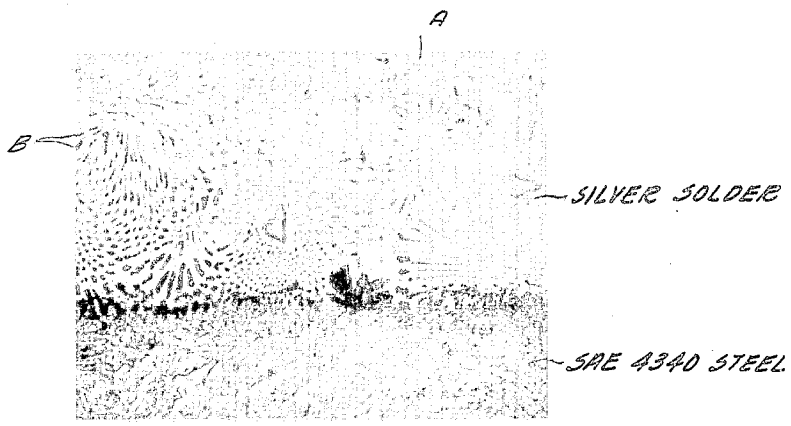
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LOW-MELTING POINT SILVER SOLDER

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MAGNIFICATION 500
HELD AT 1150°F FOR 30 MINUTES

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LOW MELTING POINT SILVER SOLDER

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5 Claims. (Cl. 75—134)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to us of any royalty thereon.

This invention relates to silver solders of the type especially useful for brazing steel; however, they may be used to braze a wide variety of metals.

One object of the invention is to provide a series of solders of the above character that have a melting point low enough so that some tempered steels may be brazed with them without drawing the temper from the steel.

Another object is to provide solders of this character which have an exceptionally high tensile strength so that strong joints may be obtained. Another object of the invention is to provide a convenient method for making such solders.

We have discovered that low melting point solders, i. e., having a melting point range between 1100° F. and 1200° F. may be made by mixing a considerable number of the metallic elements which are to be found in columns I–B and II–B of the periodic chart of the elements as published in "General Chemistry," 5th edition, by H. G. Deming, published by John Wiley & Sons Inc. The term "periodic table," as used in the appended claims, refers to Deming's table only. These elements are for column I–B, copper, silver and gold, which are listed as being ductile. The elements in column II–B are zinc, cadmium and mercury, which are listed as being low melting.

One characteristic of our solders is that they all contain mercury. Heretofore, mercury has not been regarded as an especially desirable constituent of high strength silver solders for the reason that it was believed to be injurious to strength. We have discovered that high strength solders may be made by the use of at least four of the elements named (two of these being silver and copper) plus mercury and that under these conditions an actual increase of strength results. By the use of the four elements plus mercury, in approximately eutectic mixtures, we are able to provide silver solders which exhibit a homogeneous distribution of solid solutions in copper distributed throughout a solid solution in silver.

In the illustration, A indicates the solution in copper and B indicates the solution in silver. The accompanying illustration is a photo-micrograph of such structure.

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The ranges of compositions which are comprised in our invention are as follows:

Table A

Range 1:	Per cent	Range 2:	Per cent
Ag	36 –49	Ag	36 –49
Cu	11 –19	Cu	11 –19
Zn	12 –16	Zn	12 –16
Cd	18 –33	Cd	18 –33
Hg	0.5–10	Hg	0.5–10
		Au	0.5– 3

It will be noted that gold is an optional constituent and is used only in range 2. We prefer to use it because it confers malleability and ductibility, but we recognize that the substance costs too much to make its use economical for many applications of our solders. The specific approximately eutectic compositions which we have made and tested are listed below with the temperatures at which they were brazed and the joint strength exhibited as a result. The table should not be interpreted that the joint strengths listed are the maximum that can be obtained, but rather that certain brazing temperatures are more favorable to increased joint strength than others.

Table B

Composition						Brazed at (° F.)	Joint Strength, p. s. i.
Ag	Cu	Zn	Cd	Hg	Au		
49.0	15.7	15.7	18.6	1.0	------	1,160	49,500
40.6	18.0	13.0	24.4	4.0	------	1,120	40,600
42.5	13.6	13.6	29.3	1.0	------	1,145	50,400
						1,130	61,500
37.0	11.8	14.7	33.4	3.1	------	1,120	61,500
41.4	13.2	14.2	23.6	4.6	3.0	1,180	64,000
36.6	11.7	14.1	26.2	9.0	2.4	1,110	56,000
37.0	11.8	12.6	27.0	9.2	2.4	1,120	71,000
						1,125	69,000
38.7	12.5	13.8	27.7	5.9	1.4	1,105	61,500
						1,300	70,500

The brazing should be done at a temperature slightly over the melting point, say 50° F. higher.

In making the alloys, we first melt the higher melting metals such as copper and silver together and then introduce the lower melting constituents in the form of amalgams, i. e., those of zinc and cadmium. The melt is then vigorously stirred for a short time at a temperature only slightly above the melting point and then immediately poured out. This method of making the solders is useful where small quantities are to be prepared, but when large quantities are to be manufactured, the melt is held under pressure

and the low melting constituents such as mercury, zinc and cadmium, or optionally mercury only or the amalgams may be introduced by pumping the molten substances into the pressure vessel containing the melt. No fixed ratios between any two constituents of our mixtures will be necessary. During the addition of mercury in non-pressure melting, a loss of about 25 per cent occurs by evaporation, hence, Table A represents the amounts mixed but does not represent an analysis. Table B, however, represents the approximate composition of the solders before the brazing operation.

Any steel which can be heated to 1150° F. without losing its temper can be brazed after hardening with our solders. As a specific example of steel, we recommend SAE No. 4340 for this purpose. If the brazing is done in a neutral or reducing atmosphere, no flux will be necessary. Where the brazing is done in air, any flux which melts in the proper range may be employed, for example, a mixture of sodium acid fluoride and sodium meta borate. Vapor fluxes such as boron trifluoride may also be employed. By brazing it about 50° over the melting point of the solder, joint strengths may be obtained which range from 50,000 to 82,000 pounds per square inch. In order to obtain this strength, however, a joint thickness of at least $^{3}/_{1000}$ of an inch must be employed since a lower joint-thickness introduces erratic behavior.

The invention claimed is:

1. An alloy suitable for brazing, consisting of

	Per cent by weight
Silver	36 –49
Copper	11 –19
Zinc	12 –16
Cadmium	18 –33
Mercury	1.0–10

said alloy when present to a thickness of at least 0.003 inch in a brazed joint between steel surfaces, being characterized by a tensile strength of 40,000 pounds to 70,000 pounds per square inch and having a melting point range between 1100° F. and 1200° F., and being characterized by suitability for brazing and high strength of the brazed joint.

2. An alloy, suitable for brazing consisting of

	Per cent by weight
Silver	36 –49
Copper	11 –19
Zinc	12 –16
Cadmium	18 –33
Mercury	1.0–10
Gold	0.5– 3

said alloy, when present to a thickness of at least 0.003 in a brazed joint between steel surfaces, being characterized by a tensile strength of 40,000 pounds to 70,000 pounds per square inch and having a melting point range between 1100° F. and 1200° F.

3. A brazing solder melting between 1100° F. and 1200° F. consisting substantially of

	Per cent by weight
Silver	42.5
Copper	13.6
Zinc	13.6
Cadmium	29.3
Mercury	1.0

4. A brazing solder melting between 1100° F. and 1200° F. consisting substantially of

	Per cent by weight
Silver	37.0
Copper	11.8
Zinc	12.6
Cadmium	27.0
Mercury	9.2
Gold	2.4

5. A brazing solder melting between 1100° F. and 1200° F. consisting substantially of

	Per cent by weight
Silver	38.7
Copper	12.5
Zinc	13.8
Cadmium	27.7
Mercury	5.9
Gold	1.4

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