way which will be instituted by stages during the first quarter of 1951.

3. Transmitting and Power Tube Types

Primary usage of copper in transmitting and power tube types is for anodes and radiators. High electrical and thermal conductivity are required in order to dissipate the great amount of heat generated in such types. No satisfactory substitute for oxygen-free, high-conductivity copper is currently known. It should be noted, however, that nearly all tubes of this type are used in such essential applications as commercial communications, broadcasting, industrial oscillators, and the like.

Similar programs have been instituted with respect to other critical materials. For example, tin is used in solder. The common percentages for tin for such purposes range from 35% to 60%. In tube manufacture the percentage of tin content for all solders has been reduced to 35%, and provision is now being made so that nearly all production can use a 20% tin content solder.

CONSERVATION OF TELEVISION INSTALLATION MATERIALS

While manufacturers of television receivers are not generally directly concerned with the specifications of installation materials, very important conservation programs can be adopted to substantially reduce the amounts of aluminum, copper, zinc and steel used in installation materials such as masts, brackets, lead-in wire, etc. The industry must bear in mind that antennas in most instances are a necessary part of television receiver installation. A great deal can be done to guide dealers and servicing organizations in the conservation of installation materials.

Following are some important savings of scarce materials which have been accomplished by the RCA Service Company as the result of an intensive conservation program;

1. Aluminum - The use of aluminum for masts has been reduced by almost 50% during the First Quarter of 1951. If this savings can be attained throughout the industry, it would represent a reduction of more than two million pounds of aluminum per one million receivers installed with an outdoor antenna. This conservation of aluminum by the RCA Service Company was accomplished through the following means:

   a. Standard 8' aluminum masts were replaced by 6' steel masts wherever possible.

   b. Tall masts using large-size aluminum tubing are being constructed of one-size smaller tubing.

   c. Standard 12' x 1-3/8" x .083" wall aluminum masts weighing 4.75 lbs. were replaced by 10' x 1-3/8" x .072" wall weighing 3.46 lbs. for a savings of 1.29 lbs. per unit or 27%.

   d. Standard 12' aluminum masts are also being changed over wherever possible to 10' x 1-3/8" x 16 ga. steel tubing saving 4.75 lbs. of aluminum per installation.

   e. Standard antennas have been lightened by reducing the wall thickness of aluminum tubing, used for the elements, at the same time retaining strength by using a stronger alloy even though this increases the cost. The 1/2" x .042" wall tubing has been reduced to 1/2" x .035" wall resulting in an aluminum savings of 10.4% per installation.

2. Copper - The major use of copper for television installation is in the transmission line of the 300-ohm ribbon and co-axial types. Substantial reductions in the use of copper have been accomplished by the RCA Service Company in the following manner:

a. A nation wide program has been instituted to reduce the footage of cable used per job by placing antenna as near as possible to the receiver, by measuring the required length of line accurately and by splicing together and soldering short lengths. These steps have resulted in reducing the transmission line useage from 123' per installation to 83' per installation currently. This represents a net reduction of 32% in the use of copper lead-in wire.

b. The standard 300-ohm transmission line in the past consisted of 7 strands of No. 28 copper wire which will yield 147.5' of transmission line per pound of copper. Anticipating the shortage of copper, the RCA Service Company's Engineering Department designed several lighter weight types of transmission line which have proved adequate. The latest type which will be adopted as a standard has 7 strands of No. 30 wire which will yield 234' of lead-in cable per pound of copper for a net savings of 33%.

c. Anticipating the probable future reduction of copper useage, tests have been conducted using 300-ohm transmission line with conductors of "copperweld" wire. This is a steel wire coated with a thin layer of copper. While the total weight of the metal content would be approximately the same, the major part of the copper will be replaced by steel with a net reduction of 82-1/2% in copper useage.

d. Coaxial and twin-ax cable use considerable amounts of copper. In cooperation with the Anaconda Wire and Cable Company, the RCA Service Company is conducting tests on the use of a thin aluminum foil sheath to replace the copper braid shield on these cables. A typical example would be the coaxial cable used on multiple antenna systems. This cable now uses 22.5 lbs. of copper per 1,000'. Twenty pounds of this total are in the shield. The coaxial that is being tested will replace 22.5 lbs. of copper with a cable that contains 2.5 lbs. of copper and 3/4 of a pound of aluminum per 1,000'.

3. Zinc - In order to conserve zinc normally used for plating steel masts and brackets, a plastic coating material is being used for rust-proofing steel masts and steel brackets. The total amount of zinc saved through this process is approximately 320 lbs. per 1,000 antenna installations.

4. Steel - The total useage of steel will be increased by the substitution of steel for aluminum masts wherever possible. However, it has been found that such items as roof-mounting brackets lend themselves to redesign for conservation of steel. One typical instance, for example, a mounting bracket weighing 7.4 lbs. has been replaced by two alternate types weighing 5.75 lbs. and 4.9 lbs., respectively. This redesign provided brackets of adequate strength with a net savings in steel of 29-1/2%.