Classical Loop-in-Loop Chains

Jean Reist Stark & Josephine Reist Smith
Classical Loop-in-Loop Chains
Illustrations and Finished Jewelry by Jean Reist Stark

Copyright 1999 by Jean Reist Stark
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This book is a tribute to the beauty and variety of a chain making technique that has been in use for over five thousand years. We dedicate it to Robert Kulicke, who introduced us to the exciting and fascinating world of ancient jewelry and its technology.
Sample board showing many of the chains described in this book.
INTRODUCTION TO THE REVISED EDITION

In many ways, *Classical Loop-in-Loop Chains* is an impressive book. For starters, it was written by a contemporary master of an ancient process. Jean Stark is among only a handful of people who have made such a vast collection of museum-quality chains. More than that, she has taught hundreds of students and this informs the instructions presented on every page. The author is an accomplished illustrator and is responsible for the more than 300 illustrations that guarantee success to any student willing to put in the time to understand them.

The book was first published in 1997 in paperback form by Chapman & Hall, a company not familiar with the jewelry industry. Not having found its audience, *Classical Loop-in-Loop* was allowed to go out of print soon after publication. Jean Stark considered publishing the book herself but decided, wisely I think, that her time was better spent teaching and making jewelry. In 1999, Brynmorgen Press took over the book and reprinted the original pages, this time with a laminated hard cover and a spiral binding. Over the next two decades, the book was reprinted eight times, selling many thousands of copies.

To celebrate the 20th anniversary of this important work, we are pleased to offer the book you now hold in your hands. The look is new but you can be assured that the content lives on in its original form. Every instruction, every illustration, and each of the 34 chains is presented here in the original language. What has changed is the use of color, a fresh layout and an innovative lay-flat binding. Many of the original photographs exist only in black and white scans, but where possible, archival photos of the author’s original work is included. In addition, the illustrations have been colorized, which adds sparkle and clarity.

I am thrilled to have the opportunity to keep this important work available to the public. The chains described here are not the only thing deserving the term “classic” — Jean Stark’s book is truly a classic of its own.

Tim McCreight,
Brynmorgen Press
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Chain 1  Wendy Emery
Chain 2  Wendy Emery
Chain 3  Jean Stark
Chain 4  Jean Stark
Chain 5  Stephanie McNamee
Chain 6  Wendy Emery
Chain 7  Wendy Emery
Chain 8  Jean Stark
Chain 9  Jean Stark
Chain 10 Wendy Emery
    Cal Gangi
Chain 11 Wendy Emery
Chain 12 Jean Stark
Chain 13 Jean Stark
Chain 14 Jean Stark
Chain 15 Jean Stark
    Wendy Emery
Chain 16 Wendy Emery
Chain 17 Wendy Emery
Chain 18 Wendy Emery
Chain 19 Wendy Emery
Chain 20 Wendy Emery
Chain 21 Wendy Emery
Chain 22 Jan Wunsch
    Stephanie McNamee
Chain 23 Jan Wunsch
    Stephanie McNamee
Chain 24 Jan Wunsch
    Stephanie McNamee
Chain 25 Wendy Emery
    Cal Gangi
    Jane Ferrar
Chain 26 Wendy Emery
    Cal Gangi
    Jane Ferrar
Chain 27 Wendy Emery
    Cal Gangi
    Jane Ferrar
Chain 28 Wendy Emery
    Jane Ferrar
    Cal Gangi
Chain 29 Jane Ferrar
Chain 30 Jane Ferrar
Chain 31 Jan Wunsch
Chain 32 Jan Wunsch
Chain 33 Jan Wunsch
Chain 34 Jan Wunsch

Photographs by Jean Stark
Foreword

This is not only a book of instruction in chain making but it is also a work celebrating man's continuous creativity over thousands of years. At times something that man creates has far-reaching effects; an example that quickly comes to mind is the wheel, which has enabled many developments, from pottery to computers. At this point it is important to note that these same wheels could not have been made without metal tools.

From early Neolithic times, gold was a favorite choice in the making of jewelry. During the Neolithic period these “shining stones,” probably alluvial, were prized. Actually gold was cold-worked as if it were a stone. There is a surviving example of cold-worked gold from Catalhuyuk (present day Turkey) estimated to have been made in 6500 B.C.

There were only four metals on the earth's surface that were found in sufficient quantity to be used: gold, copper, silver, and meteoric iron. An understanding of the malleability of gold, and of the annealing effect of fire, changed jewelry making; new forms were found. Gold was no longer a piece of stone but a material that could be flattened and made very thin. Sheet and foil are the oldest forms of worked gold. The smiths' tools were stone, wood and horn. Those ancient smiths, the feared, the revered guardians of fire, surely noticed what happened to metals in their hot charcoal fires and how blowing on them increased the heat. Indeed, charcoal was the fuel used by goldsmiths until the eighteenth century. Today, there is always a block, usually brick sized, of charcoal on every goldsmith's bench.

Goldsmithing has a long and distinguished history. Jewelry dating from 2500–3500 B.C. was found in ancient Mesopotamia at Ur of the Chaldees, the biblical Sumerian city. Gold was mentioned in the Ur tablets and found in quantity in Sumerian cemeteries. The skills shown in these works are so advanced that one thinks there must be earlier pieces as yet unfound. These are masterpieces of goldsmithing: chains, gold flowers for the hair, earrings, necklaces, and finger rings. The Sumerians also inlaid lapis and carnelian and agate, developed filigree, and attempted granulation.

Prehistoric goldsmithing took place in Western Europe and the Near East in the Neolithic and Bronze Ages. The histories of goldsmithing in Africa, the Far East, and South America are very different. It is most interesting that these ancient Sumerian goldsmiths actually made loop-in-loop chains from wire! For example, at Ur Site 29 a headband was found with beads of lapis lazuli, carnelian, and carnelian attached to a gold loop-in-loop chain made from wire.

The making of wire is a tremendously important advance, almost on a par with the wheel in terms of its effect on mankind's production. Jewelry, as we know it, could not be made without wire, links, jump rings, and chain. Chainmaking would be impossible without wire.

Before wire was made, smiths had discovered gold's most important properties: malleability and ductility. First they hammered it. Gold can be hammered laterally because of its malleability. Once hammered, strips can be cut and made into wire. Its ductility permits drawing.

In An Illustrated Dictionary of Jewelry, Harold Newman defines wire as “metal in the shape of a thin thread or a very slender rod usually flexible and circular in section.” In Jewelry of the Ancient World, Jack Ogden
tells us that the origin of wire is in “ribbons of gold” that were used to bind together parts of objects that were made of sheet gold. In ancient times strips of gold were cut with flint chisels. One of the ways of making wire was to roll these strips between two hard, flat surfaces. Another was to hammer them. Yet another method used as early as 3500-3500 B.C. was strip drawing. Perhaps this was done by pulling wire through a bead or a bone. Also, narrow gold ribbon can easily be twisted into a spiral like a drinking straw or twisted about its own length to make wire. From about 2500 B.C. until the Roman times wire was made by twisting strips. The ancient smiths must have been very efficient, because in their times, a great quantity of wire was needed. A Hellenistic necklace may use up to twenty yards of fine gold wire!

Archeologists tell us that some sort of drawplate was used by the Persians and also in Roman times. This tool enabled the smith to produce wire more easily and in any length required from a ductile metal. Just think that it only takes one ounce of gold to be drawn into a thirty-five mile long filament!

The drawplate seems to have been perfected in the Medieval period. In *On Diverse Arts*, written in the mid-twelfth century, the monk Theophilus, a brilliant craftsman, described the medieval drawplate as “two iron plates, three fingers wide and pierced with three or four rows of holes through which wires may be drawn.”

Chain is made from links of wire. The chain of precious metal is and was considered to be a jewel. Chains are found in many shapes and designs: necklaces, bracelets, earrings and belts. Links and chains are also important in connecting parts of an ornament.

The basic unit of a chain is the link; this is also called the loop. Usually round wires are used to make links. These are produced by bending a piece of wire and fusing or soldering the ends together. The links are joined by weaving. In *Metal Techniques for the Craftsmen*, Oppi Untract says “repetition of units, flexibility and endlessness are ideas inherent in the concept of a chain.” This seems to be a poetic understanding.

The authors of this book are to be congratulated for carrying out a tradition that is almost as old as man’s known history. Using ancient chains as their models they pull the chain like fine wire into the twentieth century by proposing new patterns and designs. This is a fine work by the best of craftspeople. A special tribute must be paid to Jean Stark for the legibility, clarity and linear beauty of her drawings.

Among the readers and users of this book many will surely carry the ideas and techniques into the new century. It will then be their turn to thank their teachers by showing others.

— Noma Copley
Preface

For many years, my students have been asking me to organize the materials on chain making that I present in workshops and classes into a book; finally, with my sister, I have been able to meet their requests. The result is this manual, which describes and illustrates procedures for making a variety of chains based on the ancient loop-in-loop technique. We have tried to make the directions clear enough that a person with some knowledge of the basics of working with silver and gold will be able to make satisfactory examples of these chains with only the book as a guide, assuming that he or she follows the procedures exactly.

Although directions for making classical loop-in-loop chains have appeared in recent books on jewelrymaking, detailed instructions are rarely provided. The learning patterns of students at the Kulicke-Stark Academy and in my workshops over the last twenty-five years have indicated a need for instructions that are organized around projects, and our book has been designed and written with these patterns in mind.

In this book, we explain the techniques used in making these chains, show how to make all of the classical loop-in-loop chains, and, in addition, show how to make some interesting contemporary derivatives. Since little needs to be added to the equipment of the basic jeweler’s workshop, goldsmiths and students will be able to use this book to construct and study chains with minimum investment in special tools. There will be those who have made these chains and have developed procedures that differ from ours. We believe that there is no “one correct way,” and our instructions represent approaches to and refinements of techniques that have evolved with us. As goldsmiths work and become more experienced with these chains, each will develop his or her own techniques to maximize efficiency and success.

The book begins with a brief historical overview and continues with a chapter that describes the equipment and basic techniques that are the foundation for making all loop-in-loop chains. A separate chapter is devoted to each basic chain type, including both ancient and modern variations. In each chapter, the first chain is the simplest of that type to make, and is usually the most ancient. As one moves through a chapter, the chains become more complicated and the modern variations are given. For the most part only the steps in a variation that are significant departures from those for making the basic chain are fully described and illustrated. The final chapter describes the construction of simple, appropriate clasps for each chain type. In addition to the photographs that illustrate the chapters, the appearance of a chain is shown in a drawing at the beginning of the instructions for its construction.

We have attempted to include all the information needed to make these chains, and, with as little duplication as possible, put this where it will be most helpful. The basic tools needed for all or most of the projects are listed in Chapter 2 and in most cases they are illustrated and discussed. A complete list of the tools used in the book is included in the Appendix. We have also included a glossary, and if an unfamiliar term is encountered and not promptly explained in the text, students should be able to find it there.

We list the materials and any special tools needed for each project at the
beginning of the directions and have tried to give the lengths of wire and the number of links that will be required to make a chain of a specified length. Because of individual variations in technique, these amounts can only be approximations, and we advise students to have extra supplies on hand until they have had enough experience to make estimates based on their own working styles.

The names we use for most of the ancient chains are those most commonly employed by modern English-speaking goldsmiths. Following suggestions made by students, we have tried to let a name indicate something about the construction of a chain; thus what is sometimes called the “quadruple loop-in-loop” becomes the “two-way double” (now allowing for a two-way single), and the “sailor’s” becomes the “pinched loop.”

For much of the information contained in this book, I thank all the friends, associates and students who have supported me so well over the last twenty-five years with their encouragement, questions, advice, tips, procedures and especially their enthusiasm. I wish to acknowledge the contributions of the Kulicke-Stark Academy to the development of many of these techniques and also its role in establishing them as significant paths for modern jewelers to follow, both as designers and craftsmen.

A number of people have aided in the preparation of this book. We thank Noma Copley, Phil London, and Julia Woodman for reading a draft of the manuscript and for their helpful comments. We thank our editor at Chapman and Hall, Henry Flesh, for his patience, knowledge, and prompt and effective responses to our questions. We thank our husbands, Bernard D’Andrea and George Smith, for the many errands and chores that they have cheerfully done and for putting up with wives in the throes of authorship.

Finally we especially want to acknowledge the contributions of Amy Start Cote, who worked on many chain projects in the past, and our chainmakers: Sara Ryan, Wendy Emery, Jan Wunch, Jane Ferrar, Cal Gangi, and Stephanie McNamee, who tested our directions by making many of the chains and who provided us with invaluable feedback. We express our heartfelt thanks for their much appreciated assistance.
The loop-in-loop was the predominant chain type used for gold and silver jewelry from the early Bronze Age in the Middle East, through the Classical period until the end of the Middle Ages. Among the earliest surviving examples of loop-in-loop chains were those discovered in the royal graves at Ur which have been dated to around 3000 B.C., but mastery of the problems associated with the technique and the quality of the craftsmanship indicate that simple chains of this type had probably been produced for some time before this. Loop-in-loop chains have also been found in jewelry from Troy II, from pre-palatial Crete, and from Egyptian burials of a somewhat later date (2100 B.C.). Because there is little evidence of trading contacts between some of the centers of civilization during the early Bronze Age, the place where loop-in-loop chain making originated cannot be definitely determined.

The earliest examples are single loop-in-loop chains, but double, two-way double (quadruple) and three-way double (sextuple) chains and pinched loop chains appear in jewelry dated from the early part of the second millennia.

There were no significant innovations until the seventh century B.C., when Greek goldsmiths developed the technique for weaving several rows of loops into a strap. This became a prominent feature of Etruscan, Hellenistic and Roman jewelry. By the third century B.C., multi-row necklaces woven from either single loops or pinched loops soldered together appeared in Hellenistic jewelry, as did the incorporation of gemstone beads woven into chains. Both chain designs became more prominent during the Roman period.

The loop-in-loop technique spread through Europe from Italy and the Mediterranean regions to Germany, the British Isles, Scandinavia and Russia. During the Byzantine and Medieval periods the more elaborate forms were gradually replaced by chains made by other methods, but the simpler loop-in-loop chains, particularly the cordlike double variations, continued to be made. From the Renaissance to the nineteenth century, loop-in-loop
techniques were used rarely if at all, by European goldsmiths.

By the Hellenistic period, loop-in-loop chains were made in eastern Asia, where, especially in India, the technique was important for more than a thousand years. It then declined significantly in both Asia and Europe. However, in a few isolated areas loop-in-loop chain making continued through the tradition of handing down craft skills in families; these chains are frequently found associated with folk art.

The archeological excavations that began in the eighteenth century awakened an interest in classical jewelrymaking techniques as goldsmiths attempted to duplicate ancient pieces. Fortunato Pi Castellani, the most significant of the nineteenth century jewelers, replicated many of these pieces and extended the techniques to the creation of new designs. His work was continued by his sons and by goldsmiths he trained, and lasted for about fifty years from around 1830 to the 1880s.

In the latter part of the twentieth century at the Kulicke-Stark Academy of Jewelry Art in New York City, techniques of ancient jewelrymaking were researched, redeveloped and taught. In that school, the technique of fusing links was adapted to modern equipment and popularized. Modern goldsmiths use a variety of names for these chains. Although “loop-in-loop” is the widely accepted generic name today, confusion exists with respect to the terminology associated with some of the different forms. The terms single and double loop-in-loop are appropriate and self-explanatory but a variety of names exist for several of the others. (“Foxtail” is a machine-made chain that looks very much like the hand-made double loop-in-loop.)

Our aim was to find and use names that are simple, clear, and if possible, to some extent describe the construction. The most significant innovations are changing the name of the sailor’s chain (also

Three-way double loop-in-loop with tapered links. Center element is gemstone with granulation.
known as the figure-eight loop-in-loop) to the pinched loop chain. Where possible, the names also indicate the orientation of the higher orders of single and double loop-in-loop chains. This provides appropriate names for the multidirectional single weaves (two-way single, three-way single, etc.) as well as the multidirectional doubles. Thus the quadruple loop-in-loop becomes the two-way double, the sextuple loop-in-loop becomes the three-way double, etc.

Today, goldsmiths want to make these chains for a variety of reasons, which may include the desire to own a copy of an antique piece of jewelry, the desire to have a beautiful and unique piece of jewelry, or the interest in using these techniques to create new jewelry designs. These chains can be worn alone as complete pieces or can be used as components in many jewelry types.

The following brief selection of books provides further information about goldsmithing in the ancient world. Although information about chains is scanty in all of these, some material can be found and it is a rewarding challenge to seek it out.


Reynold Higgins, *Greek and Roman Jewelry*, University of California Press, Berkeley, 1961


Using This Book

Although loop-in-loop chains are not difficult to make, their construction requires varying amounts of time, patience and materials depending on the choice of chain type and size. There are three basic chain types: single-loop (one loop through one loop), double-loop (one loop through two loops), and pinched loop or “sailor’s” (one loop through one loop at right angles to each other). All of these basic types can be made in mesh-like multiples. In addition, the two-way single and two-way double-loop chains can be expanded into three-way, four-way, and even six-way variations.

The construction of a loop-in-loop chain involves three fundamental procedures:

1. making links,
2. shaping the links, and
3. weaving them into a chain.

In other types of chains the open links are successively put through each other, after which the ends of each link are usually joined with solder. The technique used in the construction of loop-in-loop chains reverses this order; first the ends of the links are joined by fusing or soldering, then the links are woven together into a chain.

Fusing involves heating the link under special conditions so that the metal at the join melts and runs, filling the space between the ends. If done correctly, this produces a link that is a continuous loop of the same metal with no joint: a link that can withstand the strain of being woven and that can be worked smoothly into a chain.

In this book, fusing is the method used for joining the ends of the wire circles to make the links. Even though this will probably be a new technique for many, it is not difficult for a person with some metalworking skills to learn. The technique for preparing the fused links described later in this chapter should be used to make the links for all our loop-in-loop chains. Links for all types of loop-in-loop chains are prepared and fused in essentially the same way.

Before links are woven into a chain, they are shaped by stretching, squeezing and bending. Different chain types are achieved through shaping and weaving, so the directions for making a particular chain type mainly involve how to shape and weave the links. Where some of the procedures are the same for more than one chain, you may be referred back to the first chain in which a procedure is described for detailed directions.

In addition to some background information on loop-in-loop chain construction and directions for making fused links, this chapter contains general information about equipment and supplies, together with advice to help you avoid common mistakes and tips to make the work go more smoothly. We recommend reading all of the sections on materials, tools, fusing and weaving in this chapter before attempting to make any of the chains because much of the information is basic to all chains and...
will not be repeated in the individual directions. In addition, some general practical information is included that will be helpful in making any of the chains. The sequence of groups and of chains in each group is from the simplest and easiest to make to the more difficult. One way to proceed in mastering these techniques is to learn the basic loop-in-loop weaves of the ancient chains that are the foundation of all of the variations.

We suggest this progression:

1st **Chain 1**  
*Single Loop-in-Loop*

2nd **Chain 6**  
*Basic Pinched Loop*

3rd **Chain 11**  
*Basic Double Loop-in-Loop*

4th **Chain 16**  
*Two-way Single Loop-in-Loop*

5th **Chain 19**  
*Two-way Double Loop-in-Loop*

Another way might be to make all the chains described in a chapter before continuing on to another chain type.

### Suitable Metals & Wire Gauges

Fine silver and 22k gold have similar working properties and can be used interchangeably for most jewelry designs. Both are very malleable, can be easily fused, and are clean, that is, undergo little or no oxidation when heated. Because of the inclusion of copper in the 22k alloy, it is a little more resistant when worked and does oxidize a little when heated, in contrast to fine silver, which does not oxidize when heated.

The directions in this book call for the use of fine silver; in addition to being clean, soft and simple to fuse, this metal is relatively inexpensive. All the chains can also be made in gold, but note that some commercial 22 karat alloys will not fuse properly. We recommend using an alloy that approximates the proportions of gold, silver and copper found in the ancient examples. This ancient 22k alloy is not readily available on the market except by special order, and of course it can be made as needed in the studio.

The Appendix contains information and instructions for making the alloy. An appropriate 22k gold alloy can be substituted directly for the fine silver in the instructions; 18k gold wire can be substituted for the sterling silver used for clasps.

Although these chains can be made of sterling silver and 18k and 14k gold, it is more time consuming to make the links, because those alloys require that the joint be soldered. Not only does soldering take more time than fusing, but because of the greater hardness of the joint and the metal, it is not possible to get the tight, even weaves that give these chains such a unique beauty.

When making many of the chains shown in this book for the first time, 22 gauge fine silver wire and a 5/16” dowel are specified; some chain designs will require other wire gauges and dowel sizes. The wire gauge and dowel size will always be given at the beginning of the directions for making a particular chain. We specify particular gauges and sizes because these are the easiest to use when learning to
make a chain, but both can be varied after gaining experience with the weave. The approximate length of silver wire required for a particular length of chain will be given at the beginning of the directions for each project. Because mistakes happen, we recommend that you have extra wire of the proper gauge on hand, especially when constructing a chain for the first time.

Every goldsmith works differently, so each person will bring an individual quality to techniques and to the pieces produced. Experimentation with minor modifications in the directions may be necessary until the methods best suited to an individual’s own style are found. The characteristics of a chain can be altered significantly by varying the specifications for it. Many interesting results can be achieved by changing dowel size and wire gauge — a $\frac{1}{16}$” alteration in the diameter of a dowel can make a large difference in the size of the links made with the same gauge wire, and this in turn can greatly affect the appearance of a chain.

Chainmakers are encouraged to experiment with dowel sizes and wire gauges after learning the weave on the first chain. A table in the Appendix gives some wire gauges and dowel sizes for creating variations of basic chains with the greatest aesthetic appeal.

When working with wire, one should be aware that any kind of handling — working it with tools, fingering, hammering, wrapping, burnishing, drawing, etc. — will work-harden it and will require annealing to restore malleability.

*Multiple woven double mesh in a 22-strand bracelet with granulated clasp.*
Basic Handtools & Equipment

Most goldsmiths will be familiar with the tools and equipment on this list; however, it is important to note the special requirements for some of the tools and supplies that are used in making loop-in-loop chains. Below is a list of the basic tools that you will need. If additional tools are needed to make a particular chain, they will be given at the start of the directions. A list of the tools and equipment used to make the chains in this book can be found in the Appendix.

Dowels

The preparation of the links (or loops) is begun by winding wire on a dowel. Dowels can be made of wood or metal; in most cases either may be used, but in some projects one or the other may be specified. If there is a requirement for a wooden or a metal dowel, this will be given in the instructions. Dowels used for wrapping are about 6” long and should have a small hole drilled close to the end.

Two dowel sizes are used for many of the basic chain projects — they are 5/16” and 7/16” in diameter. Although not all dowel sizes are needed to make the chains in this book, a complete set of dowels will be useful in the long run. Some of these sizes are not available commercially as dowels but can be found in a dap set or as the shaft of a drill bit. Wood dowels are not precision cut and the naturally occurring variations may provide some of the more unusual sizes.

<table>
<thead>
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<th>The sizes in a complete set, in inches:</th>
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<tbody>
<tr>
<td>1/16</td>
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<tr>
<td>3/32</td>
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<td>1/8</td>
</tr>
<tr>
<td>5/32</td>
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<tr>
<td>3/16</td>
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<tr>
<td>7/32</td>
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<tr>
<td>1/4</td>
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</tbody>
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Pliers

Much of the forming and weaving of links is done with pliers and it is important that these tools be small enough to match the sizes of the links so that they will be easy to manipulate during operations. The smallest pliers (known as watchmakers pliers) are about 4" in overall length; both chain-nose pliers and round-nose pliers are needed in this size.

The tapered jaws, (aka mandrels) of these round-nose pliers are about 7/64" long, 1/32" in diameter at the top, and 5/32" in diameter at the base. You’ll also need larger round-nose pliers with mandrels that are about 1" to 1 1/2" long, 1/32" in diameter at the top, to 5/32" in diameter at the base. If you are going to make chains with tiny links using fine-gauge wire, it is helpful to grind down the mandrels on a pair of small round-nose pliers to even smaller dimensions.

Bench Tools

It is important to make consistently tight coils to create uniform loops. This process is made easiest when the wire being wound is secured in a solidly mounted vise.

Vises are described by the width of the jaws and can be found at hardware and home supply companies. Good quality vises can also be found from used tool dealers.

Some vises are made to clamp on, like this one, but others are bolted to a tabletop or workbench.
Handtools

Two scribes of the same size. Additional or modified scribes will be needed for some chains. These can be purchased or made by filing steel or brass rods to the desired tapers.

At least one pair of high quality fine tweezers and one pair of larger soldering tweezers.

Scissors or snips. High quality manicure or cloisonné snips are important to achieve clean cuts.

A leather or plastic mallet.

A 3” sawframe with very fine blades, e.g., 5/0 or 6/0.

A small planishing hammer. By definition this will have a polished, slightly domed face.

Needle files in coarse (2-cut) and fine (4-cut) grades. If purchased separately, get a round taper, barrette and half-round. These files are also sold in sets and any set will include these three shapes.

Two metal blocks, aka “surface plates.” These are used to flatten links.
Equipment and Materials for Fusing & Soldering

Torches and Tips

Acetylene, propane or oxygen-acetylene torches can be used as long as the flame is fairly soft and rather small. Here are some of the systems most commonly used by jewelers in the US. Further information is available through jewelry supply companies.

THE PRESTOLITE SYSTEM
A No. 1 tip will generally work with all wire sizes except for the gauges used for making large heavy links, where a No. 2 tip is needed.

Like the torch below, these require purchasing or leasing an acetylene tank from a local welding supply company.

SMITH REGULATOR AND HANDLES
Both the No. 00 and the No. 0 tips work well for making all link sizes.

THE BERNZ-O-MATIC
(and similar home torches)
Torches of this type have flames that tend to be strong and somewhat difficult to regulate; however, successful fusing can be accomplished with them after a technique for controlling the flame has been established through practice.

OXYGEN-ACETYLENE OR OXYGEN-PROPANE
This category of torch requires two tanks — oxygen and a fuel gas. The regulator and tip must be chosen to give a small, soft flame. These mixtures of gases burn hotter than either acetylene or propane and air, so a certain amount of experimentation will be needed to determine the optimum setting, best distance from the links, and technique for applying heat that will lead to the desired results.
Kilns

Many jewelers like to use a small electric kiln when fusing fine silver links and for annealing wire. The heating area should be 3” in diameter and have a removable top lid. Although it is possible to fuse silver links on a charcoal block or fire brick, experience has shown that the success rate is usually greater when the kiln is used in conjunction with the torch, especially for beginners.

Caution: When the top is left on, these kilns can become hot enough to melt silver very quickly. Once the link has been put on the heating surface, close attention should be paid to it until fusing is completed. If a link melts on the heating surface, remove the metal promptly before continuing to fuse other links. To do this, use the torch flame to heat the melted silver sticking to the kiln surface until it is molten and forms into a ball. Touch the metal with a soldering pick and the ball will attach itself and can be lifted off. If there are multiple areas of melted silver, push the bits of molten metal together into one bigger mass and then lift this off.

Charcoal Blocks

Charcoal blocks are used for several procedures; they should be new or newly sanded so that the surface is flat and retains no flux-soaked areas or any other possible contamination. It is a good idea to buy a new, large block. One side can be kept for making links and annealing and the other side can be used when working on projects that involve soldering and the use of flux. Before using the block, wrap binding wire around the outside to keep the pieces together if the block splits in two.

Gold links can be fused very successfully directly on the charcoal block, and for many students, the block may also be used for fusing silver links. Beginners especially often find that silver links have a higher percentage of loss when fused on the block without the heating help of the little kiln. Students should experiment with both procedures to determine which of the two works best for them. Some goldsmiths have successfully substituted fire brick for the charcoal block.

Solders & Fluxes

Because the projects in this book are planned for fine silver, only silver solder and yellow liquid flux or blue liquid flux should be used. The fused link is used for all loop-in-loop chain types and the procedure used to make this link does not vary, although different wire gauges and dowel sizes are used. Experienced metalsmiths usually have no difficulty in learning to make fused links, but those with less experience with heating metal and using torches may at first find it difficult to make the required number of links without experiencing some failures. With practice, fusing the links will become easy and routine. Before beginning to fuse links for the first chain, make and test some links. After doing that and rereading the directions, details of the procedure often become much clearer.
The Basic Technique for Making Fused Links for All Loop-in-Loop Chain Types

Annealing
Annealing is very important at all stages of the construction of loop-in-loop chains, because as the metal work hardens, the links will distort or break. You will be told to anneal at certain places in the directions for making a chain, and you should always do this. In addition, if the metal seems to become resistant, it is usually safe to anneal as needed. If there is a reason not to anneal at or beyond a given point, such as when beads have been added, this is also noted in the directions.

To prepare for annealing either on the charcoal block or in the kiln, wrap wire around two fingers and secure the ends by folding them in or wrapping with thin binding wire.

For annealing on the charcoal block, the wire is prepared and heated to red-hot with a soft flame constantly moving around the bundle, then cooled by immersing in water. The size of the flame will depend on the job. This method of heating on the charcoal block may be used to anneal the wire before wrapping on the dowel, to anneal the coil before cutting, to anneal links during construction, and to anneal the chain during and after weaving.

For annealing in the kiln, the wire is prepared and heated until red-hot, then quenched in water. This method of heating in the kiln may be used to anneal the wire before wrapping and for annealing individual links during construction. Always use this method for very fine wire.

Either unannealed or annealed wire may be wrapped on the dowel and cut to make links for a chain, but once one type has been used, it must be employed for all the links used in that chain. Because annealed wire coils more tightly around a dowel, it creates a tight and even wrap. Unannealed wire will spring back after wrapping, which means that loops made with “hard” wire will be slightly larger than those made on the same mandrel with annealed wire. Though the difference appears slight, it is enough to show up in the chain.

Preparing Links: Wrapping, Cutting & Butting
The size of the link depends on the diameter of the dowel on which it is wrapped. The appearance of the chain is affected by the size of the link and the gauge of the wire used to make it; these should be chosen and matched to produce the desired effect (see Appendix).

If the wire is too thin for the dowel size, the chain may appear too open; if the wire is too thick, the links will be hard to form and weave. Appropriate dowel sizes and wire gauges will be suggested for each chain type. To maximize the learning process and your chances of success, it would be best to follow the specifications for wire gauge and dowel size that are given at the beginning of the directions the first time you construct a chain type.
Wrapping
1. Select wire and dowel.
2. Anneal the wire and quench to cool it.
3. Put one end of the wire through the hole in the dowel, pull about ¼” through, and press this up against the short side.
4. Put the other end of the wire into a vise.
5. Turn the dowel, wrapping the wire closely and evenly around it, using consistent pressure to keep the coil even and smooth. Uneven wrapping results in loops of different sizes which will make an uneven chain. Do not try to wrap too long a piece of wire because coils longer than about 4” can be difficult to slide off the dowel.

Cutting with Scissors
It is important to cut very carefully because diagonal cutting can change the size of the links.

6. Carefully snip the wire at the top of the coil beside the hole and remove the coil from the dowel. Removal can be difficult if annealed wire has been used on a wooden dowel. If the coil cannot be slipped off the dowel, carefully loosen it by turning the coil backward in the direction opposite to the direction in which it was wound until it is loose enough to move. Clip the wire next to the hole and let the
coil spring back. With an indelible pen, mark a line down the center of the coil parallel to the edges.

7. Anneal the coil and cool it.

8. Brace one end of the coil firmly between the thumb, index finger, and middle finger of your left hand (right hand if you are left handed).

9. Using only the interior part of the scissors and not cutting to the tips, make a single straight cut through the first four turns of the coil. As you cut, let the rounds fall off onto the bench.

10. Move the next segment of coil into the braced position, and repeat the cut. Repeat until the entire coil has been cut.

*The number of turns to cut varies with the thickness of the wire; you should only cut as many as you can control both with respect to the firmness of the bracing and the evenness of the cutting.

Cutting by Sawing

Use No. 05 or No. 06 Blades

The coil is made on a wooden dowel and the sawing is done with the coil on the dowel. Carefully snip the wire at the top of the coil beside the hole and move the coil down to the end of the dowel. Mark a straight line with an indelible ink pen down the
length of the coil. Saw on the line through the first rounds on the end; the links will drop off and the coil can be moved down and the next rounds sawn. The line shows where the centers of the links are located even though the coil may have moved.

**Butting**

Overclose each link from side to side several times to put a little spring into it, so that when you butt it, the ends will push toward each other and butt tightly together. Make sure that the butted ends are evenly aligned with respect to the sides and to the top and bottom of the join. Arrange the links on the clean smooth surface of the charcoal block with the joins turned toward you.

**Fusing**

The element that is most important in determining success in fusing is the ability to control the heat. The degree of heat and the amount of time it is applied must be precise to allow a small area of metal to flow without melting the rest of the wire. For the metal to run and fuse properly when the tip of the flame is applied to create the joint, the link must be heated evenly throughout so that colder metal does not draw heat away from the join. With silver, this even heating may be most easily achieved in the kiln. Use a torch tip that will give a soft pointed flame; the size of the tip needed may depend on the gauge of the wire.

"Butting" refers to gentle manipulation of the ends of a loop until they meet in an almost invisible joint. Time spent on this step is critical to making a smooth and uniform chain.

Position loops on a charcoal block with the seams all facing the same direction (usually toward the worker). This means you don’t need to search for the joint each time.
**Fusing on the Kiln**

*Have the small kiln turned on and heated to redness.*

11. With tweezers, pick up a link from the charcoal block at the point opposite of the butted join and place it in the kiln with the join toward you.

12. Put the cover on the kiln and heat the link for approximately 30 seconds to a minute (if the kiln seems very hot, leave the cover off); the time will vary depending on the gauge of the metal. It is important that the link be heated to a faintly visible orange, but if left too long it might melt.

13. Turn on the torch, adjust the flame, and direct the tip of the flame to a point directly in front of the join. There will be a bright flash and the metal will appear shiny and liquid; pull the torch away **immediately**. The fusing can also be accomplished by moving the tip of the flame back and forth over the join so that both sides are evenly heated, then directing the tip to the join for a split second until the metal runs and fills the gap. Either technique requires a very light hand with the flame.

14. If the joint is still visible, move the tip of the flame toward it once more until it again appears liquid, then **immediately** withdraw the flame and remove the link.

15. Repeat steps 11, 12, 13 and 14 with each of the remaining links.
**Fusing on the Block**

16. Arrange the links on a clean, convenient surface with the joins facing you. Pick up a link and place it on the clean smooth surface of the charcoal block with the join turned toward you.

17. Turn on the torch and rapidly move the torch tip in circles around the link without ever allowing the flame to stop or linger at one spot. When the link is red hot, direct the flame on the join and let it touch briefly. When you see the metal run and fill the gap, remove the torch *immediately*.

18. Repeat with the remaining links.

**SPECIAL CONSIDERATIONS**

- If the torch is applied to a link that has not been sufficiently heated, the surface of the link will be disturbed, and the link will not fuse properly.
- After some experience has been gained, several links may be fused in the kiln or on the block at the same time.
- When heating heavier wire (gauges 18 and thicker) to redness, it is usually necessary to supplement the kiln. Heat for a minute as usual, then remove the lid and rapidly move the torch tip in circles around the link without ever allowing the flame to stop in one spot on the link. Don’t force, be patient. When the link is red hot, direct the flame to the join and let it touch briefly.
- Some metalsmiths pick up fusing techniques on the first try but others may require more practice. With enough experience, anyone can make large numbers of links with very few failures. It is a good idea to practice on some extra wire before beginning to make links for the first few projects. Good links made for practice can be used in a project requiring the same wire gauge and dowel size.
Shaping Links and Weaving

The links are now ready to be shaped before weaving. The link is put on pliers to form the basic shape, stretched until both sides are parallel, and squeezed with tweezers or pliers.

Shaping the Links

1. With masking tape, mark the round-nose pliers at the proper place to give the desired link dimension. Place each link over the slightly opened nose of the pliers to the mark with the joint in the middle.

2. Open the pliers, stretching the link until the sides are parallel; this also tests the link. If links break during this procedure, either fuse them again or make new links for replacements.

3. With the link still on the pliers, start shaping it by squeezing in the middle according to the directions for a particular chain.
The segment of the link that is squeezed and other details of the squeezing are determined by the weave of the chain being made. Links for some chains can be shaped by this first squeezing alone; links for others may require additional shaping steps. Several shapes can be achieved with this first squeezing; the names of these first shapes refer to objects roughly suggested by the link's outline; the “bow tie,” the “lopsided bowtie,” the “dog bone,” the “long dog bone,” and the “exclamation point.”

The type of pliers and the way that these should be positioned to achieve a link type are shown in the diagram that accompanies the drawing of each link. Since any additional shaping will vary with the chain type, it will be described when the instructions for a chain are given.

**Weaving**

**BASIC SHAPES**

- bow tie
- lopsided bow tie
- dog bone
- exclamation point
- long dog bone

*This illustration indicates using round-nose pliers in the center of a loop to make a bow tie link.*

*Here, round-nose pliers are used in a similar way to make a lopsided bow tie.*

*In this drawing we see round-nose pliers pressed against the jaw of the pliers holding the loop to make what we call the exclamation point link.*

*In this illustration, chain-nose pliers are used to make a dog bone link.*

*The arrows indicate that this long loop is pinched by moving chain-nose pliers along the length of the link.*
While the interest in loop-in-loop chains is often focused on the patterns created by their design, much of their beauty comes from evenness in their weaving. Control over three aspects of the weaving process helps to achieve evenness: consistency in working, rhythm, and link malleability. For consistency, it is important to cultivate a manner of working so that the pressure applied to links and tools is even and insertions are uniform. Rhythm should be developed for repetitively carrying out each operation. Annealing the links after shaping before beginning to weave makes them malleable and thus easier to weave and less likely to break from having become work-hardened. During weaving, a chain usually should be annealed frequently; this is particularly true for the more complicated chains.

In addition, for many chain types, attention must be paid to the orientation of the chain and the direction in which the links are added. Some chains, such as the pinched loop and the single and double loop-in-loop, have no specific orientation and new links may be added to either end without affecting the appearance of the chain. Others, such as the two-way single or two-way double loop-in-loop, and the mesh, are oriented in one direction and their links must always be added to the end opposite the starting end.

In the former, after an inch or so of chain has been woven, it can be difficult to tell which end was the starting end, so I suggest threading a few inches of wire through the first loops for a marker. This wire is easily removed after the chain has been woven and can be used to help pull the chain through a wooden or plastic drawplate if this finishing step is desired.
Common Problems and How to Avoid Them

The common problems that occur when making loop-in-loop chains result from the following four errors, either singly or in combination: (1) variations in link size that result from careless wrapping, cutting, and stretching, (2) malformed links, (3) insufficiently fused links, (4) uneven pressure when weaving.

Malformed Links

Although skilled metalsmiths usually have little or no trouble making fused links when beginning to learn to construct loop-in-loop chains, people with less metalworking experience may have a high proportion of over-fired or malformed links at first, but these problems become less frequent with practice. It is not worthwhile to try to weave malformed links into a chain because they are hard to work with and often break. Types of malformed links and their causes include:

Overfired Links
- Pockmarked surface or uneven and lumpy, caused by too hot a flame or too much application of flame to the metal.

Lumpy Joins
- The ends of the loop were poorly butted.

Thin Joints
- These are created when the torch flame is held too long at the joint.

Insufficiently Fused Links

Several problems that can occur in making loop-in-loop chains are the result of failure to fuse the links. Insufficiently fused links are likely to break during the stretching and shaping or during weaving.

Insufficiently fused joints can be recognized by careful examination because the join does not disappear as it will in a fully fused bond. To avoid problems, take pains to completely fuse the joints and inspect the links before using them for weaving. Reject those that look suspicious.

RECOGNIZING STERLING SILVER

It is easy to confuse sterling silver wire with fine silver wire; however, links made with sterling silver cannot be fused using the techniques described here. To find out if a wire is fine silver or sterling silver, heat one end to red hot. As it cools, sterling silver will change color and become dull and gray whereas fine silver remains clean and lustrous.
Repairing Broken Links in a Chain

A link will sometimes break after it has been woven into a chain and other links have been added. In most cases this can be repaired. The technique used to make the repairs is related to the chain type.

Repairing Links in Single Loop-in-Loop Chains and Pinched Loop Chains

In most single-loop chains there is enough interior space in the link so that the ends of a broken link can be aligned and soldered. Pull the ends out and butt them together. Grip the chain in a third-hand or other holding device, positioning the broken joint as far away as possible from the adjacent links so that it is not inadvertently soldered to either of them.

Flux and dry the join and place a very small piece of solder on the join with a small brush. Use medium or easy solder, depending on the position of the break in the chain and what remains to be done. Heat carefully until the solder runs; pickle and reform the affected links.

A point-soldering tool can be used, in which case the link should be heated carefully with a small flame until it is hot, then the solder is applied. The link gets hot very quickly and the solder should be promptly put to the join.

Repairing Links in Two-Way Double and Other Double Loop-in-Loop Chains

- Find the broken link, and with small pliers or tweezers, carefully pull an end out.
- Tack a very small amount of solder on the end and push it back into the chain so that the chain’s weave looks even. The end does not have to be aligned with or joined to the other broken end.
- Flux this area of the chain and heat until the solder runs. The small amount of solder will hold the broken ends without affecting the chain’s appearance or flexibility.
General Description

The basic principle of weaving single loop-in-loop chains is one-in-one addition of the links, with all the links having the same orientation. In building this type of chain, each new link is inserted through the previous link, causing the chain to grow in a single direction.

The most common problems with single loop-in-loop chains are related to the proportions of wire to loop size and to the openness of the weave. Too small a wire wound on too large a dowel produces a flimsy chain and too heavy a wire for the dowel produces one that is difficult to weave. Wire lighter than 24 gauge, unless wound on a very small dowel, is extremely vulnerable to bending and distortion. This is a very open chain, so if the weaving is not done carefully and precisely the loops will appear uneven and the chain will look awkward.

From top to bottom: Centerball chain, Side-weave single, Basic single-loop chain, Foldover, Single-through-bead.