SYMPOSIUM ON SOLDER

INTRODUCTION

By Bruce W. Gonser[1]

The importance of soldering in our everyday life can scarcely be overstressed. It is one metallurgical operation that is probably known better and practiced, more or less aptly, by more people than any other. One wonders how many millions of fond fathers have been forced into buying a Little Jiffy Soldering Kit by the pleadings of his offspring to fix their toys, or by the loose connections on his own favorite electric train. Soft soldering is easy, even for the novice.

Aside from the amateur, the handyman, and the fix-it-yourself advocate, soldering is really of great industrial importance. Historically, the use of low melting tin-lead solder goes back to Roman days, and beyond. We continue to marvel at the workmanship and permanence of their lead plumbing with its soft-soldered joints. Solder is still used in plumbing, although the emphasis has changed more to soldered joints in copper tubing, rather than wiped joints in lead pipe. Large quantities of solder are used for heat exchangers, as for automobile radiators, air-conditioning equipment, and in refrigeration. In building construction the drainage system of roof gutters, down spouts, etc., normally have soldered sections. Among mass produced items, perhaps the most common in the household is the tin can with its soldered-side seam, or the incandescent electric lamp bulb with its soldered contacts at the socket. Cans are now numbered in the tens of billions per year in the United States alone. Then, there are the many, many miscellaneous applications of soldered joints in the electrical and communications industry to make tight connections, and in general manufacturing for joining suitable parts.

Perhaps of greatest interest to us now, among these many applications, is the use of solder in making electrical connections in instruments and circuits. With the tremendous present and potential growth in automation and instrument-controlled devices, the need for billions of tight, dependable connections is apparent. Moreover, the performance of this automatic machinery and these many controls is literally at the mercy of any one of its many connections. Soldering can easily be the weak link in a chain of complicated equipment if it is not done properly. One can sometimes solve, temporarily, a bad soldered connection in a radio by a well-placed kick. The some treatment is seldom feasible for an airplane instrument or a guided missile.

The simplicity and ease of applying soft solders is sometimes misleading. Actually, the whole subject of choice of solder composition, flux, and proper

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application is complex and rather confusing since so many factors are involved. Chief of these are the conditions under which the soldered joints must operate. Almost any metal pieces can be soldered. It may take a lot of special preparation of the surfaces and sometimes even a coating with another metal, but usually it is possible to secure a tight, firm joint. The real task is to keep it that way.

Fortunately, soft solders cover a rather wide range of properties. The usual tin-lead base alloys can be fortified by alloying-additions to meet some of the demands of usage. In others, a lead-free tin-base solder may be used—as tin-antimony or tin-silver; a tin-free lead-base solder has been used also, as lead containing up to 2 or 3 per cent silver. Bismuth, cadmium, indium and, to a very limited extent, even mercury and gallium are used in forming solders of low-melting range. This field of alloying to meet specific desired properties is by no means exhausted, and considerable continued progress can be expected.

The use of fluxes is perhaps the least understood and most difficult to solve satisfactorily of any of the broad problems associated with soldering. Fundamentally, fluxes are to clean the surfaces to be joined to allow true metal-to-metal contact with the molten solder. This is undoubtedly too simple a statement, because fluxes are expected to do a lot; in fact, there is a bit of magic often thought to be associated with their use. The subjects of preparing a surface for soldering and the theoretical background for obtaining proper intermetallic-cohesion are too complex for more than mention at this time. The thing to remember about fluxes is that the solderer wants something with a bite that can dissolve oxides or the surface of the parts to be jointed, but he wants it to be perfectly inert corrosionwise after the job is done. That is a dilemma.

From the great diversity of applications for solders has evolved a number of means of application. The common way of soldering with a soldering iron is still important. In fact, one of the recent developments, although of limited application, is a supersonic soldering iron with built-in transducer. However, other means are useful too, as by dip soldering to cover large areas and penetrate many joints (as in radiator manufacturing), flame soldering, furnace soldering, use of induction heating, by electric resistance heating, or numerous clever ways to heat the surfaces sufficiently for the solder to flow. Soldering has become mechanized or made at least semiautomatic for a great many commercial operations where the number and uniformity of joints justify the fixture expense. This has been aided by using wire solder containing a flux, solder powder in a flux paste, or special forms of solder to fit the particular job.

The problems connected with soldering, then, are many fold. Not only must the best solder composition be considered, but also the proper flux, the best mechanisms for application, and the care of the joined parts afterward to give a satisfactory life. Some soldered parts are subjected to extremes of vibration, so fatigue life may be important; others may support a weight which makes resistance to creep a big factor. For applications at low temperatures, the stability of the solder itself is important. Almost always, corrosion in one form or another comes into the picture.

This brings up campatability of the solder with the metals being joined. In soldering aluminum, and this is one of the greatest needs and one of the best fields for improvement, it is not

particularly difficult to form a good joint. The trouble is that most of the common solder compositions are entirely wrong from the standpoint of preventing corrosive attack in use if moisture is present. Protective coatings over the soldered junctions is not always effective.

These many problems are being attacked. It has been to bring together men who have secured worthwhile results in this field and to discuss some of these items that this symposium has been organized. It is one of the current activities of Subcommittee III on White Metal Alloys of Committee B-2 on Non-Ferrous Metals and Alloys, a group that is much concerned with solders and their specifications.

On behalf of Committee B-2, I wish to thank the authors of the various papers presented at this Symposium and the discussers for their cooperation. In particular, we all appreciate the work of George Harnden and his Symposium Committee in so ably arranging the program for this series of meetings. G. H. Clamer, Chairman of Subcommittee III, has strong reason to be gratified by the excellence of the program and the attention it has received.