DESIGN OF A HOUSEHOLD ELECTRIC IRONING MACHINE

Thesis by

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ABSTRACT

The design of a household electric ironer was selected as the subject of this thesis in response to the functional deficiency in present types.

A study of the existing market, consumer finances, preferences, and desires as well as problems of the distribution and sale of ironers established important facts to consider in the design. These facts in addition to a functional analysis of ironing and the ironing machine together with a consideration of possible production methods led to the essential form of the unit. Further engineering and appearance refinement defined the final form.

The proposed ironer consists of a roll with a main shoe beneath it. This shoe position provides maximum operator comfort and is the most rapid shirt ironing arrangement. A smaller shoe on the roll support enables the unit to iron ruffles and "in-between" areas. The unit folds up on end into a vertical cabinet which provides a working surface at counter height.

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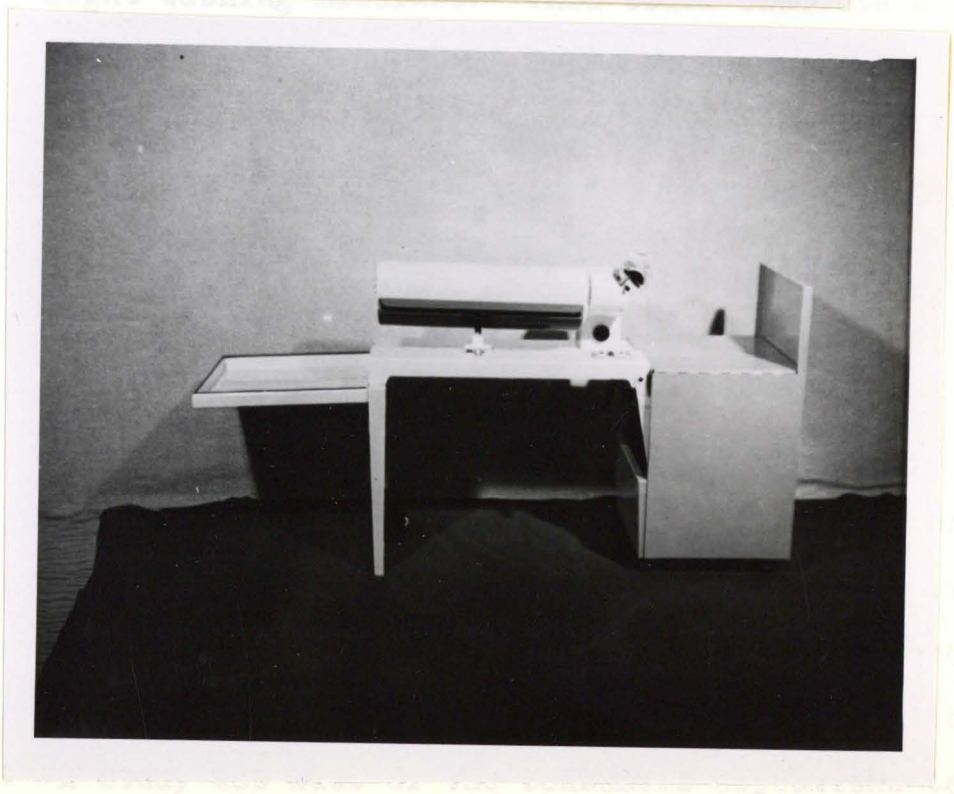

Photographs of Final Design

INTRODUCTION

A product design must fulfill certain criteria.

"Product design resolves itself simply and basically into the external organization of products to reflect their internal efficiency in (1) manufacture, (2) performance, (3) use.

Improved appearance is essentially a look of efficiency, competence, stability, durability, simplicity, and honesty revealed with grace and charm".---
Walter Dorwin Teague

A preliminary investigation of likely thesis subjects led to the observation that almost one half of the electric ironers in use today are used for flat work alone. For a supposed labor saving device, this was considered to be an unpardonable situation. In addition, only one ironer is in use for about every eight washing machines. This would indicate a strong sales resistance on the part of consumers toward buying ironers. It was believed, therefore, that an improved ironer design was very definitely in order. Due to the time involved, however, the problem was limited to the ironer alone and did not include the seating of the operator beyond the ordinary consideration of proper knee height and working height.

The design was preceded by a thorough market and product study. Investigations were made into the distribution of the ironer market by geographic region, by income group, and by age groups. Investigations were also made into the consumer's preference for ironers by brand, and into his financial position. A study was made of the consumers objections to present

ironers and his desires and needs in a new one. The characteristics of the consumer and the difficulties encountered in the distribution and sale of ironers were investigated. A study was also made of the ironers now on the market.

A fundamental investigation was made into the technique of ironing and the ideal solution to the problem. The fundamental machine was analyzed from the standpoint of ironing flat work, shirts, and ruffled, difficult areas. Folding mechanisms were studied and the essential final design proposed.

An analysis was then made of the selected design. Proper ironing temperatures, pressures, and speed were established. The proper motor, drive, and operating mechanisms were decided upon and the material and construction of each part was established.

MARKET

BACKGROUND

Although the electric ironer was introduced in 1907, the first spurt of consumer interest in household models is placed in the early 1920's. The sales of ironers reached 40,000 units in 1925 at an average retail price of $150. In 1929, 126,000 units were sold at an average retail price of slightly over $76.00. Then, of course, in the early depression years, a down trend in sales occurred, reaching a low of 50,000 in 1932. At the end of that year, the estimated number of homes posessing ironers was 739,700 or 3.7% of the wired dwellings in the country(1)*.

The length of time required to master the technique of using the electric ironer has been blamed for its relatively slow acceptance. Many women are naturally slow at mastering a mechanical device. Hence they became discouraged in the learning period and went back to using the flat iron. Their reaction to the ironer, then, was unfavorable and was passed along to friends and neighbors.

There was a marked increase in consumer interest in electric ironers by the middle 1930's. This was helped along by the rising national income as compared with depression lows. At this time, there was an increased effort on the part of

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* Numerals in parentheses refer to references in Appendix.

dealers and manufacturers to promote ironer sales, especially to prospective washer buyers. This activity promoted some consumer research which revealed major sales appeals, and uncovered much information about women's attitudes and interests.

A telephone survey, believed to be the first national sampling of ironer prospects, was conducted in 1935 by the Norge Division of the Borg Warner Corporation. It represented a higher than average income group and revealed a current ironer saturation of 15.4%. A large proportion - 40.3% - of the group was interested in purchasing ironers the following year. The flat plate type was favored by 19.3% of the prospective purchasers, the rotary type by 49.3%, and the balance was undecided. The results indicated a reversal in the earlier trends toward the flat plate type. About 98% of all ironer owners used them regularly but 46.6% used them for flat work only.

In 1938 there were approximately 26 manufacturers of household electric ironers. Five companies manufactured the flat plate type and the balance made the rotary type. Portable ironers also appeared at about this time. The Horton Company introduced their model with a free home trial offer to prospective washer purchasers. It sold for $29.00 and gained considerable acceptance. Horton attributed its popularity to the fact that it encouraged women to become familiar with machine ironing without their having to make a substantial financial investment. Also, the home trial feature, which let them practice in private, gave the women confidence in their own ability

to use the machine.

An official of the American Ironing Machine Company expressed the opinion that portable ironer sales would not affect console sales adversely; on the contrary they would eventually increase them by spreading interest in mechanical ironing and paving the way for later sales of console models to portable owners who might otherwise never have become interested in them.

In 1941, the last full year of production before war stoppages, 259,668 ironers were sold, representing a retail value of 14.5 million dollars. There was an increase in the ratio of ironer sales to washer sales. In 1940, one ironer was sold for every 8.3 washers, while in 1941, one ironer was sold for every 7.3 washers. Production delays held 1946 sales to 175,000 units, but in 1947, sales rose to an all time high of 564,000 units. The ratio of ironer sales to washer sales continued to increase, rising to one ironer for every 6.34 washers. In 1948, however, ironer sales dropped to 470,000 units. The ratio dropped as well to one ironer for every 9 washers. Although ironer sales dropped approximately 20% from the 1947 level, they are still far ahead of any pre war year (see table I, Appendix A)[2].

The rather recent development of self service laundries may be a factor in further expanding the market for electric ironers. Empire Ironer, Inc. has started a development of considerable importance in introducing ironers into self service

laundries with its Ironerettes. It provides an opportunity for women lacking modern laundry equipment to become familiar with the operation and convenience of an ironer. Some believe that this development may do for the electric ironer industry what it has not been able to do for itself in 25 years - make U. S. women electric ironer conscious.

Despite the marked improvement in the promotion and sale of ironing machines, there is room for a good deal more.

"Ironers are still in the stage where effort must be made to sell them. They are by no means yet in sight of the market which they should reasonably be expected to enjoy. Among established appliances it seems clear that there is no appliance on which increased effort and promotion on the dealer's part could result in greater return than the ironing machine."(1)

PRESENT CHARACTERISTICS OF THE IRONER MARKET

Geographical Distribution

The number of homes in the country posessing ironing machines is 2,856,000 which is 8.1% of the 35,205,000 Domestic and Farm electric customers. An 11 year summary of ironer sales by States reveals that the biggest proportion of the total volume goes to the East North Central group which accounts for 31% of the sales, Tables II and III. Next come the Middle Atlantic states with 22% and third are the Pacific states with 15%.

Another indication of the geographical distribution of ironing machine business is power company statistics for 1948. These statistics show that the biggest proportion of ironers sold in 1948 went to Pacific States with 15 ironer sales per

1000 utility customers. Second highest was the West South Central - normally a poorer market - where 11 ironers were sold per 1000 customers. The Mountain, East North Central, and West North Central regions also were above the national average with 10 ironer sales per 1000 customers.(2)

Income Group Distribution

Market studies conducted by the Milwaukee Journal, the Omaha World Herald, the Columbus Dispatch, the St. Paul Dispatch, and the Seattle Times indicate that ownership of electric ironers is considerably higher in the upper income groups, Table IV.(1)

A survey conducted among the readers of the Sunset Magazine, representing a considerably higher than average income group showed that 24% in the North, 28.1% in the Central, and 21.7% in the Southwestern part of the country owned electric ironers.(3) These figures are considerably above the national average of 8.0%.

Age Group Distribution

Two studies conducted by Fawcett publications in 1947 showed the characteristics of young women compared with older women. They revealed that older women showed somewhat less interest in buying ironers than younger women largely because ownership of ironers was higher in the older group, tables V and VI.(1)

Brand Preferences

The preferred brands of electric ironers owned in Milwaukee, Omaha, Columbus, St. Paul, and Seattle are Thor first, General Electric second, and Kenmore third, table VII.(1,4)

The preferred brands of ironers owned among the subscribers to Michigan Farmer, Ohio Farmer, and Pennsylvania Farmer in percent of total mentions are Ironrite 27.6%, Thor 17.2%, and Speed Queen 13.8%, table VIII.(1)

The ironers preferred among the readers of the Sunset Magazine are Thor first, Ironrite second and General Electric and Easy approximately tied for third, table IX.(3)

The overall most preferred brands appear to be Thor, General Electric, and Ironrite.

Characteristics Desired in Ironers

A study conducted by the Norge Division of the Borg Warner Corporation showed that the most important factors influencing buying decisions were labor saving first, time saving second, and better results third, table X.(4)

In 1938, the Westinghouse Corporation conducted a study of the reasons why people had bought Westinghouse ironers. Labor saving led all other factors with 82% of the respondents naming it. Time saving was second, named by 66%. Manufacturer's name was third and better results and economy tied for fourth place.(1,4)

Nevertheless, the owners of electric ironers have some serious objections to them. In order of importance they are:

"Limited use - Too many housewives believe their ironers do too little of the work. Possibly they have not been sufficiently well instructed in the proper use of this appliance.

Hard to Operate - Is closely related to the above. The difficult jobs of ironing shirts, dresses, etc. cannot be done - even large flat pieces are hard for many to handle.

Heat Control - And the difficulty of adjusting for proper heat is a minor objection."(4)

Women want their appliances to do the complete job. They are irked by exaggerated advertising promises and point out that automatic ironers are not really automatic. They feel that if they have gone to the expense of buying one, they are entitled to one that will really do the work.(5)

Consumer Study

In order to get some first hand information about consumer desires, needs and preferences, a sample survey was conducted in a typical middle class section of Pasadena. It consisted of interviews with thirty consumers. Then dealers, demonstrators, and home economists were consulted for further facts and impressions. Four of the thirty owned ironers (13% compared to a 12% saturation for California). Of the four who owned ironers, one reported that she did everything on it but had some difficulty with gathers and ruffles. The other three used it only for flat work, doing all "fussy" work by hand. When questioned about a reasonable price for the appliance, answers ranged from $75.00 to $150.00 with most replies around $100.00. Another interesting fact learned was that space is at a premium in many homes. Many of the women thought that a unit that

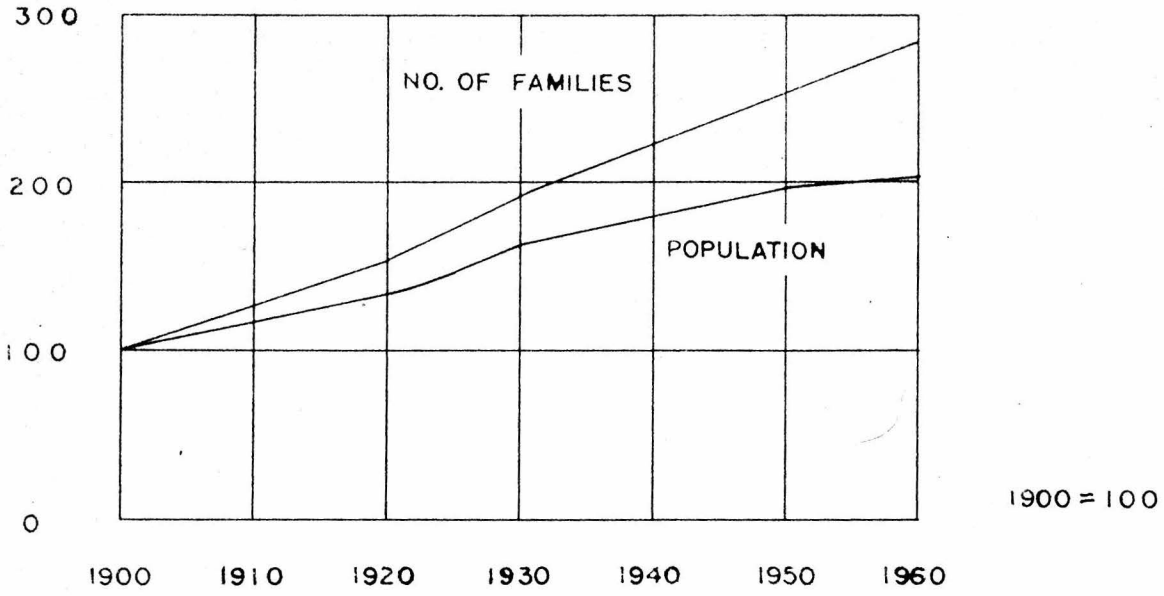


FIGURE 1. POPULATION AND FAMILY GROWTH
(REFERENCE 6)

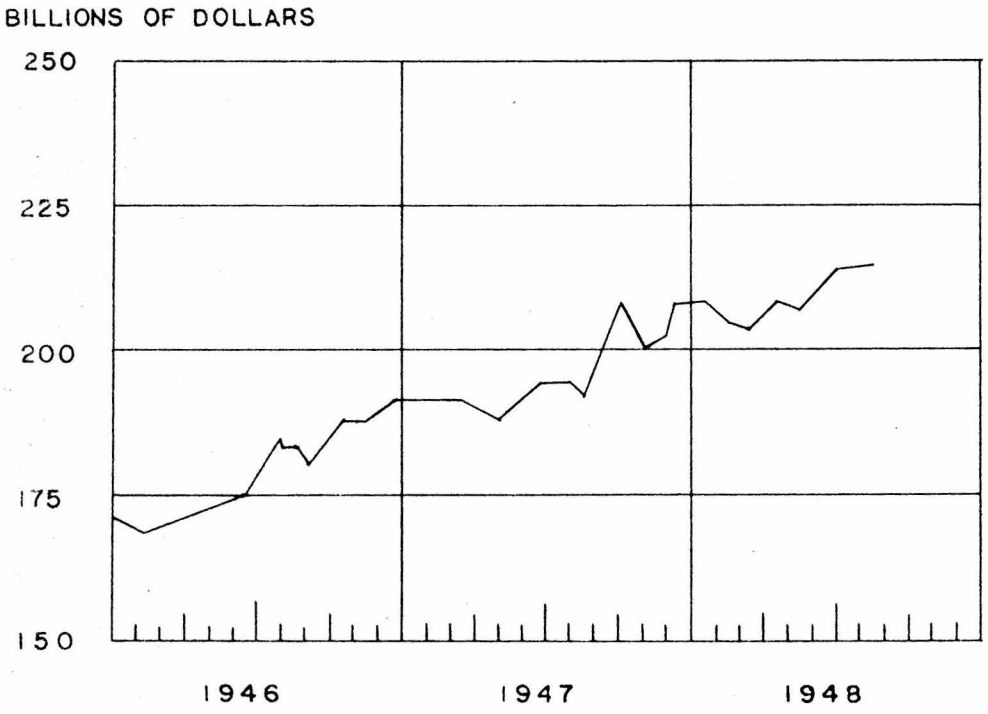


FIGURE 2 PERSONAL INCOME TRENDS
(REFERENCE 7)

would fold up to fit away into a small space when not in use was a good idea. It was noted that the women as a whole were blissfully unaware of the advantages to be had with an ironing machine. Many had just not heard nor thought much about ironers. Others had seen some demonstrated and were not impressed.

Individual research with dealers, demonstrators, and home economists further substantiated many facts that have already been learned about the ironer market. Women like to be able to use the top of the cabinet for a table when the ironer is not in use. Fifty percent or more of the people who buy electric ironers buy them for flat work alone. Ironers are hard to keep sold, due largely to the long learning time involved and to inadequate demonstration. Many women are afraid of the learning process on an ironer. More will try it if the price is low. It takes a good deal of time and practice to learn how to use an ironer properly. If a woman is proficient with a flat iron, she is tempted to go back to it for everything but flat work. The investigation revealed further that Ironrite has put out a model in a Walnut cabinet so it can be set up in a living or dining room as a piece of furniture when not in use.

NATIONAL CONSIDERATIONS

Since the ironer proposed in this thesis is purchased primarily by the family for family use, the important factors to consider in the national picture are population and family growth trends, the financial position of the consumer and

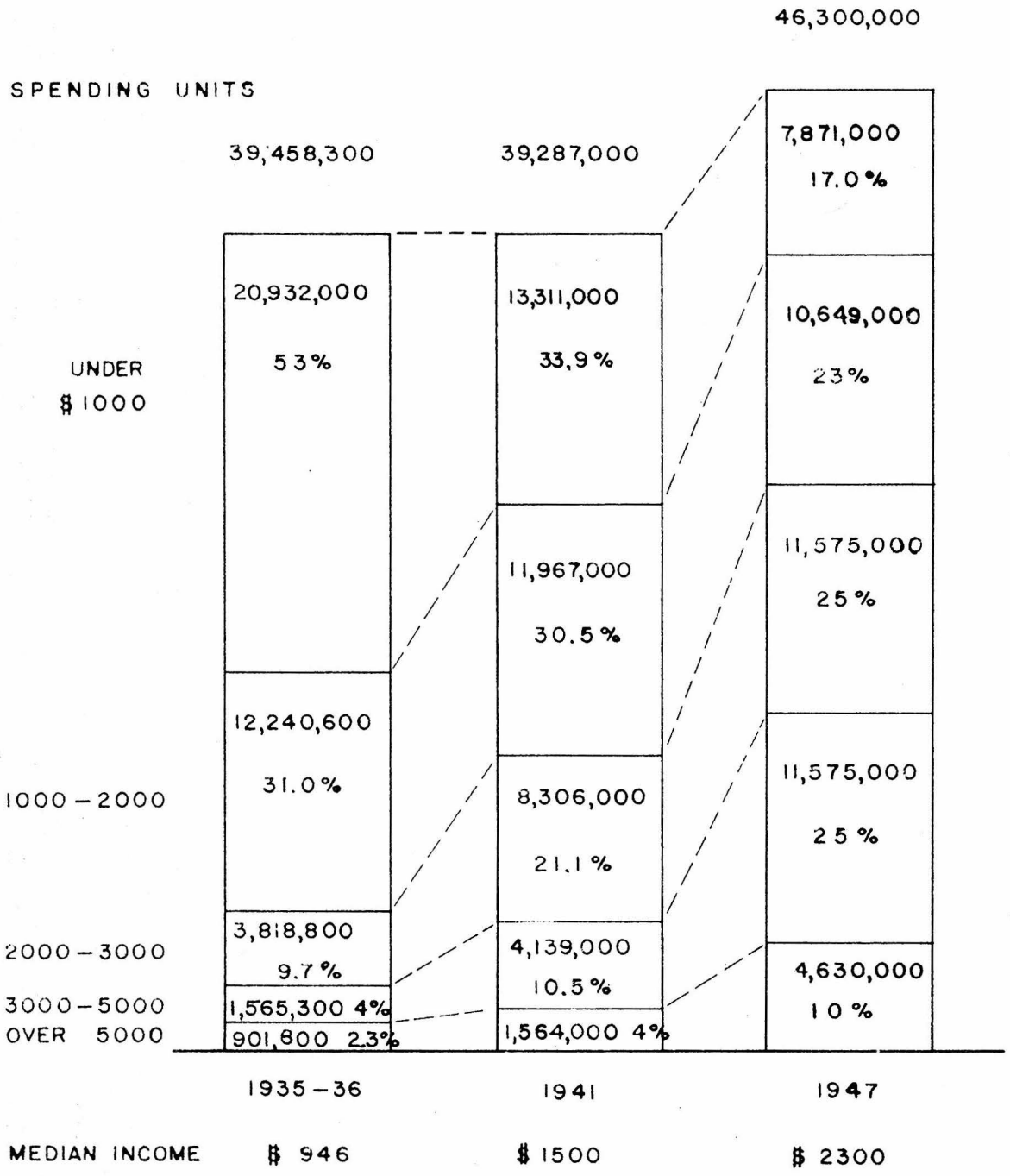


FIGURE 3. INCOME DISTRIBUTION

(REFERENCE 9)

home ownership and housing starts.

The population of the United States has increased 10.5 million since 1940 and the number of families has increased 5.5 million in the same period, figure 1. The number of families are increasing at approximately twice the rate of population growth, indicating an expanding market for family use items particularly.(6)

Personal income has risen to an all time high of 215 billion dollars(7) with a third quarter (1948) average of 214 billion dollars.(8) It is nearly 3 times the 1939 level and more than 1/4 above the early 1946 level, figure 2.(7) The median income has risen from $946 in 1935 - 36 to $2380 in 1948 (after taxes),(10) figure 3.(9)

Nevertheless, there is a growing feeling of uneasiness among American consumers. Some of the highlights brought out in a survey conducted by the University of Michigan Survey Research Center in July 1948 are as follows:

"1. Despite the higher incomes received by many of the respondents, the feeling that people were not quite as well off financially as they had been was slightly more widespread than in July 1947. About 40% of the spending units felt that their financial position had deteriorated over the past year, whereas only 25% felt that their situation had improved.

2. Spending units who were optimistic about the general economic outlook for the coming months constituted a smaller proportion of all spending units in July 1948 than they did in the earlier surveys. Since the survey early in 1947, the proportion has gradually declined from 55% to 41%.

3. Two of every three consumer spending units believed that prices would at least remain at their present levels or possibly go higher during the next year. Only about one in six saw definite prospects of price declines."(11)

A survey conducted for Sales Management puts it this way:

"A substantially greater proportion of people as compared to 1947 are now

1. Doing more shopping around for values.
2. Buying less expensive merchandise as a temporary substitute.
3. Spending money on repairs instead of replacement.
4. Buying less expensive substitute brands instead of the preferred brand.

One consumer in four, frightened at the prospect of running in the red, will not make any purchase costing over $50.00 within the next six months."(12)

The final important factor to consider in the national picture is home ownership and housing starts. There are more home owners in the country now than ever before. About 18.5 million families own homes and approximately 17 million families live in rental dwellings.(10) Experts expect 875,000 new homes to be started in 1949 as compared to 925,000 in 1948.(13) Builders have found that the market for homes selling above $12,000 is pretty well satisfied now. At the same time, the demand for houses selling for less than $8,000 is practically unlimited. The big problem that they now face is to get enough value into a $6,000 - $8,000 house to keep buyers happy. Many builders figure they cannot come down to that range without cutting the size of the house to 700 square feet or thereabouts.(14) Houses are getting smaller and smaller and must be given careful consideration in the design of new home appliances.

MARKET POTENTIAL

The ultimate potential market for ironers might be considered to be all the owners of flat irons in the country (97.5%

of the families[15]). However, due to income and family size considerations, a much more reasonable estimate of the ultimate potential market is 50% of the owners of electric washers (33.7% of the wired homes in the country)[1,2]. This goal probably will not be attained for a number of years and the estimate for the coming year will be based on more conservative figures. Table I shows 23 year sales, average price, and retail value of ironing machines. The number sold in 1947 and 1948 was 564,000 and 470,000 respectively. A comparison of the brand preference figures indicates that of all the ironers owned, 20 - 25% were made by the Thor Corporation, while 10 - 12% were made by General Electric. Assuming that the ironer proposed in this thesis will be manufactured and distributed by a Company that has 1/5 of the market of approximately 500,000 units a year, it is estimated that 100,000 ironers can be sold the first year. The market has indicated a declining tendency and may decline even more, but with a good design and vigorous sales promotion, 100,000 units can be sold.

DISTRIBUTION CHANNELS

Certain factors involved in the distribution of ironers should be considered in the design of the unit. Approximately two thirds of the output of electrical appliances follows the normal distribution channels of manufacturer to wholesaler to retailer to consumer while the remaining one third goes direct to retailer, consumer or industrial user.[16] The largest pro-

portion of ironers seems to be handled by an exclusive distributor in an area who in turn supplies the retailers.

At the present time, there is a certain reluctance on the part of retailers to handle electric ironers. It is caused by the fact that heretofore ironers have been hard to sell and hard to keep sold compared to other appliances. It takes a good deal of effort on the part of the retailer to demonstrate and instruct a new prospect well enough to make her a satisfied customer who may later be the cause of more business. It is this reluctance on the part of the retailer or sales resistance on the part of the consumer that must be overcome in a new design.

In setting up effective distribution channels, it is of interest to know where the consumer likes to buy electric ironers. A study made for Printer's Ink in 1945 showed that the most popular retail outlets for the purchase of electric ironers were department stores first, Gas or Electric Company second, and Dealer Agent and Electric Store tied for third, table XI.(4)

A continuing home audit survey conducted by the Los Angeles Times in 1945 - 46 showed that the most popular retail outlets for the purchase of ironers in Los Angeles were department stores first and electrical appliance stores second, table XII.(17)

SALES FACTORS

In designing a product, it is appropriate to consider the characteristics of the prospective purchasers. Since women influence the purchase of approximately 85% of the ironers sold,

it will be of interest to look into some of the general psychological characteristics of women as well as factors which cause them to buy.

It has been found that there are three basic and distinct types of women to be considered. The first is the True Housewife whose sole interest is in her home; the second is the Career Woman who hates housework; and the third is the Balanced Homemaker who has interests both in the world outside the home and in efficiently managing her household.(5)

The True Housewife takes great pride and satisfaction in her ability to maintain a comfortable and well run household for her family. She considers herself indispensable and believes that no one else can handle her job. Her reaction to appliances is best expressed in her own words:

> "I don't think there is any way to make housework easier for myself, because I don't believe that a machine can take the place of handwork. A machine cannot think and you can't rely on it; it doesn't do as thorough a job as a person. Oh, it might work easier in some instances, but it can never replace a human being."(5)

The size of this group has diminished in recent years but still predominates the market, comprising 51% of the sample taken.

The Career Woman is not necessarily a job holder. Indeed many in this group have never actually worked, but they feel imprisoned and unhappy in their homes. They perform household duties against their will. This woman's attitude is expressed as follows:

"I want a mechanical maid. That's what I want - a robot.

If they can make other things, they can make them too."(5)

While this woman buys appliances, her demands and expectations are apt to be unreasonable and unrealistic. She makes up 11% of the market.

"The Balanced Homemaker is from the market standpoint, the ideal type. She has an interest both in the world outside the home and in managing a well run household. She has confidence in her ability to do and enjoy either or both and hence is endowed with a well balanced personality. She has an intelligent and realistic attitude toward mechanical appliances; she readily accepts the help they can give but does not expect them to do the impossible. Obviously, then, the women in this group are the easiest to "sell" and are the manufacturer's best prospects!"(5)

Their number has increased recently and now makes up 31% of the total.

On the basis of these findings, 31% of 40,525,000 families in the U.S. in 1949 is 12,570,000 families in the country in which the lady of the house is a Balanced Homemaker. The number of homes with electric ironers is 2,856,000. Selling at the rate of 500,000 a year with the number of families increasing at the rate of approximately 400,000 a year, it will take approximately 26 years to sell an ironer to every Balanced Homemaker. However, it is only wise to direct considerable educational and sales effort toward the other two groups as well.

Since approximately 85% of appliance purchases are made by women, it is also appropriate to consider "how to sell the girls". B.J. Kidd, author of the book Just Like a Woman, says to sell a woman, "Put it in her hand - get her to taste it or touch it - have her try it on - let her push it around the floor to see how light it is. Do anything that will get her to make an identification of what you have for sale with herself and her world, and your sale is made."(18)

That is especially necessary with ironers. A woman cannot see how it operates just by looking at it. It must be demonstrated proficiently and preferably within the natural setting it would assume in a home. The finished work might be put on display for all to examine with a little sign on it to tell how long it took to iron. Many demonstrators are not very fussy ironers; on the other hand, many women are, and they will not be favorably impressed with a machine that cannot be shown to equal their standard of quality in less time. Women should also be encouraged to sit down at one and try it out for themselves, perhaps with the helpful attention of a demonstrator.

Some manufacturers and dealers demonstrate their ironers. Sears Roebuck and Ironrite demonstrate ffequently and guarantee a home demonstration for every new owner. A surprising number of dealers, however, make no attempt to demonstrate them or to instruct a new owner in their use.

MARKET CONCLUSIONS

The important facts pointed out in the above discussion, that have been considered in the design of the proposed ironer are as follows:

1. The ironer market is ripe for expansion with vigorous dealer efforts in their promotion and sale.
2. The largest proportion of recent ironer sales went to the Pacific and West South Central states.
3. Ownership of ironers is considerably higher in the upper income groups.

4. Younger women are somewhat more interested in purchasing ironers than older women, probably because ownership is lower in the younger group.
5. The most preferred brands of ironers are Thor, General Electric, and Ironrite. They may have some desirable characteristics.
6. Many women believe their ironers do too little of the work. They feel that they are entitled to one that will do the complete job.
7. There is a widespread feeling among consumers that they are worse off financially than they were a year ago. The ironer should sell for approximately $100.
8. Homes are becoming smaller, necessitating more versatile and compact designs.
9. Sales resistance to ironers is high, largely because most women are afraid of the long learning time involved. A new design should require less learning time. The ironer's complete ability should be readily demonstrable.
10. Vigorous sales efforts are needed in the ironer market. Ironers require frequent demonstrations and free trial arrangements. Every effort should be made to get the prospect to try it out. Career Women and True Housewives should be made the objects of educational campaigns.

PRODUCT STUDY

An investigation of the ironers on the market revealed that although many claims are made for each and every one, none of them are capable of handling the complete family ironing task satisfactorily. Some are more versatile than others and some do better work than others, but there are certain types of work that none of them can perform satisfactorily. Ruffles and gathers, for instance, can either not be done at all or can be done faster by hand. Areas between two ruffles or two converging gathers just cannot be reached.

Classified by function, there are three major types of ironers on the market. The first and most common makes use of a heated shoe located behind the roll. With this type of ironer, the work is arranged on the roll and for convenience, the roll of many of them turns freely in either direction when not pressing against the shoe. Furthermore, only one end of this ironer is free to use for anything but flat work. Since one end is used much more frequently than the other, many machines have two thermostats on the shoe so that the one on the unused side can be turned off when not in use. The second type makes use of a shoe beneath the roll. The work is arranged on a plastic forming board in front of the shoe. Both ends of the shoe are equally available for intricate ironing and only one thermostat is deemed necessary. Also, since the work is arranged on the forming board, instead of the roll, it is not

necessary that the roll be free wheeling. The third type is a flat plate ironer. It consists essentially of a rectangular ironing board and a heated platen. The platen is hand operated and the clothing is fed by hand. The manufacturer recommends the use of a flat iron for intricate work and even provides a receptacle for one on the machine.

A further classification of ironers by size reveals the portable and console types. The portable models are low in cost and are designed to be placed on a table of proper height for use. They are light in weight (28 - 34 pounds). Some come equipped with a table or tubular stand at extra cost. The console models are complete in themselves. They are larger, exert higher pressures, and do better work. They are also heavier, occupy more space and are more expensive.

Rotary ironers today generally provide for continuous ironing; for stopping the ironer temporarily to give a "press" or to dry out very damp clothing; and for "steaming" - accomplished by turning the shoe to a horizontal position, putting a wet towel on it, and placing the material to be steamed on top of that. Some of the machines have an intermittent stop and go action which makes it possible to iron the same area repeatedly and which is said to give shirt collars a "polish" and linen a "sheen".

Tables XIII and XIV in Appendix A give descriptions and prices of several ironers on the market.

DESIGN CONSIDERATIONS

INTRODUCTION

Before attempting to design an ironer, it is a good policy to establish a fundamental understanding of ironing. Ironing, as employed by the housewife, is the operation of removing wrinkles from textiles after they have been washed and dried. The clothing is usually dried completely first. Then it must be re-dampened and ironed. Ironing consists essentially of drying a textile out in an unwrinkled condition. Any method of drying it out while it is in an unwrinkled condition, or of holding the material in an unwrinkled condition while it dries, will perform the same function satisfactorily. For instance, a handkerchief can be rendered wrinkle free by stretching it out on a flat smooth surface and allowing it to dry - very much as photographic prints are dried.

Up to the present time, the fastest way to dry out textiles in an unwrinkled condition has been the use of a heated element to evaporate the moisture, while just enough pressure is applied to keep the material wrinkle free. The most common form of this type of device is the flat iron. Approximately 97% of the families in the country own and use electric flat irons[15]. Practically every housewife has learned to use one and can iron any type of garment with it to her satisfaction.

The flat iron, then, can be considered the fundamental ironing device. Most usually, it consists of a 1000 watt heating element distributed over an area of approximately 23 square

inches. The average weight is 3 or 4 pounds. The garment is pressed by moving the iron around on the cloth to remove the wrinkles while the heated element evaporates the moisture. The point on the iron allows the operator to get into the more intricate places although it is somewhat damaging to certain types of gathers.

Recently, steam irons have been coming into some use. Their chief advantage is that they permit ironing, without previous dampening, of silks and synthetic fabrics, woolens and light weight cottons. These advantages are minimized, however, by the fact that many of these fabrics are used in garments which - in women's minds - do not need ironing or do not require perfection in ironing. Steam irons have some advantage over dry irons for pressing rayon and wool dresses, women's wool and rayon suits, and men's and boy's suits, slacks, and sport clothes. They remove wrinkles more satisfactorily and impart to wool a "live" look. The steam in the iron takes the place of steam which would otherwise be supplied by a damp pressing cloth. However, the advantage is reduced greatly by the necessity of pressing these fabrics on the wrong side to prevent shine or with a pressing cloth between the iron and the fabric. Then the steam from the iron is of less value because the supply is not sufficient to penetrate a heavy pressing cloth[19].

In a survey conducted by the Bendix Corporation in 1948, it was found that 60% of the housewives named ironing as the

most disliked household task[4]. If there are more than two or three people in the family, the weekly ironing, by hand, is a long tiring task for any woman.

IDEAL SOLUTION

The ideal solution to the ironing problem would be the use of textiles that dry wrinkle free after being washed and hung out to dry. Few washable fabrics in use today possess that quality, so until the day arrives when textiles are wrinkle proof, some means must be employed to take out the wrinkles after washing. Assuming that some machine will do the job, the ideal device has been expressed as follows: "I would like an automatic ironer, but I mean really automatic, so you could just leave the clothes and come back and find them ironed"[5]. This is the ultimate of course and at present is somewhat beyond the realm of practical possibility. Nevertheless, it is the goal toward which to work.

The desirable characteristics of the unit can be set up. Probably the most important is that the machine should require as little human attention as possible. To be within the practical realm of achievement today, the machine must have an operator. Granting the necessity for an operator, the next consideration is to make her comfortable. To hold fatigue to a minimum, her required movements must be held to a minimum. Raising and lowering of the arms and reaching back and forth are to be avoided particularly.

The largest single factor holding down the sale of ironers

today is the length of learning time involved. This is closely related to the above. A minimum of learning time should be required by the ideal machine. If possible, the complete operation of the machine should be obvious by just looking at it. Admittedly, this will be very difficult to attain, but there is room for considerable improvement over present types, especially in ironing intricate, difficult work.

The ironer should be capable of ironing every item in the weekly wash. One principal objection to present ironers is their limited use. They do too little of the work. The machine should iron shirts and ruffled intricate work as readily as flat work.

The ideal machine should be low in cost. The consumer study indicated that the price should be approximately $100. An important difficulty with present ironers is that the price of the good ones is too high. The present average price of ironers is 145 dollars which is considerably above $100. The proposed combination of desirable features in the design will make the $100 price difficult to attain.

The ironer must require a minimum of maintenance. Home appliances take a good deal of abuse through neglect and the housewife's ignorance of their proper care. This indicates permanently lubricated moving parts and a finish that will stand up well for the expected life of the unit.

Finally, since modern homes are small, the ideal machine should be compact in design and versatile in use. By this it is meant that the ironer should fold up to occupy a minimum

of floor space when not in use and that a surface of the folded unit should be provided at such a height and composition as to be useable for other things. The unit should be readily moveable from one part of the house to another and hence should be rather light in weight. The unit must have a design and finish that will fit in pleasingly with the contents of any room in the house.

It has been found that the ultimate ideal solution is not possible of practical achievement today. However, it is quite possible and practical to incorporate many of the desirable characteristics of the ideal machine into a new design. Acknowledging the necessity of having an operator, it is possible to hold her fatigue to a minimum, to considerably decrease her learning time, and to enable her to iron every item in the weekly wash. It is also possible to make the unit compact, attractive and versatile in the home, but costs will have to be watched very closely to hold the selling price down to approximately $100.

MODIFIED SOLUTIONS

Basic Machine

The basic ironing machine consists of one or more heating elements to evaporate the moisture from damp clothing and some method of moving the clothing over the heated element in an unwrinkled condition. There is an ironer on the market that consists merely of a heated platen with no means provided for

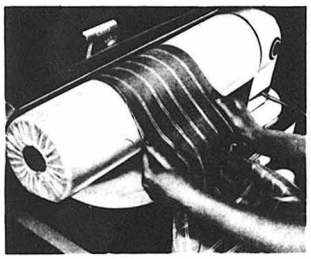
feeding the clothing over it. However, since the operator must provide all the energy for feeding the material, the ironer cannot be considered much of a machine. The most common type of ironer in use today consists of a cylindrical roll that rotates against a concave mating shoe. The movement of the roll feeds the clothing over the heated shoe under a certain amount of pressure. The material is guided by hand into an unwrinkled condition and the pressure between the roll and the shoe holds it that way until the moisture has been driven out. Laundries, hospitals and hotels use ironers with two to six long rolls cooperating with a long steam heated shoe. Somewhat smaller establishments may use a three roll arrangement in which one roll is heated either by gas or electricity. In all cases there is a heated element and some means of moving the material over it.

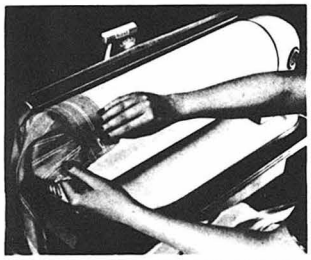
Flatwork

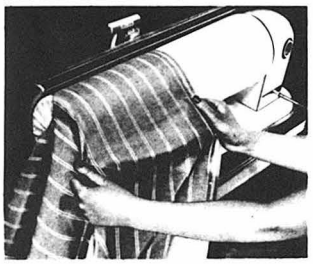
The easiest task the ironer must be able to perform is the ironing of flat work. Flat work varies in size from handkerchiefs to sheets and includes towels, pillow cases, napkins, etc. The fastest way to iron a sheet would be to run it through a basic machine large enough to iron it in one pass. That is in fact what is done in laundries and housing establishments that use a large number of sheets. However, because of the space limitations in a modern home a 90 inch (width of a double sheet) roll is out of the question.

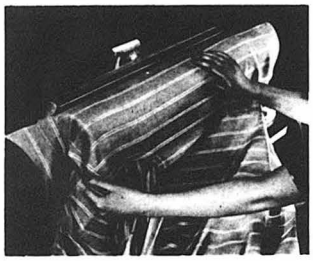
The smaller flat work can be handled very nicely on a much smaller machine. Some laundries use special small flat presses,

FIGURE 4. SHIRT IRONING TECHNIQUE ON CONVENTIONAL ROTARY IRONER









Men's Shirts

1

Fold yoke across back from arm seam to arm seam, then place yoke diagonally on roll and iron up to collar. Release shoe, move shirt to left to iron center portion. Release shoe again, and slide shirt to iron other side of yoke.

2

Straighten sleeve, using underarm seam as guide. Place sleeve on roll with cuff down below lower edge of shoe. Iron sleeve from cuff to shoulder seam, using pressing control to dry out double thickness at seam.

3

Iron sleeve placket, ironing from cuff to end of placket on both sleeves. (Not illustrated.)

Iron cuffs, first on wrong side, then on right side. Hold cuff firmly, as shown, to prevent wrinkles.

4

Place button-side of shirt on the roll with the buttons toward the roll, and iron up to the collarband.

5

Place button-side of shirt lengthwise on roll, right side up. Move roll forward by hand until buttons are below shoe, and iron from buttons to underarm seam. Release shoe.

6

Move shirt to left on roll, to permit ironing right underarm seam. Iron to back side of sleeve, and release shoe. Use pressing control to dry out seam.

7

Slide shirt back on roll so that yoke is at edge of roll. Iron across back of shirt, from sleeve seam to sleeve seam, as shown. Release shoe.

Move shirt to left again, and iron left underarm seam, in same manner as right. Release shoe.

8

Place buttonhole side of shirt on roll, right side up, as shown, and iron from bottom to armpit. Hold as shown.

9

Move shirt to left until front edge of armhole seam is on edge of roll. Iron up to collarband, holding as shown.

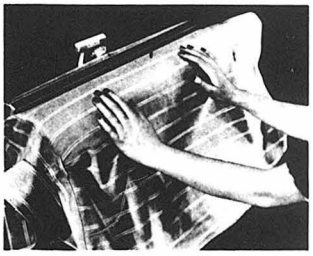
10

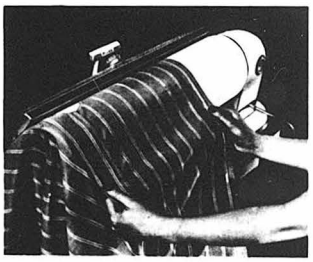
Iron wrong side of collar first, letting the body of the shirt hang over the open end of the roll.

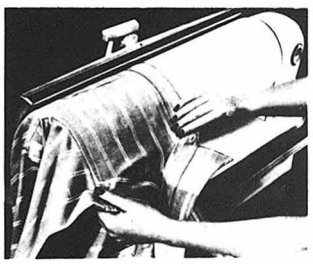
Turn, and iron collar on right side. Hold collar firmly, as shown, to prevent the formation of wrinkles at the points of the collar.

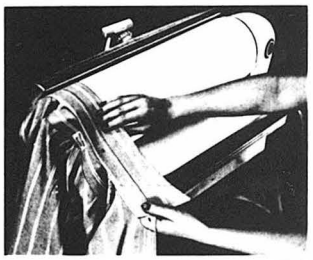
11

Fold and crease yoke as shown, and iron well on to sleeve of shirt. Turn the collar down, but do not iron it. Button the collar button, center and last buttons, and then fold.









just a little larger than the largest handkerchief for pressing handkerchiefs and napkins. Although very satisfactory for laundry use they are a little too specialized for the home.

Flat work can be handled adequately by almost any basic machine. For sheets, the larger it is, the better. Since a 90 inch roll and shoe is much too large for a modern home, some equal segment of 90 such as 45, 30, or 22.5 inches will iron a correspondingly folded sheet.

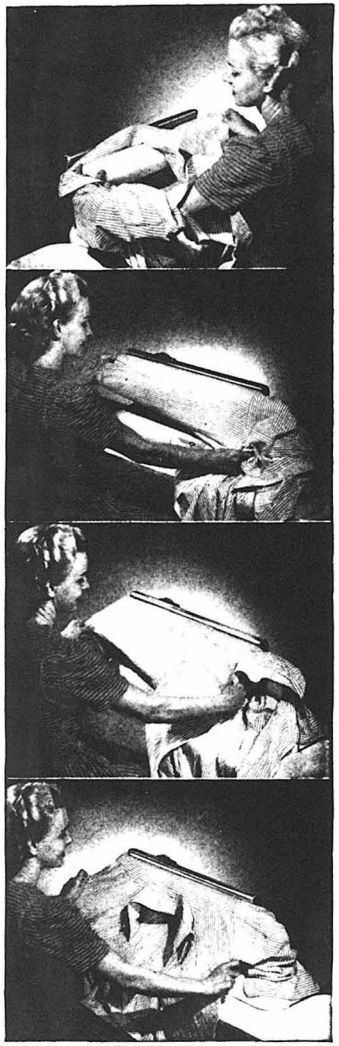
Shirts

The ironing of shirts is considered by many women to be one of the most difficult types of work. The more shirts a man wears, the more particular he is likely to be about their appearance. Consequently the housewife is very fussy about the quality of work she performs on a shirt. The average woman cannot iron a shirt to her satisfaction in less than 10 minutes with a flat iron. An ironer, therefore, should be able to equal her quality in 2 or 3 minutes or less.

Laundries probably make use of the fastest method of ironing shirts. They are ironed in large numbers on a mass production basis. Three special presses are used. The sleeves are done in one press, the front and back are done in another and the cuffs and collars are ironed in another press. The whole operation is very rapid and wonderful for a large number of shirts, but a little impractical for home use.

The sequence of operations for ironing a shirt on a conventional rotary ironer, shown in figure 4, is a rather long and tedious procedure. Many of the steps are awkward to per-

FIGURE 5. SHIRT IRONING TECHNIQUE ON THOR GLADIRON



1. Place shirt in position on the roll

Hold shirt with front (label side!) facing you. Put your *left* arm through the *right* sleeve (starting with the cuff) and continue across the shoulder and through *left* sleeve until the entire shirt is threaded on your *left* arm. Place the fingers of your *left* hand on the end of the roll. Grasp the *left* cuff with your *right* hand and draw *left* sleeve over the roll. Continue drawing shirt onto the roll until the *right* sleeve is well over the roll and *left* sleeve and body of shirt hang loosely over roll support.

2. Iron the right sleeve first . . . all but the cuff

Smooth sleeve on roll so underarm seam comes directly beneath the center of the shoe. Let the cuff hang over the end of the roll. Placket (slit in sleeve) should be facing you. Now iron around sleeve to button side of placket, stopping roll by using press position or releasing shoe to adjust fabric when necessary. Release shoe and slide ironed sleeve to the left.

3. Iron the shoulder portion of the yoke

Move shirt to the left until collar band lines up with right end of roll. Smooth out gathers and iron over the shoulder approximately to collar button.

4. Iron the back of the yoke

Center the unironed portion of yoke and adjust roll (just turn it with your hand) to start 6 or 7 inches below back of collar. Iron to collar seam and stop. Release shoe and move shirt to left until left shoulder is lined up with left end of roll. Iron over shoulder to first buttonhole.

Now place the second sleeve in position, iron exactly as you did the first sleeve and remove from roll.

Now center the back of the shirt on the roll and iron from the tail to the unironed portion of the yoke.

5. Iron the front

Take shirt by the collar and draw it toward you to bring tail again to starting point. Adjust to avoid armhole and iron to collar buttonhole. Turn shirt over and iron the button side the same way but on the wrong side with buttons cushioned against the roll.

Note—Normally you will have to take in an inch or two of the back which will not have been ironed as most backs are wider than the roll is long.

6. Iron the cuffs

Iron cuffs around the left end of roll, first on the wrong side, then on the right side. For glossy sheen hold shoe at press position for a few seconds. Cuffs may also be ironed by running flat under shoe and pressing.

7. Iron the collar

The collar may be done either by placing it the long way of the roll, doing first the under side and then the "right" side and using the "press" position each time, or it can be ironed at the end of the roll like the cuffs. "Shape" the collar with your fingers or iron in the crease over the end of the roll. A high finish may be put on collars and cuffs by getting them into the press position, "right" side against the shoe, and working the roll back and forth a few times with the hands.

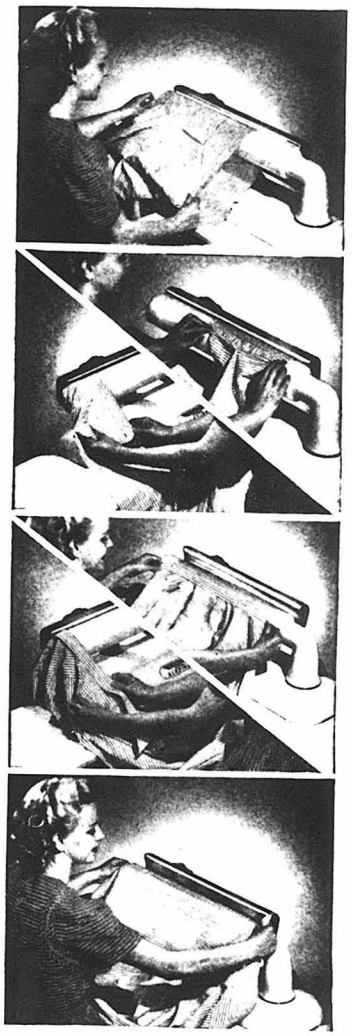
8. The finishing touch

Center the buttonhole band on the roll ("right" side facing shoe) so the edge of collar comes just over the right end of roll. Stretch slightly and press for a few seconds to finish smartly.

Special Tips for Special Shirts

Shirts with two large gathers at yoke may not lie flat enough to iron as shown in Illustration 4 without causing wrinkling. In this case do not try to iron the whole yoke at once but do one gather and the part of the yoke directly behind the collar. Do the second gather when ironing the left shoulder. They may also be ironed by ironing *around* the body starting with the button front (buttons up) under the shoe. Iron to sleeve. Release shoe, pull shirt back, move to left and iron tail portion from buttons all the way across the back to side seam. Release shoe, pull shirt back and move to right, ironing from sleeve seam to sleeve seam, pulling out pleats or gathers over open end of roll. Remove shirt from roll and iron buttonhole front in same manner as button front but on wrong side of material.

Women's and children's blouses are easily ironed by ironing around the body as described above.



form. The sequence of steps for ironing a shirt on a Thor gladiron, shown in figure 5, constitutes a patented process (No. 2,280,720). First the left sleeve and the back of the shirt are slid over the roll and over the gooseneck of the ironer while the right sleeve is ironed (the roll of this machine is 3.25 inches in diameter). Then the yoke of the shirt is pulled out over the roll and ironed, and next the left sleeve. The rest of the shirt is done like flat work. The number of steps is quite large. The roll of this ironer is used like a sleeve board and consequently is not very good for larger pieces.

The sequence of steps for ironing a shirt on the Ironrite or the Bendix, using a shoe beneath the roll, figure 6, is rather difficult to understand completely from the photographs. Basically, there are five steps. The right sleeve and the left sleeve are ironed first, one on each end of the shoe. Then the back is ironed, all the way up to the collar. Next comes the right front and the left front. Those are the five steps. The cuffs and collar are then pressed. After observing the three methods, trying out the first one and examining the results of them all, it was concluded that the last method was the fastest and simplest. It also turned out the most professional product.

Considering this method, then, as the most suitable for ironing shirts in the home, it may well be examined for other characteristics. In making use of a shoe beneath the roll,

FIGURE 6. SHIRT IRONING TECHNIQUE ON BENDIX AND IRONRITE

MEN'S SHIRTS (Size 15 and Larger)

Because of the flexibility of the IRONRITE IRONER, by having two identical and usable open ends, various garments can be ironed in different ways. For instance, the fronts and backs of shirts can be ironed either across or from the bottom up, to the neck.

The most common and fastest method used for shirts, size 15 and larger is as follows:

SLEEVE, OPENING AT CUFF—When the sleeve is made with the fullness gathered into the cuff by pleating, this may be ironed first by feeding the side of the placket that has the pleats (or buttonhole side) in by putting the cuff end under the roll and then iron the pleated section single, straight down flat from the cuff with wrong side to shoe. Fig. 35. Continue and finish the other side of the placket or opening in same manner. Lay the sleeve on top of the roll to straighten and smooth.

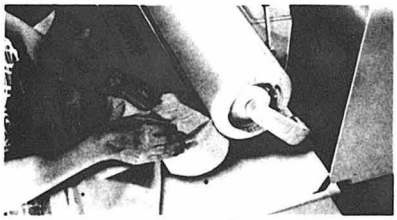


Fig. 35

BODY OF SLEEVE—Insert the body of the sleeve at one open end of the shoe or roll, dropping the cuff below the roll. If the fullness at the cuff should be placed in gathers, these are usually placed near the underarm seam and then when starting to iron the body of the sleeve, these gathers can be spread out over the end of the pointed shoe and ironed out perfectly: taking hold of the seam with the thumb and fore-finger, this fullness can be pulled out nicely. Iron four or five inches or length of the opening or placket, with the sleeve on an angle. Fig. 36. Raise roll, straighten sleeve and iron up to armhole seam, Fig. 37, using left knee press control on the seam to dry out thoroughly. Turn the sleeve over and iron the other side in the same manner by inserting the sleeve at the opposite open end of the roll and shoe.

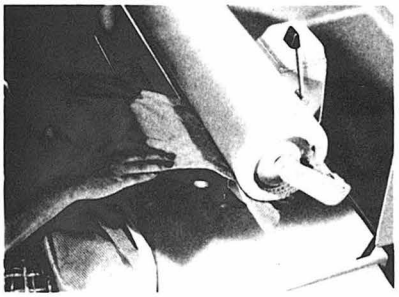


Fig. 36

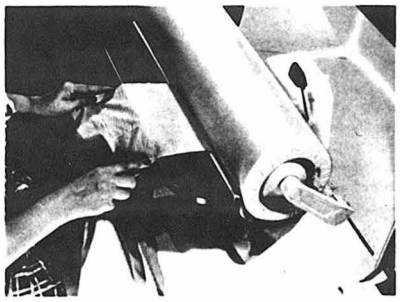


Fig. 37

CUFFS—Feed the cuff in flat on one side of the forming board with the wrong side next to the shoe and iron to body of sleeve. Fig. 38. Stop and press. Turn the cuff over and iron the other or right side of the cuff on the opposite end of the forming board and shoe. This shows plainly how we do use the entire surface of the shoe and not just one part of it all of the time.

To shape the cuffs after they are ironed, iron them around the ends of the roll. Fig. 39.

Fig. 38

Fig. 39

BACK—Start the tail of the shirt with the wrong side placed next to shoe, Fig. 40, and iron to armholes, Fig. 41, stop and raise roll, shift shirt slightly making

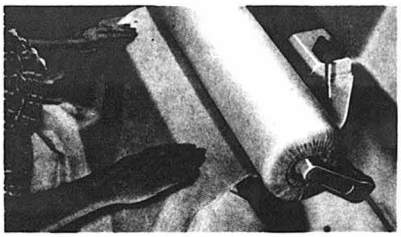


Fig. 40

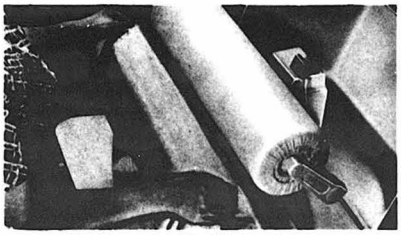


Fig. 41

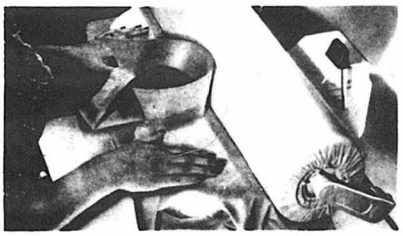


Fig. 42

sure that it is free from the roll and that the armholes are open and the points of the shoe are fitted into the sleeves. Continue ironing up over the top of the back and onto yoke. Fig. 42. Use left knee press control on the yoke to thoroughly dry it. Remove the shirt from the ironer after the back is finished by taking hold of the sleeves and lift up and toward the operator.

COLLAR—Feed the collar in flat with the wrong side placed down upon shoe, Fig. 43, iron to the body of the shirt and use the presser or left knee press control. Turn over and repeat.

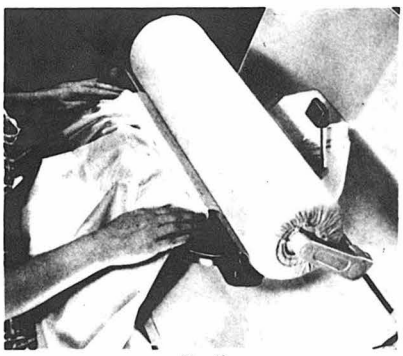


Fig. 43

FRONT—Lay the front, right side down to the shoe or forming board and feed it in and iron across the front to the armhole seam. In doing this have one inch of neck band placed on shoe. Fig. 44. This will eliminate some angling in order to iron the point of the front at the neckline. After doing the top of the front, slide the shirt down on the forming board so as to miss the sleeve and finish the bottom of the front, ironing across to underarm seam, and under armhole.

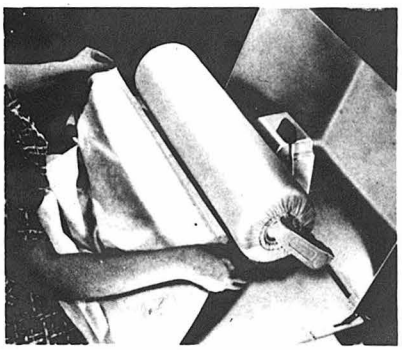


Fig. 44

the work is arranged on a smooth, cool, plastic forming board in front of the shoe. This forming board is at approximately waist height and eliminates the necessity of having to reach forward over the roll to arrange the material. Both ends of the shoe are equally open for any type of work and will probably be used equally. Two corners of the shoe can be so shaped as to assist materially in the handling of certain short gathers as occur at the cuff of a shirt sleeve. Furthermore, the roll rotates forward with this arrangement instead of backward, causing all the hot steam to escape beneath the shoe and follow the roll up the far side away from the operator. A shoe length of approximately 24 inches will handle shirts size 14 and larger very nicely as shown in figure 6. Smaller shirts, then, must be passed diagonally over the shoe but present no difficulty.

Ruffles and Intricate Work

The task which has been neglected most in the design of ironers is the capability of ironing ruffles, of ironing between two closely spaced ruffles, and of getting into difficult intricate corners. While this capability is perhaps not the most important in itself, its deficiency makes the ironer incapable of ironing certain types of garments and renders the unit incomplete. There is no household ironer on the market that can iron ruffles faster than a flat iron. Difficult areas between two converging gathers cannot be ironed at all.

Considerable thought was given to the problem of ironing ruffles, gathers and difficult "in-between" areas. It was

Figure 7. Cylinder Fitting a Ruffle

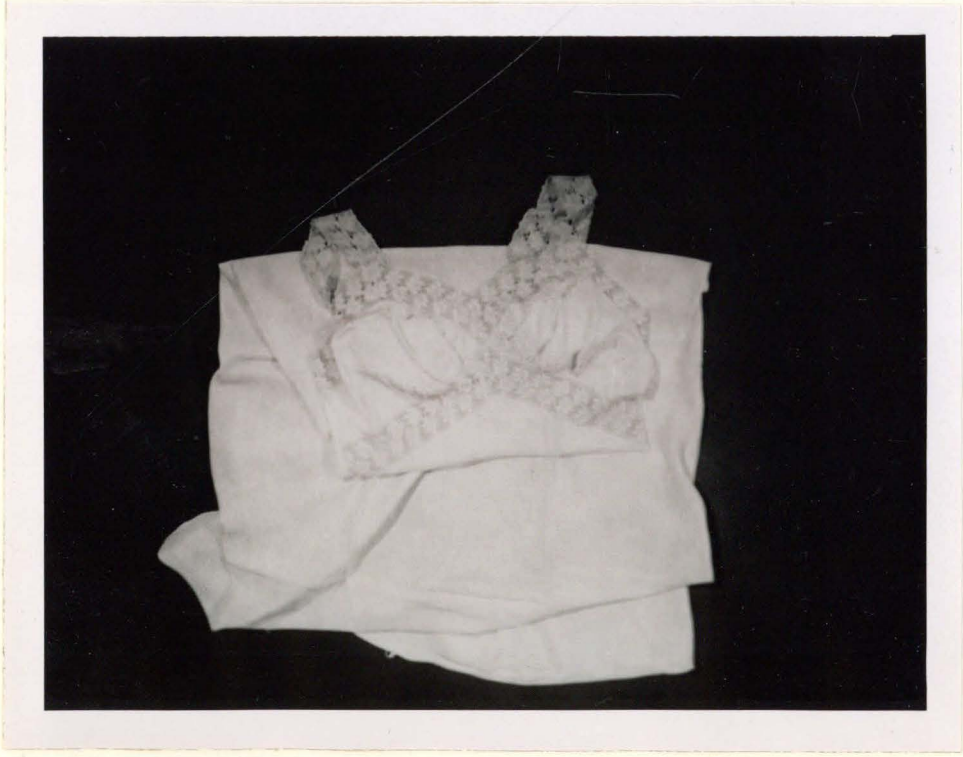


Figure 8. Garment with Converging Ruffles

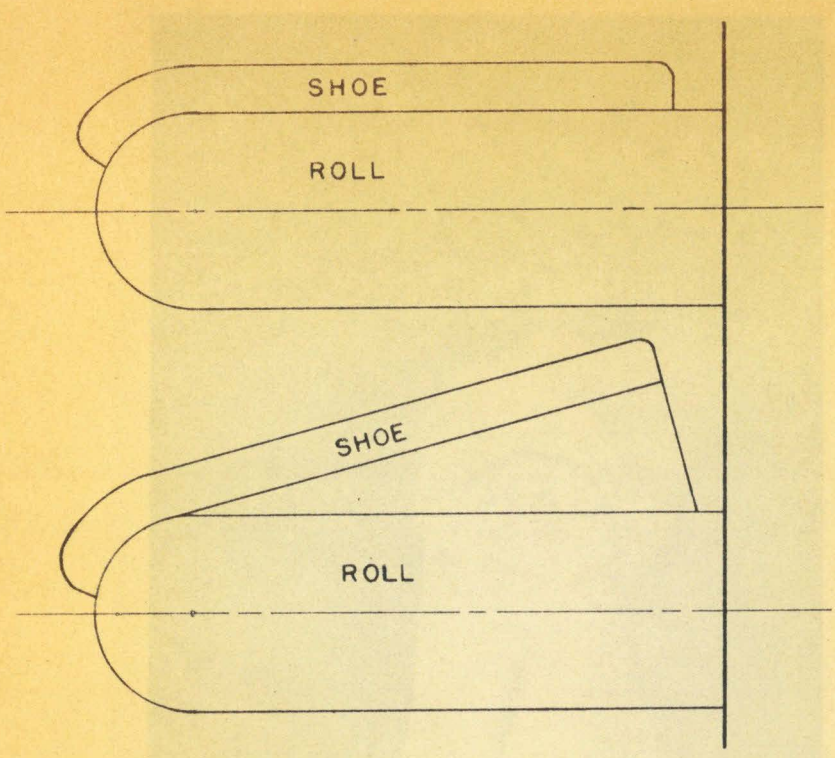


FIGURE 9. CYLINDRICAL ROLL & CONCAVE SHOE

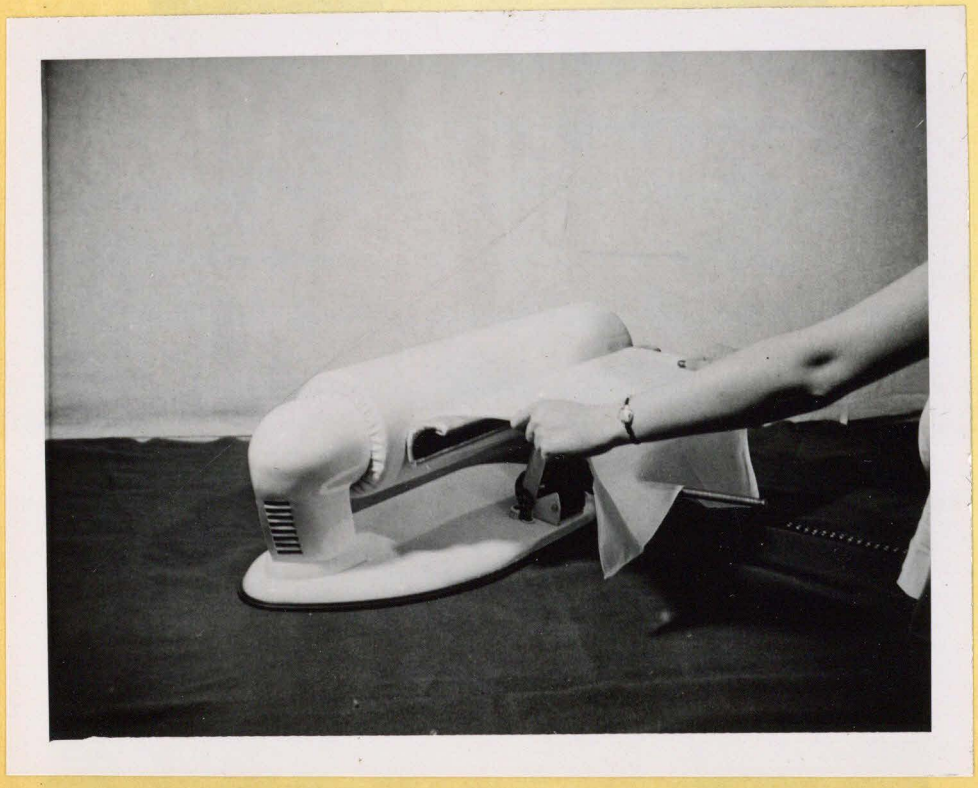


Figure 10. Experimental Convex Shoe

found that ruffles fit very nicely over the rounded end of a small cylinder as shown in figure 7. This cylinder could be a roll with a cooperating shoe that fit over it or the cylinder might be a heated shoe over which the ruffles were passed. At the present time there is an ironer manufactured for use by laundries by the Maxant Button and Supply Company for the purpose of ironing ruffles. It embodies the first arrangement mentioned, a roll with a rounded end and a cooperating shoe. While this arrangement will undoubtedly iron ruffles very satisfactorily, it still could not get in between two converging ruffles (see figure 8) unless some arrangement were employed for varying the amount of shoe in contact with the roll, figure 9. Any such arrangement would be quite complicated and would undoubtedly prove confusing to the housewife.

The other alternative is to make the heated shoe in the form of a cylinder or portion of a cylinder. The best diameter for this cylinder was found to be approximately three inches. It then remains to provide some means of feeding the material over the shoe. It is conceivable that the convex shoe could be mated with the roll, forming only a line contact, yet perform a satisfactory ironing job by the operator's holding the material taut over the remainder of the shoe, figure 10. If such a shoe were found to iron heavily dampened flat work satisfactorily, perhaps it would be possible to separate a small section from the main shoe for the purpose of ironing "hard to get at" areas between ruffles and pleats. Such a shoe was made up and tested

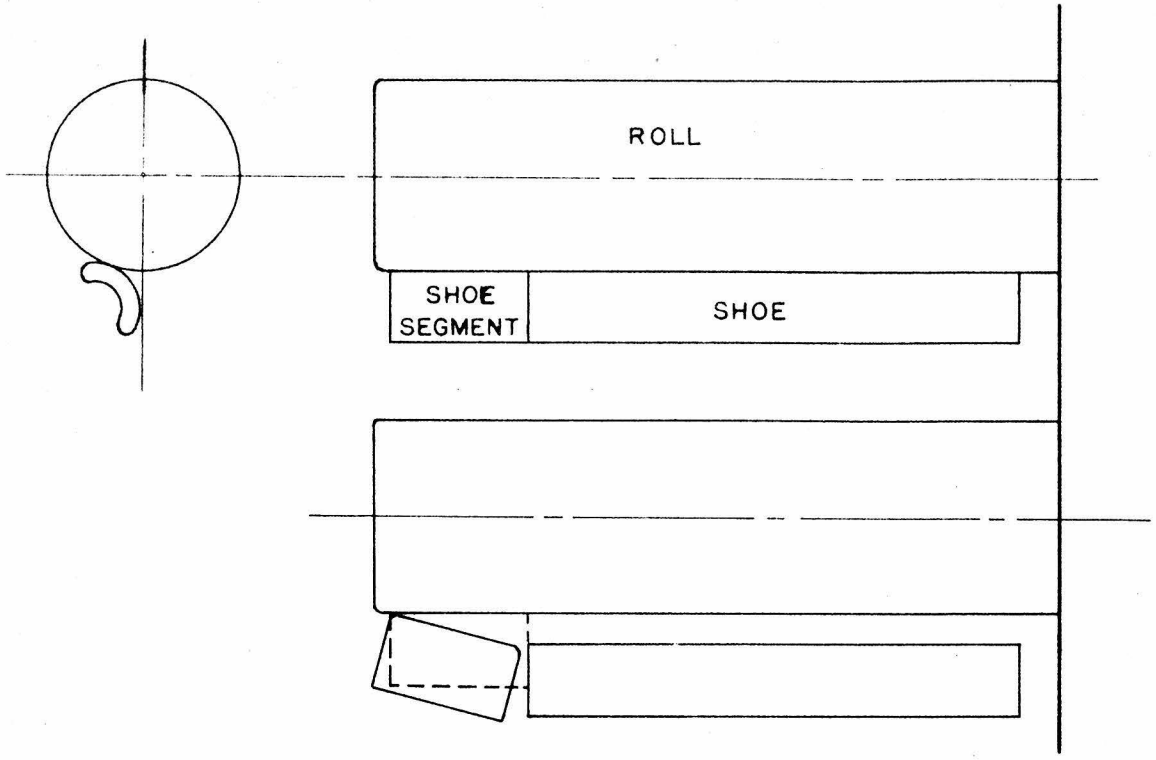


FIGURE 11. CONVEX SHOE WITH SHOE SEGMENT

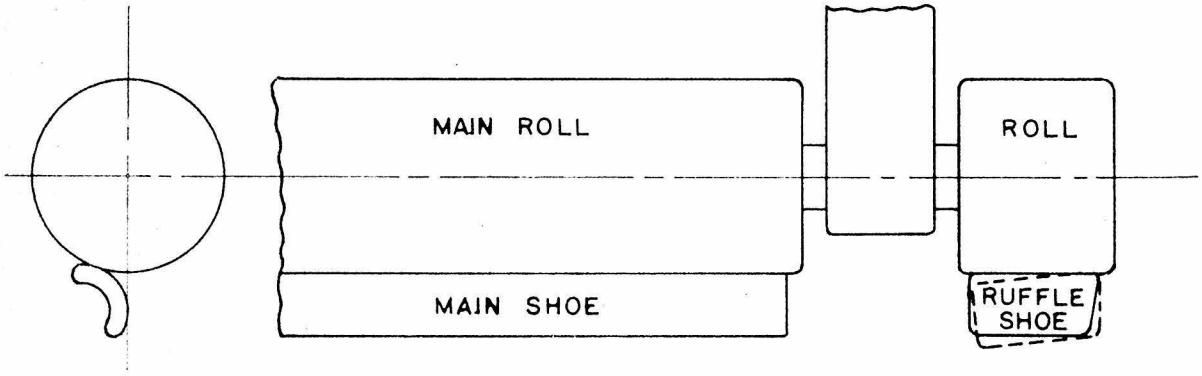


FIGURE 12. CONVEX SHOE WITH SEPARATE ROLL

and found to have a few disadvantages. Since the shoe was only three inches in diameter, it had a limited working area, making it difficult for it to adequately remove the moisture from a heavily dampened piece of cloth in the same length of time as a shoe 4 or 5 inches wide. But with 24 watts per square inch, it did pretty well. The largest portion of the shoe was necessarily left exposed, providing a serious burn hazard. The last few inches of the material could not be ironed as well as the rest because a person could not very well hold his hand on top of the hot shoe while holding the material taut.

A small segment of this shoe, operating independently of the rest of the shoe for intricate work, is subject to the same limitations mentioned previously; namely that a garment of the type shown in figure 8 would require a varying amount of the shoe to be in contact with the roll, figure 11. The mechanism involved would be complicated and confusing to the housewife. Furthermore, it would be almost impossible to use the segment of the shoe without burning hands on the main section of the shoe.

It would appear that the smaller shoe should be separated entirely from the main shoe in order to function properly. Perhaps it could be installed separately on the other side of the roll support cooperating with its own smaller roll. The extra roll means added expense and the shoe needs at least two positions of contact with the roll as in figure 12. The arrangement is rather complicated yet and this type of shoe still presents a burn hazard.

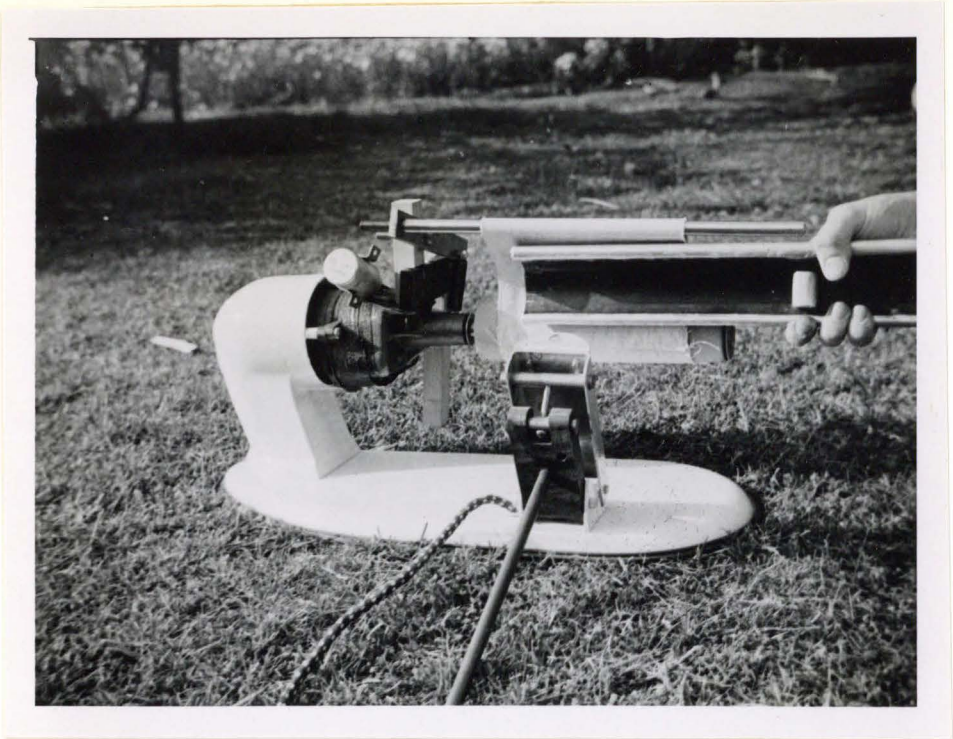


Figure 13. Convex Shoe with Endless Belt

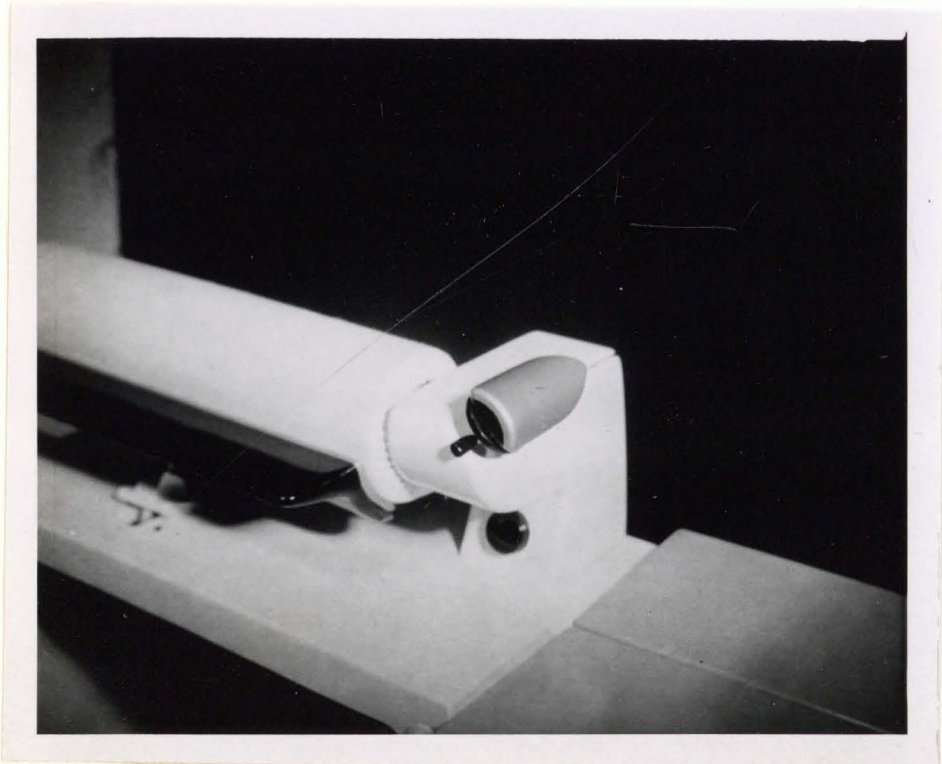


Figure 14. Final Form of Ruffle Shoe

Another possibility would be a short convex shoe cooperating with an endless canvas belt as in figure 13. The belt would be held under proper tension with a spring. When in cooperation with the shoe, the belt would completely cover it and eliminate the burn hazard. The mechanism involved, however, is even more complicated than before.

Intricate difficult work would undoubtedly involve frequent change in direction and much stopping and starting and re-arranging of the clothing. The only times when this would not be so is in the case of long ruffled curtains. For the majority of ruffled work, then, perhaps power feed for the material is unnecessary. It may even be a hindrance. The simplest and most versatile solution to the problem, then, would be a plain shoe shaped to assist in the handling of intricate details (see figure 14), one end to fit ruffles and the other end to get into difficult corners. The most convenient mounting position on the ironer would be on the upper right corner of the roll support, figure 15.

An important characteristic of this type of shoe is that it operates very similarly to a flat iron. Any woman would catch onto its use immediately. The particular shape of the shoe puts a maximum of heated surface in contact with the ruffle being ironed and hence dries it out very rapidly. A ruffle can be ironed in one motion as contrasted to the necessity of getting a pointed iron into every little gather.

The disadvantages are that the shoe by itself is a burn hazard and that the last few inches of the material cannot be

Figure 15. Ruffle Shoe Mounted on Ironer

FIGURE 16. THOR GLADIRON, FOLDED

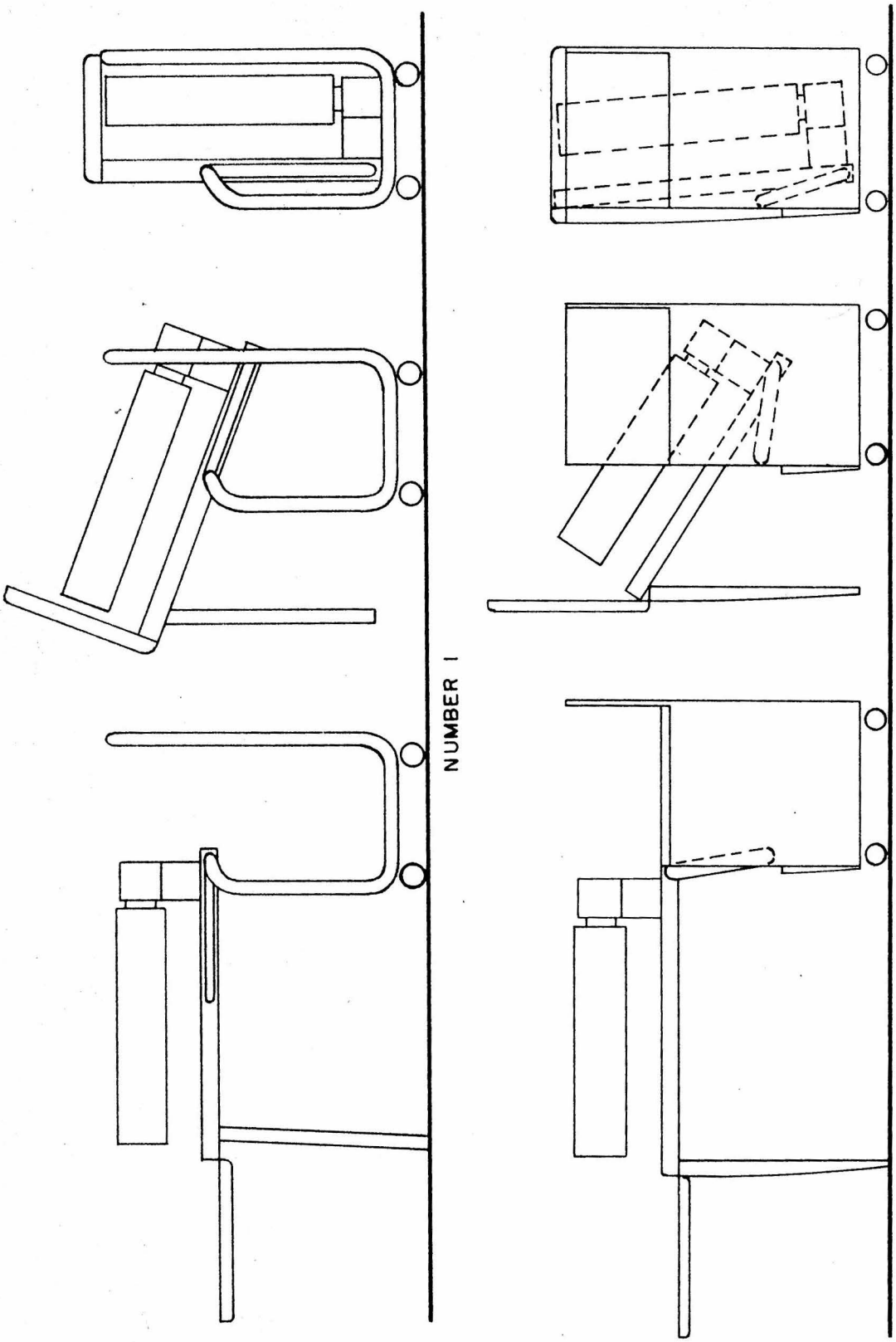


FIGURE 17. POSSIBLE FOLDING ARRANGEMENTS

ironed without burning the fingers. The way to get around these difficulties is to put a cooperating padded cover over the shoe. It would always remain close enough to the shoe that it would be very difficult to get a burn, yet its normal position would be distant enough from the shoe that material to be ironed could readily be slipped between it and the shoe. The last few inches of material would be ironed by lowering the cover onto the shoe either by hand or by knee.

Folding Arrangement

Because of the ever increasing shortage of storage space in modern homes, some method must be devised of storing the ironer in a configuration that will occupy as little floor space as possible. The Thor gladiron folds very simply (figure 16), but when folded it is below counter height, does not provide any useful working surface, is unattractive, and the roll is exposed to dust and dirt. Minimum floor space would be occupied by storing the ironer on end. In this event, one end should be at counter height (36 inches) in order to provide a useful working surface. The roll should be enclosed in a dust free container and the whole unit should present an attractive appearance in any room of the home. Two types of folding arrangements have been worked out of which the second has been selected as the most suitable, figure 17.

Conclusions

The factors considered in the above discussion have led to

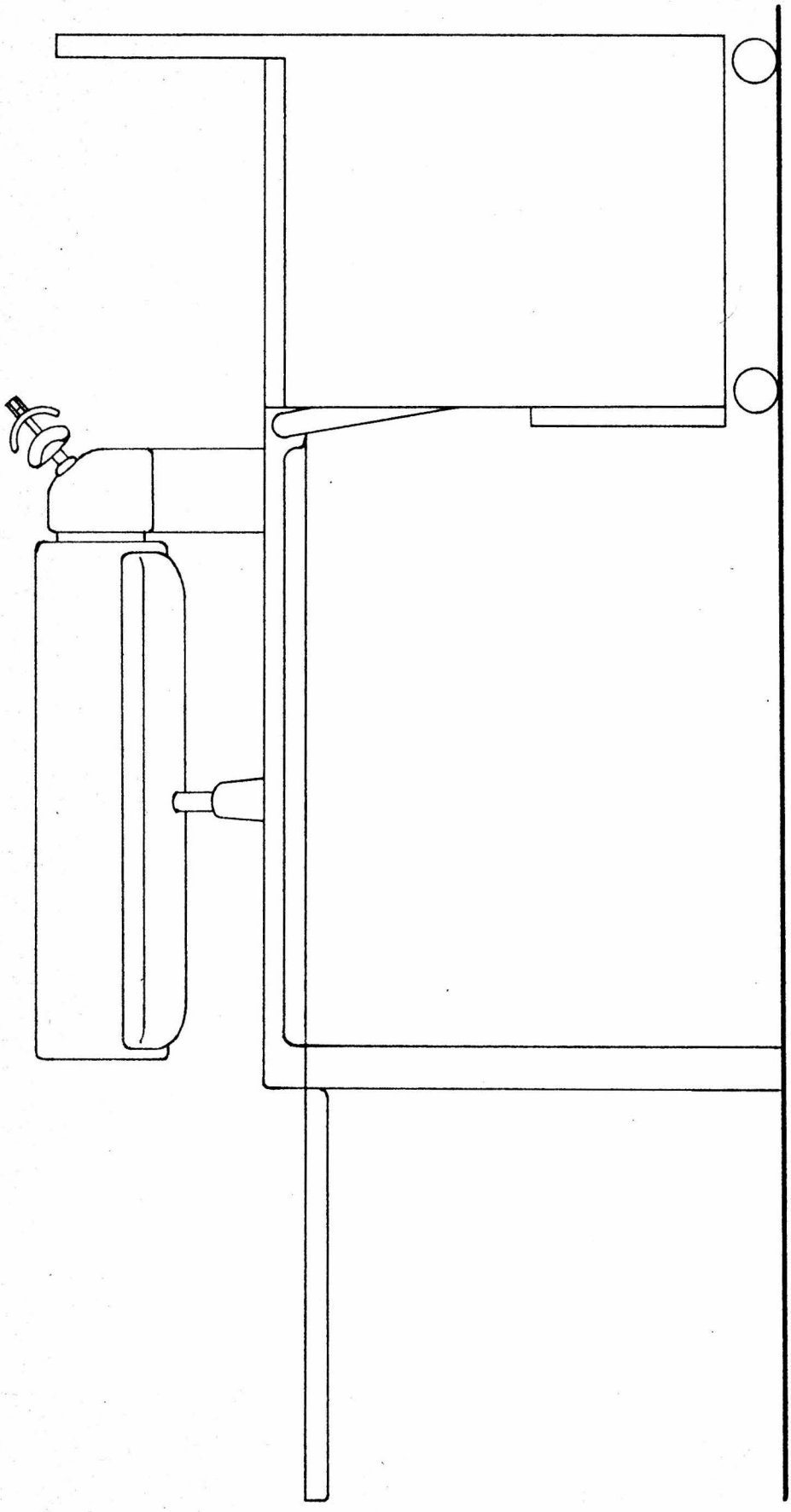


FIGURE 18. BASIC DESIGN

the following configuration of the ironer:

1. The ironer will consist of a roll with a concave cooperating shoe for flat work and shirts. It will have an additional shoe for intricate work.
2. To minimize the fatigue of the operator and to make the ironing of shirts easier, the main shoe will be located beneath the roll.
3. For handling all flat work and shirts size 14 and over (the majority), the main roll and shoe will be approximately 24 inches long.
4. The roll will be approximately 6.25 inches in diameter.
5. The shoe for intricate work will be a portion of a cylinder shaped as shown in figure 16, located on the upper corner of the roll support, figure 15.
6. The folding mechanism is shown in figure 17. The entire ironer will appear substantially as shown in figure 18.

ENGINEERING ANALYSIS

TEMPERATURE AND PRESSURE

The design of an ironing machine requires an investigation into the proper ironing temperatures and pressures. The Good Housekeeping Institute has conducted some tests on the proper ironing temperatures for various types of textiles, but there does not seem to be any published material on proper ironing pressures. The temperatures recommended by the Good Housekeeping Institute are[19]:

Rayon - Low and Nylon	300 - 350 F
Rayon - High and Silk	350 - 400 F
Light and Starched Cottons	400 - 450 F
Wool Pressing	450 - 500 F
Heavy Cottons and Linens	500 - 550 F

It is generally conceded that temperature is more important than pressure in ironing. The pressures in use vary considerably. Flat irons vary in weight from 3 to 4.25 pounds distributed over an area of approximately 23 square inches giving a pressure range of .13 to .19 pounds per square inch. The Thor gladiron uses a pressure of 1.2 pounds per square inch and the Frigidaire claims the use of pressures between 2 and 2.75 pounds per square inch. Other ironers range between the two. The chief function of the pressure appears to be keeping the clothing unwrinkled while the heat of the shoe dries it out. In so doing, it assures intimate contact between the moisture

and the shoe, thus assisting the drying process. The movement employed in the use of flat irons obviates high pressures for them. The finished work performed by several ironers was examined for a clue to the proper pressure to use. It appeared that proper pressures could very well be the subject of a long study in themselves. However, due to the limited time available, and the necessity of considering other phases of the problem, it was decided to use 1.5 pounds per square inch ironing pressure. This pressure is included in the range of usual practice and yields good ironing results.

IRONER SHOES

Most ironer shoes are made of steel, chromium plated for corrosion and scratch resistance. Two models used chromium plated cast iron shoes, and some portable ironers use aluminum extrusions. Sears Kenmore uses a stainless steel shoe. It is important that the main shoe of the proposed ironer has two conveniently shaped corners. It must be corrosion and scratch resistant and it must be simple and inexpensive to manufacture. The cast iron shoes in use are cast, machined and ground to proper dimensions and then plated. Cast iron has the very desirable property of storing heat, with the result that ironers so equipped handle very damp pieces with ease. However, the costs involved in the machining of the cast iron are considered prohibitive. Steel shoes can be pressed out, but it is then doubtful if the corners could have the desired shape.

The method selected has been to die cast the shoes of

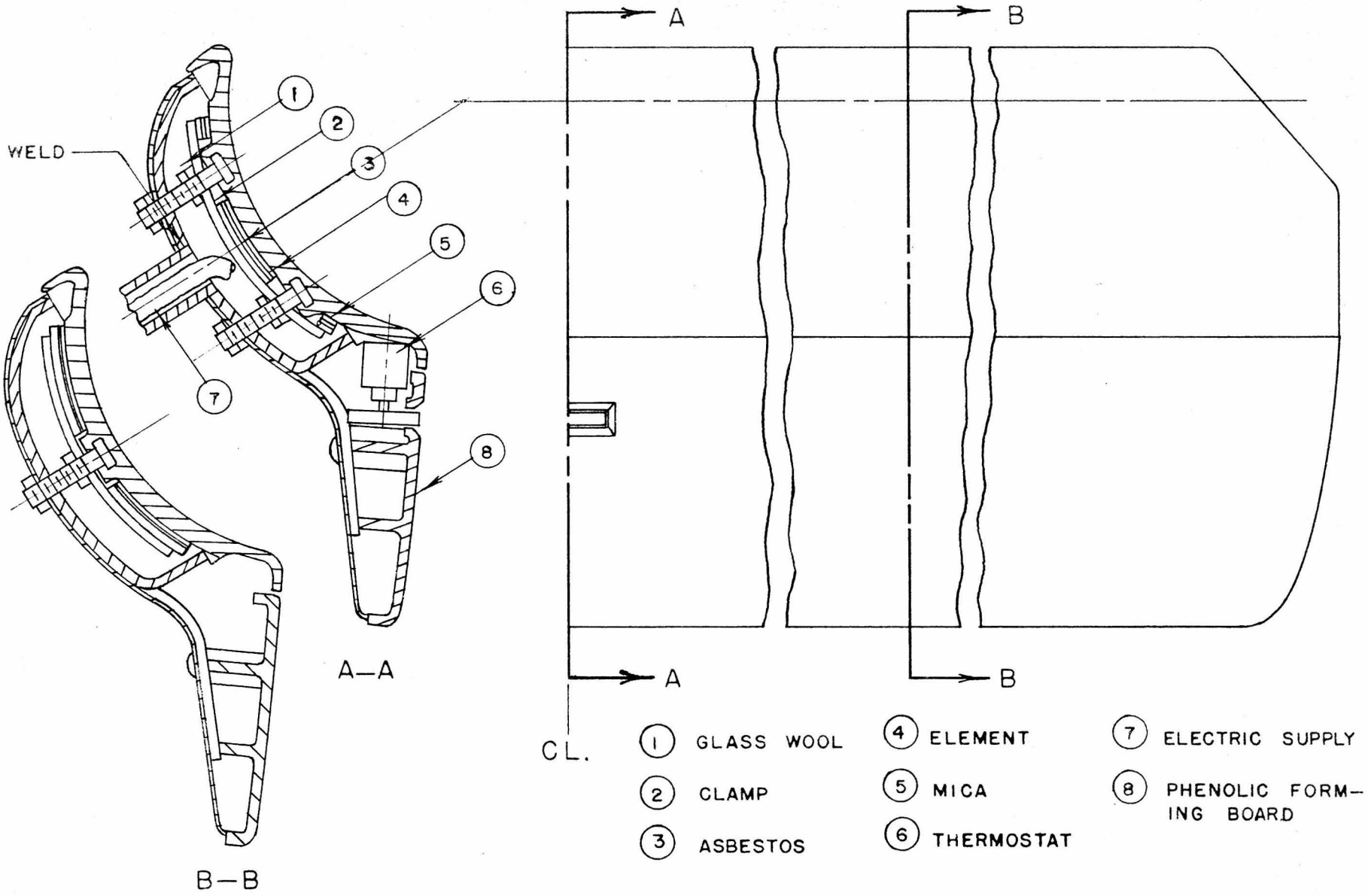


FIGURE 19 MAIN SHOE ASSEMBLY HALF SCALE

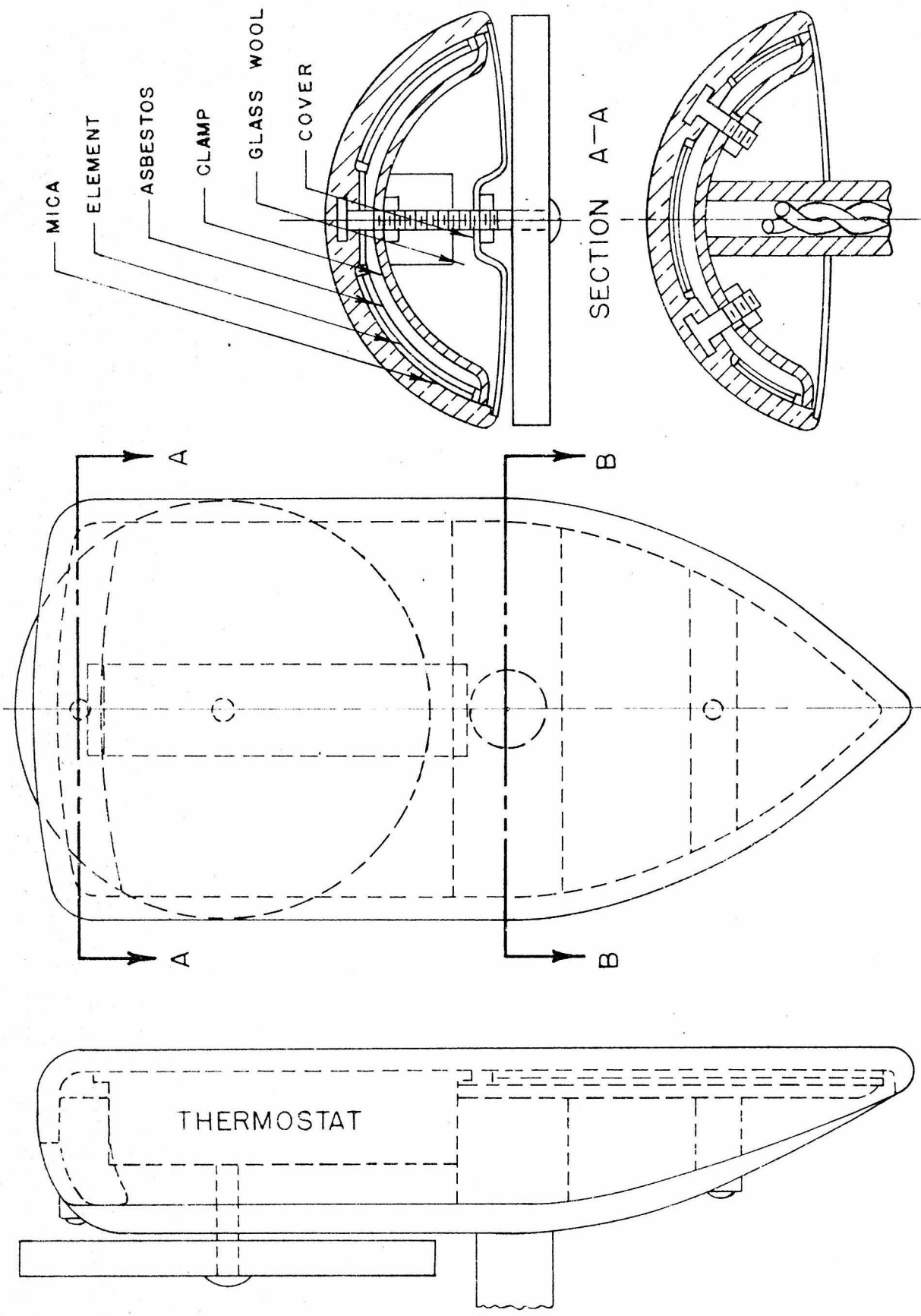


FIGURE 20. RUFFLE SHOE — FULL SIZE

aluminum alloy 218. They would then be sand-blasted and anodized for scratch resistance. Aluminum has the further advantages of high heat conductivity and light weight. Although a sulfuric anodized surface on aluminum is not as hard as chrome plated steel, it is nearly as scratch resistant. Tests of samples of each indicate that under ordinary use - including passing buttons and buckles through the ironer - the aluminum shoe would not scratch.

The main shoe will be equipped with a 1500 watt nichrome heating element installed as shown in figure 19. The small shoe will have a 700 watt nichrome element installed as per figure 20. Both shoes will be constructed in substantially the same manner and each will be equipped with one thermostat. Since the main shoe has both ends open, they will probably be used equally, and only one thermostat will be required. The thermostat will be of a special type, however. In order to be able to use two shoes with 1500 and 700 watt elements as well as a 1/15 horsepower motor on a house circuit without overloading it, it is proposed to wire the heating elements as shown in figure 24, appendix C. Essentially the circuit is a blocking circuit preventing more than one ironing shoe from drawing current at the same time and yet keeping both shoes hot. The ironing shoe selector switch is put in the position to send current through the element that is about to be used. When this element heats up, the thermostat moves to its hot position and directs current into the other element through its thermostat. When both elements are hot, both thermostats move

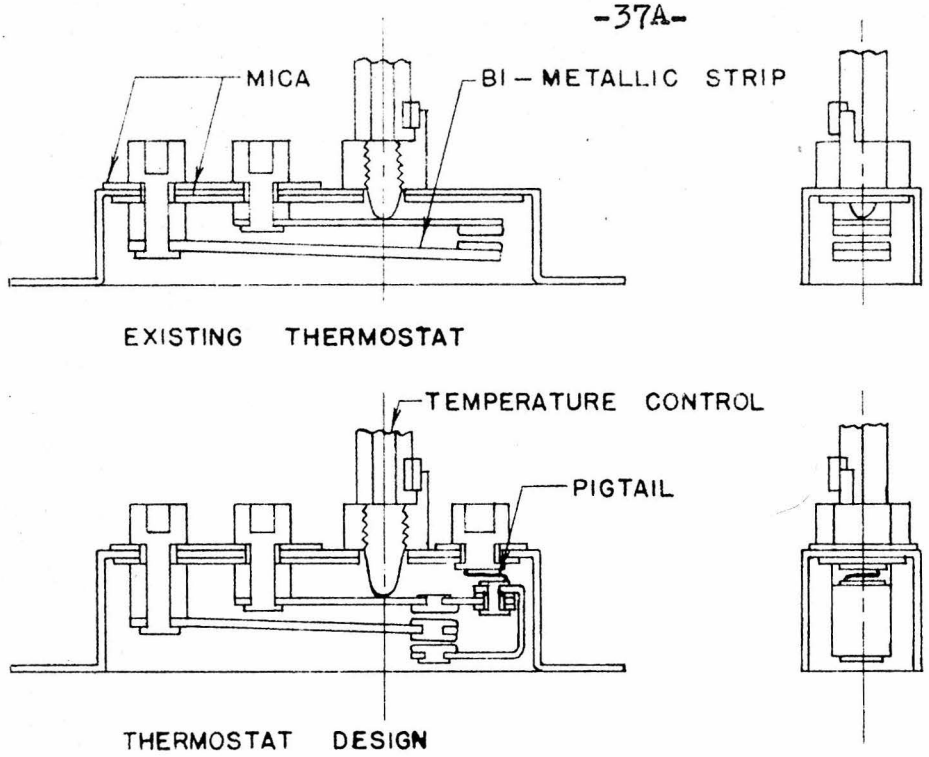


FIGURE 21 THERMOSTAT DESIGN

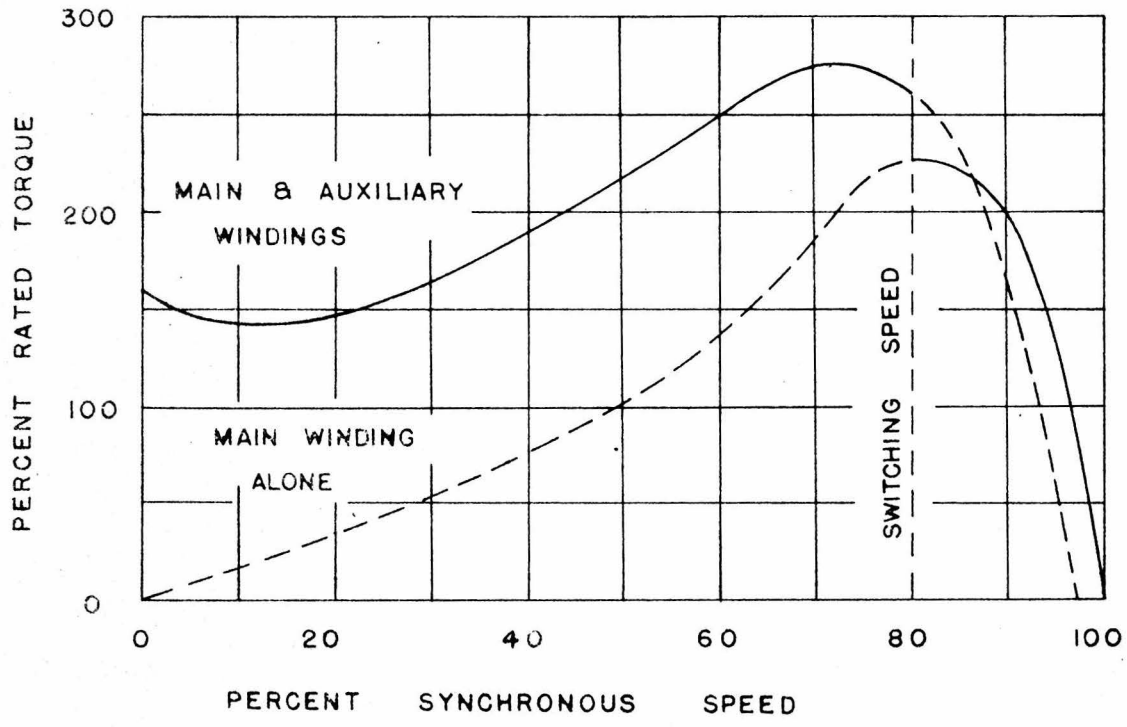


FIGURE 22 PERFORMANCE CURVES OF SPLIT PHASE INDUCTION MOTOR (REFERENCE)

to their hot positions and shut off the current. It is believed that in this way both shoes will be kept hot enough to be ready for immediate use whenever put into use by the shoe selector switch. The thermostat design is shown in figure 21.

ROLL SPEED

The proper ironing speed varies with the dampness of the clothing and the speed with which the shoe can remove moisture from it. It depends on the heat input to the shoe, the size of the shoe and the material of which it is made. The speeds in use vary from 7.5 to 14 feet (0 on the flat plate) per minute. The fastest ironers had cast iron shoes of approximately 136 square inches of surface area supplied with 1300 watts. The slower ironers used steel or aluminum shoes supplied with 1200 watts. It is planned to use an aluminum shoe of 121 square inches of surface area, supply it with 1500 watts and iron at the rate of 12 feet per minute. A 6.5 inch roll would turn at 7.1 rpm to iron at 12 feet per minute.

MOTOR AND DRIVE MECHANISM

It is proposed in this design to drive the roll with the motor and close the shoe with a foot operated toggle linkage. With this arrangement, a smaller motor can be used and the emergency release mechanism can be eliminated. The shoe will be closed and the roll started with one movement of the foot pedal, leaving both hands free for manipulating the clothes at all times.

Present ironers are classed as automatic and non-automatic. An automatic ironer has been defined as one in which the closing and opening of the shoe as well as the turning of the roll is accomplished by the motor. Another definition is that a single motion of the knee control closes the shoe and starts the roll at the same time. In either case, the advantage is that the ironer is operated by knee control, reducing arm movements and leaving the hands free for manipulating the clothes.

The motor will be a 1/15 horsepower split phase induction motor (calculations in Appendix B). Its performance curves appear in figure 22[20]. The motor has a high enough starting torque to start the roll under load if necessary but will normally be engaged with a clutch, figure 23, Appendix C. The roll will have one speed for simplicity. It will iron at the rate of 12 feet per minute which is 7.1 rpm. The normal motor speed is 1725 rpm. Hence a reduction of approximately 240 to 1 is indicated. It will be accomplished by the gear train shown in figure 23. The first step will be a 24 to 1 worm, followed by spurgear steps of 4.5 to 1 and 2.2 to 1.

The American Gear Manufacturer's Association recommends the following gear tolerances for a three inch gear:

	Speed	Tolerances	
Class	Ft/min	Total "run out"	Tooth Profile
1	80	.005"	-.0015"
2	400	.0015"	-.00075"

The worm turns at 298 ft/min and all the other gears turn at less than 80 feet per minute. Die cast gears comply approxi-

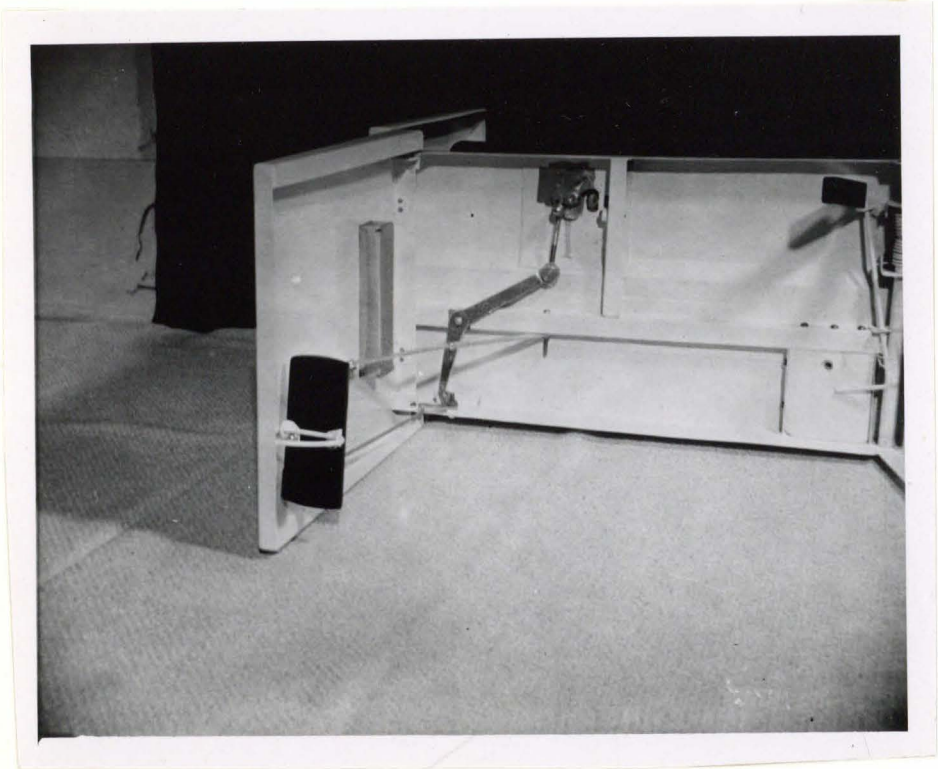


Figure 25. Main Shoe Operating Mechanism

mately with Class 1. However, silence of operation is very important in a home appliance. Since the silence of operation is directly dependent on the accuracy of tooth form, all gears will be cut. Furthermore, the last two spur gear steps must transmit loads (Appendix B) that cannot be handled adquately by any die cast metal save aluminum bronze and the Dohler Jarvis Corporation does not recommend die casting gears of aluminum bronze. In order to further contribute to the silence of operation, the worm gear will be non metallic and the two spur gear steps will be provided with a hunting tooth. All metal gears will be machine cut from S.A.E. 1020 steel. In quantities of 100,000, gears can be cut at low cost.

SHOE OPERATING MECHANISM

The shoe operating mechanism is shown in figures 24 and 25, Appendix C. It consists of a foot pedal and actuating rod, a bell crank and toggle linkage, and a cam plate and shoe support. The foot pedal is either die cast or stamped, rubber covered, supported as shown and pinned to the actuating rod. The rubber covering is glued to the pedal with any adhesive similar to 3M EC - 870. The other end of the actuating rod is pivotally connected to the bell crank which actuates the toggle linkage. The toggle linkage rotates the cam plate which raises and lowers the shoe, through the shoe support, into and out of engagement with the roll. The shoe support is pivotally connected to the top of the ironer table so that it can be merely pulled out a-

way from the roll when desired to be used for steaming. The bell crank, and toggle links are stamped of S.A.E. 1020 steel. The cam plate is forged and coined from the same material and the parts are cadmium plated for corrosion resistance. The shoe support is die cast of S.A.E. 218 aluminum alloy. An Oilite type bushing is pressed into each end of the hole as shown in figure 24.

GEAR HOUSING

The gear housing of the ironer is one of the main structural members. It acts as the support of the roll under the 200 pound closing load of the shoe. The stress calculations are given in Appendix B. The housing will be die cast of aluminum (Alsiloy #10, 10% silicon, 0.5% magnesium, remainder aluminum). It will be made in two parts. The left hand portion will be essentially a plate containing the roll support and the gear shafts, cast in as inserts. The right hand section of the housing will appear as shown in figure 23 and the two will be fastened together with screws. The gears will be enclosed in a bath of oil as suggested in the figure and the entire housing will be finished in white baked enamel.

ROLL

The roll of the ironer will be made of 6.0 inch steel tubing with two stamped ends spot welded in place. The ends will have dished out central portions that will be equipped with

Oilite type bushings, figure 23. The roll support consists of a 2.5 inch steel tube, pressed into the gear housing. The roll drive shaft will pass through the tube and fasten to the far end of the roll as shown. The near end of the support tube will be reduced in diameter and provided with an Oilite type bushing. To the roll will be glued approximately 18 inches of burlap. The last 8 to 10 inches of the burlap will be left unglued and will provide a flap for starting the padding. Approximately six feet of cotton flannel padding are rolled up on the roll and the whole thing is covered with a muslin cover with draw strings at each end.

IRONER TABLE

The ironer table is the other major structural element of the ironer. It will be stamped of 18 gauge sheet steel and is shown in figure 24. The gear housing will be fastened with screws to the rear edge of the table and to a reinforcing box section running between the gear housing and the left end of the table. Further reinforcing of the table top is necessary above the cam plate that actuates the main shoe. This is accomplished by raising the forward portion of the top and spot welding a heavier plate in place immediately above the cam plate as shown in the figure. The calculations appear in Appendix B.

RUFFLE MECHANISM

The ruffle shoe is made in the same manner as the main shoe and is fastened to a steel tube through which the electrical supply is fed, figure 23. The tube is knurled at point A and used as an insert in die casting the handle arm. The handles are compression molded of phenolic resin and attached to the handle arm with screws.

A steel insert is provided in the right gear housing section, as shown. The ruffle shoe tube bears against the insert and does not cause excessive wear of the aluminum. A hole will be drilled in the housing to provide for a steel ball and spring. The ball will fit into a slot in the shoe tube shaped as shown in the figure. This slot will prevent the shoe from being pulled out of its socket and will provide 180 degrees of movement of the shoe with reasonably fixed end positions. The 180 degree limit is provided so that the supply wire will not be twisted excessively and so that either end of the ruffle shoe may be used as desired.

The shoe cover pad mechanism is also shown in figure 23. The cover is stamped of 28 gauge sheet steel with the support clip spot welded in place. The supporting arm is stamped of 16 gauge steel, fastened to the housing with a press fit pin and attached to the cover clip with another pin. It is spring loaded in the open position for convenience of operation. The operating linkage consists of a knee lever, shaft, crank and operating wire, figures 23 and 24. The knee lever and crank

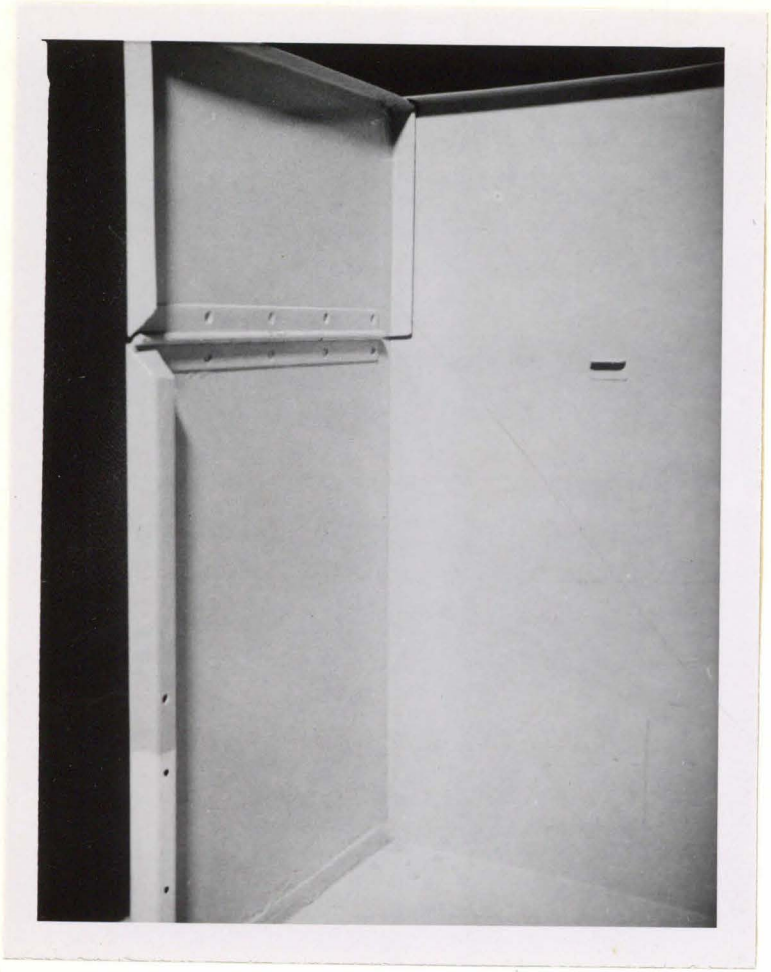


Figure 26. Cabinet Construction

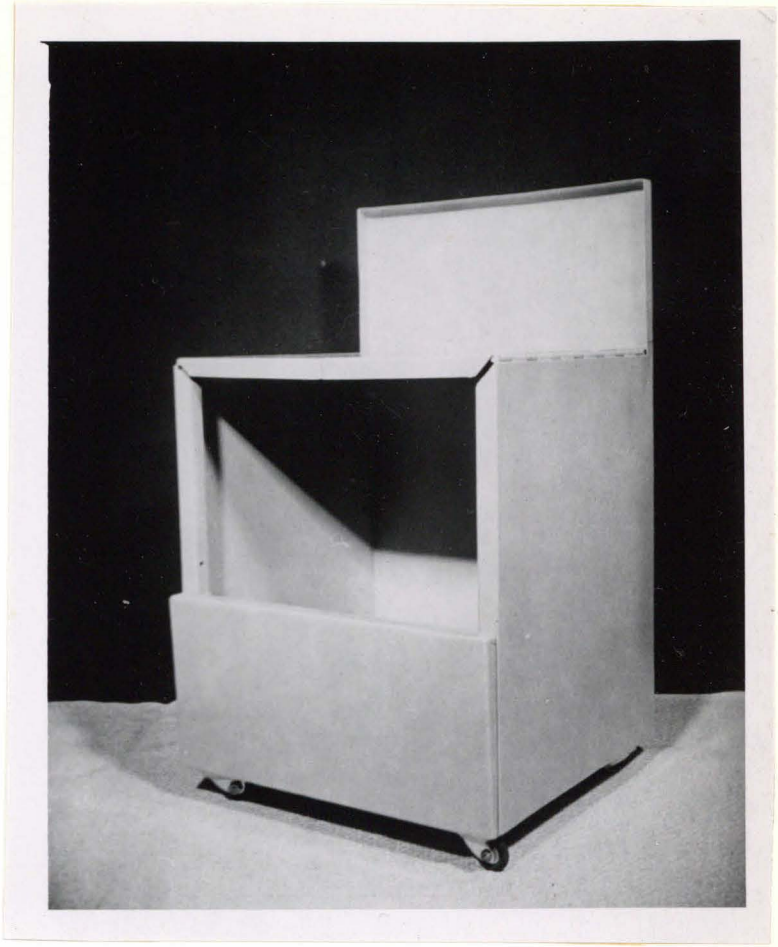


Figure 27. Cabinet, Folded

are stamped of 30 gauge steel and are spot welded to the shaft. The knee lever is rubber covered. The operating wire is looped through the cover support arm at one end and the crank at the other.

The cover is equipped with a 1/4 inch thick felt pad glued in place. The felt used will be flameproofed S.A.E. F - 5. It will be glued in place with an adhesive similar to 3M number MSA-6003.

IRONER CABINET

The ironer cabinet will be made of 22 gauge sheet steel. The majority of it will be formed on a brake and spot welded together as shown in figures 24, 26, and 27. The upper sides are stamped out of the same die and are fastened to the cabinet with hinges. The lower front is stamped, the edges are folded over and it is screwed in place. The upper front forms the outer leg when the ironer is unfolded. It is stamped and hinged to the table top. The top of the cabinet forms the outer extension wing when the ironer is unfolded. It is also stamped and hinged to the outer leg, figures 24 and 28.

The folding linkage is illustrated in figures 24 and 28. The linkage consists of a shaft and two side links. It has been decided to stamp both links of 12 gauge sheet steel and weld them to the shaft. Fixtures used for a run of 100,000 units would make this an extremely rapid operation. As the shaft of the linkage is inserted into the table top, a counter balancing torsion spring is attached to its center. The pin

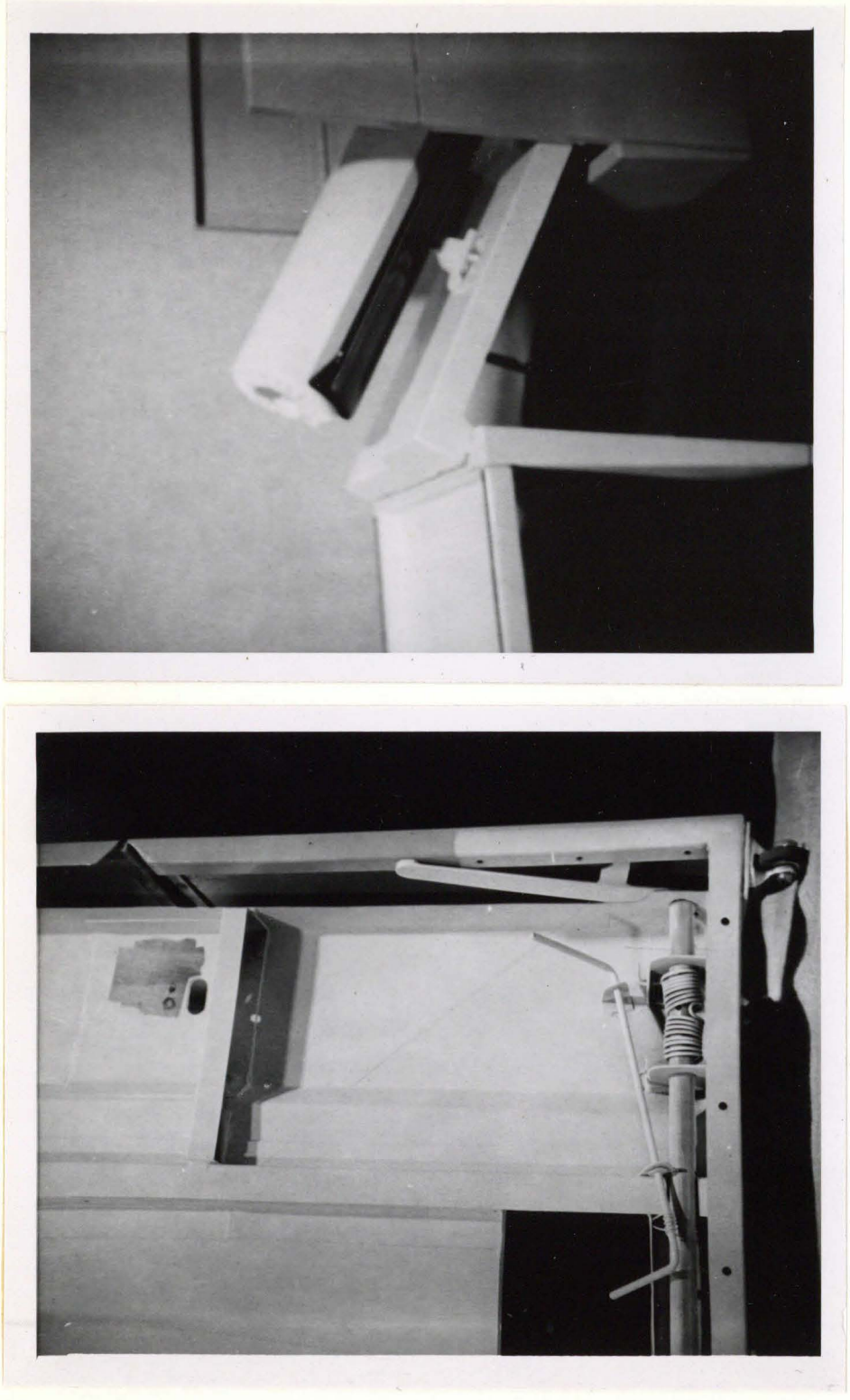


Figure 28. Folding Mechanism

in the shaft causes the spring to act between the shaft and the table top in a manner that tends to unfold the ironer. The lower end of the link is fastened to the case as shown in figure 24. A stripper bolt is screwed into a plate nut that has been spot welded to the inside of the corner post of the cabinet. The bolt has a shoulder on it at the base of the threads. It jams against the nut and locks in place.

CONTROLS

All but the press control of the unit are located in a small panel on the table top in front of the gear housing, figure 24. They consist of two switches and two lights. The first switch turns on the motor and the second switch selects the particular shoe that it is desired to use. One of the lights goes on when the main shoe is on and the other goes on when the small shoe is on. The press control is located on the front of the gear housing, figure 23. It is a two inch knob fastened to an eccentric that disengages the motor clutch when it is desired to press garments.

CONCLUSIONS

The ironer design resulting from this study is simple both in design and construction, moderate in cost, and will perform the complete household ironing task. The unit can be readily moved from one room to another, provides maximum operator comfort, requires little learning time, will iron anything, is low in cost, and folds up into a minimum space, providing a working surface at counter height.

The design is such that it will materially assist dealers in its sale. Its unique as well as its regular capabilities are readily demonstrable. However, ironers still need a good deal of vigorous sales promotion to overcome consumer resistance that has been built up.

The methods of manufacture have been selected on the basis of producing 100,000 units per year.

The subjects of ironing speeds and pressures are worthy of further examination. There does not seem to be any published material on the subjects and the manufacturers of flat irons and ironing machines apparently have not conducted any controlled investigations into the problems.

APPENDIX

TABLE I SALES OF HOUSEHOLD ELECTRIC IRONERS

YEAR	NUMBER SOLD	AVERAGE PRICE	RETAIL VALUE
1947	564,000	$112.71	$63,571,200
1946	175,000	75.12	13,146,000
1945	30,000		
1942	66,090	73.40	4,850,836
1941	259,668	55.80	14,489,056
1940	175,466	58.24	10,219,140
1939	127,093	68.46	8,700,786
1938	110,540	80,20	8,865,308
1937	178,858	70.00	12,520,060
1936	180,281	57.60	10,384,185
1935	143,856	54.64	7,860,291
1934	116,069	53.38	6,196,420
1933	69,991	49.16	3,411,230
1932	50,000	70.00	3,500,000
1931	80,000	84.00	6,720,000
1930	100,000	76.00	7,600,000
1929	126,000	76.48	9,637,000
1928	92,000	93.00	8,556,000
1927	68,000	160.00	10,880,000
1926	57,000	154.96	8,833,000
1925	40,000	150.00	6,000,000

(Compiled by "Electrical Merchandising" and the American Washing Machine Mfrs. Assn.)

TABLE II

ELECTRIC IRONERS... *Sales by States, 1939-1947*

State	1939 (Units)	1940 (Units)	1941 (Units)	1942 (Units)	1946 (Units)	1947 (Units)	Total Sales (6 Years)	% of Total
Maine	719	858	1,061	132	735	3,379	6,884	.50
New Hampshire	564	723	893	53	308	1,600	4,141	.30
Vermont	382	360	492	59	205	771	2,269	.16
Massachusetts	3,653	5,139	8,110	1,839	3,728	14,345	36,814	2.66
Rhode Island	575	596	981	633	821	3,142	6,748	.49
Connecticut	2,035	2,702	14,225	1,404	906	34,915	56,187	4.07
New England	**7,928**	**10,378**	**25,762**	**4,120**	**6,703**	**58,152**	**113,043**	**8.18**
New York	12,375	18,085	26,046	7,231	13,868	43,688	121,293	8.78
New Jersey	4,592	6,781	8,614	1,450	3,882	15,353	40,672	2.95
Pennsylvania	12,266	18,973	26,257	7,462	14,860	46,415	126,233	9.14
Middle Atlantic	**29,233**	**43,839**	**60,917**	**16,143**	**32,610**	**105,456**	**288,198**	**20.87**
Ohio	11,578	13,480	23,340	7,020	20,007	59,634	135,059	9.78
Indiana	4,926	5,209	8,691	2,446	9,029	19,206	49,507	3.58
Illinois	9,493	17.018	22,082	6,598	24,436	38,531	118,158	8.56
Michigan	10,020	12,017	19,690	5,221	12,090	37,345	96,383	6.98
Wisconsin	3,314	5,680	8,562	3,078	7,114	12,923	40,671	2.94
East North Central	**39,331**	**53,404**	**82,365**	**24,363**	**72,676**	**167,639**	**439,778**	**31.84**
Minnesota	3,378	3,598	7,704	1,615	3,711	12,271	32,277	2.34
Iowa	2,042	2,885	3,182	989	3,027	13,634	25,759	1.86
Missouri	3,190	3,908	5,880	1,707	4,685	16,124	35,494	2.57
North Dakota	265	371	345	86	616	2,134	3,817	.28
South Dakota	309	318	350	99	598	1,719	3,393	.25
Nebraska	1,335	1,342	1,553	508	1,505	6,343	12,586	.91
Kansas	914	1,311	1,191	244	1,659	5,453	10,772	.78
West North Central	**11,433**	**13,733**	**20,205**	**5,248**	**15,801**	**57,678**	**124,098**	**8.99**
Delaware	367	261	397	138	154	830	2,147	.16
Maryland	1,247	1,336	1,803	738	1,402	5,394	11,920	.86
District of Columbia	1,183	1,036	2,083	600	1,333	4,624	10,859	.79
Virginia	709	620	1,505	336	1,146	5,809	10,125	.73
West Virginia	1,783	1,334	2,449	613	2,052	7,232	15,463	1.12
North Carolina	374	686	959	171	1,402	5,987	9,579	.69
South Carolina	126	166	228	59	547	2,430	3,556	.26
Georgia	471	812	1,843	343	838	6,876	11,183	.81
Florida	724	955	1,653	250	1,060	7,529	12,171	.88
South Atlantic	**6,984**	**7,206**	**12,920**	**3,248**	**9,934**	**46,711**	**87,003**	**6.30**
Kentucky	1,028	988	1,901	435	1,402	5,335	11,089	.80
Tennessee	866	1,396	2,338	699	2,377	9,129	16,805	1.22
Alabama	468	400	718	204	855	3,794	6,439	.46
Mississippi	169	185	261	40	291	2,608	3,554	.26
East South Central	**2,531**	**2,969**	**5,218**	**1,378**	**4,925**	**20,866**	**37,887**	**2.74**
Arkansas	247	352	394	53	906	3,320	5,272	.38
Louisiana	489	719	989	277	1,265	5,394	9,133	.66
Oklahoma	716	765	1,007	211	1,642	5,632	9,973	.72
Texas	1,595	2,093	3,402	817	3,779	18,376	30,062	2.18
West South Central	**3,047**	**3,929**	**5,792**	**1,358**	**7,592**	**32,722**	**54,440**	**3.94**
Montana	548	895	827	250	393	1,897	4,810	.35
Idaho	427	426	643	105	205	1,126	2,932	.21
Wyoming	276	185	188	13	120	533	1,315	.10
Colorado	1,166	1,547	1,882	415	1,214	4,446	10,670	.77
New Mexico	181	64	148	26	342	1,245	2,006	.14
Arizona	332	374	642	99	462	1,778	3,687	.27
Utah	708	1,449	1,219	343	923	2,905	7,547	.55
Nevada	229	173	183	53	103	1,719	2,460	.18
Mountain	**3,867**	**5,113**	**5,732**	**1,304**	**3,762**	**15,649**	**35,427**	**2.57**
Washington	2,706	4,584	6,858	1,226	2,394	14,049	31,817	2.30
Oregon	1,464	2,534	2,104	653	1,419	8,773	16,947	1.23
California	13,039	24,512	29,805	6,875	13,184	65,088	152,503	11.04
Pacific	**17,209**	**31,630**	**38,767**	**8,754**	**16,997**	**87,910**	**201,267**	**14.57**
TOTAL UNITED STATES	**121,563**	**172,201**	**257,678**	**65,916**	**171,000**	**592,783**	**1,381,141**	**100.0%**

Prepared by Market Analysis Department, ELECTRICAL MERCHANDISING, from figures compiled by the American Washer and Ironer Manufacturers Association

TABLE III OWNERSHIP OF ELECTRIC IRONERS BY STATES
(reference 2)

State	Total Electric Customers with Electric Ironers	% of State Electric Customers
Maine	15,841	6.4
New Hampshire	11,183	6.94
Vermont	6,732	6.52
Massachussetts	88,188	6.94
Rhode Island	14,613	6.87
Connecticut	79,049	14.74
New England	215,606	8.52
New York	262,080	6.80
New Jersey	91,582	7.28
Pennsylvania	271,035	10.64
Middle Atlantic	624,697	8.16
Ohio	268,404	13.13
Indiana	88,453	8.63
Illinois	225,627	10.52
Michigan	191,762	11.75
Wisconsin	77,376	8.55
East North Central	851,622	10.99
Minnesota	70,439	9.41
Iowa	47,342	7.15
Missouri	75,714	8.22
North Dakota	8,663	8.81
South Dakota	8,346	7.29
Nebraska	28,785	9.69
Kansas	24,544	5.41
West North Central	263,833	8.01
Delaware	5,251	6.84
Maryland	24,184	7.62
Virginia	20,244	3.30
West Virginia	34,884	8.75
North Carolina	18,393	2.35
South Carolina	6,514	1.82
Georgia	22,384	3.68
Florida	21,477	3.53
South Atlantic	179,367	4.37

TABLE III (continued)

State	Total Electric Customers with Electric Ironers	% of State Electric Customers
Kentucky	21,501	4.09
Tennessee	29,296	4.83
Alabama	13,713	2.54
Mississippi	5,857	1.86
East South Central	70,367	3.54
Arkansas	8,343	2.40
Louisiana	16,780	3.42
Oklahoma	23,317	4.91
Texas	62,291	3.87
West South Central	110,731	3.79
Montana	13,020	9.37
Idaho	9,716	6.23
Wyoming	5,086	8.49
Colorado	25,686	8.64
New Mexico	3,831	3.46
Arizona	9,491	6.20
Utah	18,028	10.82
Nevada	3,861	10.88
Mountain	88,719	7.94
Washington	75,050	11.89
Oregon	43,787	11.07
California	332,221	11.82
Pacific	451,058	11.76
TOTAL UNITED STATES	2,856,000	8.11

TABLE IV OWNERSHIP OF IRONERS BY INCOME GROUP
(reference 1)

Figures expressed in percent of total respondents.

	Milwaukee	Omaha	Columbus	St.Paul	Seattle
Prosperous	20.4%	16.4%	25.8%	20.4%	26.0%
Comfortable	14.7	8.0	17.2	9.3	---
Getting by	12.5	6.0	15.5	8.8	---
Poor	11.0	4.0	11.5	9.0	9.3

TABLE V OWNERSHIP AND PLANS TO BUY BY AGE GROUP
(Fawcett publications,reference 1)

Figures are expressed as percentages of the total of 8000 women interviewed

Age group	own	would like to own	plan to buy
18-30	7.0	47.9	9.4
31-65	10.8	38.3	7.8

TABLE VI OWNERSHIP AND PLANS TO BUY BY AGE GROUP
(Fawcett publications, reference 1)

Age group	owned	plan to buy
under 26	7.3	12.7
26-35	11.3	11.6
over 35	17.0	8.0

TABLE VII BRAND PREFERENCES IN IRONERS -

Milwaukee, Omaha, Columbus, St. Paul, & Seattle
(references 1 & 4)

Figures are expressed in percent of the total number of families owning ironers.

Brand	Milwaukee	Omaha	Columbus	St.Paul	Seattle
General Electric	14.3	5.6	12.3	16.8*	8.2
Thor	14.3	39.2	10.3	14.7	24.0
Kenmore	8.5	5.6	1.5	1.2	14.8
Westinghouse	8.4	---	9.1	7.9	2.7
Conlon	7.9	---	4.9	3.0	4.7
Ironrite	7.2	8.3	6.0	2.3	9.1
Simplex	6.6	2.0	3.7	6.1	5.8
Horton	4.9	2.3	7.0	2.3	---
Hotpoint	3.7	2.7	4.4	*	3.2
Universal	3.5	2.3	---	2.6	1.8
A. B. C.	3.1	2.0	---	1.6	---
Speed Queen	2.6	4.0	1.2	1.9	1.8
Easy	2.4	5.3	6.0	4.9	4.5
Apex	2.3	2.7	3.9	4.2	3.2
AMC (Lazarus)	1.4	---	2.3	---	---
Norge	1.3	2.7	1.0	---	---
Maytag	1.0	2.0	---	6.8	---
Meadows	---	1.7	---	---	---
Bendix	---	---	1.3	1.0	1.2

TABLE VII (continued)

Brand	Milwaukee	Omaha	Columbus	St.Paul	Seattle
Frigidaire	---	---	---	---	---
Montgomery Ward	---	---	1.0	6.8	---
Sunbeam	---	---	2.5	3.7	---
Fairday	---	---	---	1.2	---
American Beauty	---	---	3.2	---	---
Proctor	---	---	1.8	---	---
Prima	---	---	1.0	---	---
White House	---	---	1.0	---	---

* Included Hotpoint (see General Electric).

TABLE VIII BRAND PREFERENCES IN IRONERS -

Michigan, Ohio, Pennsylvania
(reference 1)

Figures expressed in percent of total mentions

Brand	Michigan	Ohio	Pennsylvania	Total
Ironrite	35.7	---	60.0	27.6
Thor	21.4	10.0	20.0	17.2
Speed Queen	14.3	20.0	----	13.8
General Electric	7.1	10.0	20.0	10.3

TABLE IX BRAND PREFERENCES IN IRONERS -

Readers of Sunset Magazine
(reference 3)
Figures expressed in percent of total mentions

Brand	North	Central	South
Thor	16.0	21.2	26.2
Ironrite	17.4	13.1	9.2
Easy	7.2	13.8	12.4
General Electric	18.8	8.0	9.2
Sears (Kenmore)	8.7	3.7	14.6
Conlon	7.2	4.4	2.3
Montgomery Ward	0.0	5.8	2.3
Apex	0.0	5.8	2.3
Simplex	0.0	3.7	4.6
Westinghouse	4.4	2.2	2.3
A. B. C.	2.9	2.2	2.3
All Others	17.4	16.1	12.3

TABLE X REASONS FOR BUYING IRONERS - Norge

(Reference 4)

	1937	1936
Time saving	25.9%	26.9%
Labor	38.0	47.0
Better results	11.7	11.5
Economy	13.0	1.8
Price	1.4	2.2
Maker & Dealer	6.8	0.8
All Others	1.7	5.0
Don't Know	1.5	5.0

TABLE XI OUTLETS FOR PURCHASE OF IRONERS - Printer's Ink
(reference 4)

Will Buy From	
Electric or Gas Company	23.8%
Department Store	28.6
Hardware Store	7.9
Dealer Agent	20.6
Electric Store	20.6
Others	1.6
Don't know	1.6
No answer	1.6

TABLE XII OUTLETS FOR PURCHASE OR IRONERS -

Los Angeles Times
(reference 17)

Type of Store for Purchase	
Department Stores	25.2%
Electrical Appliance Stores	13.0
Furniture stores	2.3
Other	6.8
Don't know	52.7
Name of Store	
Barker Brothers	2.3%
Eastern Columbia	1.5
Edison Company	0.8
Elsters	1.5
General Electric	0.8
Star Outfitting Company	2.3
Sears	18.3
Taylors	1.5
Thor	1.5
Western Auto Supply	1.5
Other	18.3
Don't know	49.7

TABLE XIII PRODUCT STUDY PORTABLE MODELS

IRONER MAKE	ELECTRICAL RATING WATTS	IRONING SPEED FT./MIN	SHOE	ROLL SIZE	FEATURES	PRICE
MONITOR	1080	10		22.5 X 5.375	OPERATING HANDLE IN FRONT. ONE SPEED	
BENDIX	1212		CHROME PLATED STEEL	22 X 5.375	ONE SPEED	
UNIVERSAL (APPEARED IDENTICAL)	1250	7.5			OPERATING HANDLE IN FRONT	$57.95
SIMPLEX (APPEARED IDENTICAL)	1250	7.5			OPERATING HANDLE IN FRONT	$65.45
SPEED QUEEN (APPEARED IDENTICAL)	1250	7.5			OPERATING HANDLE IN FRONT	$64.95
A M C (AUTOMATIC)	1575	9	CHROME PLATED STEEL	22 X 6.0	AUTOMATIC IRONING & PRESSING CONTROL. COULD BE ADJUSTED FOR OPERATION EITHER BY HAND OR BY KNEE.	$69.95
HORTON (AUTOMATIC)	1575	9	CHROME PLATED STEEL	22 X 6.0	AUTOMATIC IRONING & PRESSING CONTROL. COULD BE ADJUSTED FOR OPERATION EITHER BY HAND OR BY KNEE.	$79.95
HOTPOINT (AUTOMATIC)	1575	9	CHROME PLATED STEEL	22 X 6.0	AUTOMATIC IRONING & PRESSING CONTROL. COULD BE ADJUSTED FOR OPERATION EITHER BY HAND OR BY KNEE.	$79.95
GENERAL ELECTRIC (NON AUTO.)	1275	7.5	CHROME PLATED STEEL OR ALUMINUM	22 X 6.0	NONE.	$44.95
HOTPOINT (NON AUTO.)	1275	7.5	CHROME PLATED STEEL OR ALUMINUM	22 X 6.0	NONE.	$49.95
EMPIRE	1100	7	CHROME PLATED STEEL	21 X 5.25	ELBOW CONTROL IN FRONT	IRONER ALONE $59.95 WITH STAND $69.95 WINGS & PANEL $79.95
FAIRBANKS MORSE	1100	7	CHROME PLATED STEEL	21 X 5.25	ELBOW CONTROL IN FRONT	IRONER ALONE $59.95 WITH STAND $69.95 WINGS & PANEL $79.95
ARMSTRONG	1100	7	CHROME PLATED STEEL	21 X 5.25	ELBOW CONTROL IN FRONT	IRONER ALONE $59.95 WITH STAND $69.95 WINGS & PANEL $79.95
CONLON	1230		ALUMINUM	22 X 5.0	CONTROL IN FRONT	IRONER ALONE $54.95 WITH STAND $74.95

TABLE XIV PRODUCT STUDY CONSOLE MODELS

THOR	1620	9	CHROME PLATED STEEL	21 X 3.5	PATENTED METHOD OF IRONING SHIRT (AS ON SLEEVE BOARD). FOLDS UP WHEN NOT IN USE, OCCUPYING 1.75 SQ.FT. OF FLOOR SPACE. 1.2 PSI. ONE SPEED.	$99.50
GENERAL ELECTRIC	1575		CHROME PLATED STEEL	30 X 6.0	TWO SPEEDS & PRESS.	$199.95
HOTPOINT	1575		CHROME PLATED STEEL	30 X 6.0	TWO SPEEDS & PRESS.	$199.95
GENERAL ELECTRIC	1575		CHROME PLATED STEEL	26 X 6.0	ONE SPEED. FOLD-AWAY CABINET.	$169.95
HOTPOINT	1575		CHROME PLATED STEEL	26 X 6.0	ONE SPEED. FOLD-AWAY CABINET.	$169.95
HORTON	1575		CHROME PLATED STEEL	26 X 6.0	ONE SPEED. FOLD-AWAY CABINET.	$169.95
GENERAL ELECTRIC	1575	0	300 SQ. IN. ALUMINUM. CALROD ELEMENT.	NO ROLL	HAND OPERATED FLAT PLATE. 1.3 PSI	NO COVER $199.95 COVER $229.95
HOTPOINT	1575	0	300 SQ. IN. ALUMINUM. CALROD ELEMENT.	NO ROLL	HAND OPERATED FLAT PLATE. 1.3 PSI	NO COVER $199.95 COVER $229.95
SPEED QUEEN	1500	9.5	CHROME PLATED STEEL. NICHROME 1350 W. ELEMENT	26 X 6.0	RUFFLER PLATES ON EACH END OF SHOE.	$179.95 ONE SPEED $154.95 TWO SPEED $169.95
UNIVERSAL	1500	9.5	CHROME PLATED STEEL. NICHROME 1350 W. ELEMENT	26 X 6.0	RUFFLER PLATES ON EACH END OF SHOE.	$179.95 ONE SPEED $154.95 TWO SPEED $169.95
SIMPLEX	1500	9.5	CHROME PLATED STEEL. NICHROME 1350 W. ELEMENT	26 X 6.0	RUFFLER PLATES ON EACH END OF SHOE.	$179.95 ONE SPEED $154.95 TWO SPEED $169.95

A P P E N D I X B

1. MOTOR SIZE CALCULATIONS

Roll rpm to give 12 ft. per min. ironing speed

$\frac{\pi Dn}{12} = 12 \qquad n = \frac{144}{6.5\pi} = 7.06$ rpm.

$D = 6.5$

$\frac{1725}{7.06} = 242$ to 1 reduction

Assuming a coefficient of friction of 0.4 between the shoe and the roll, 200 x 0.4 = 80 lb. tangential force on the roll.

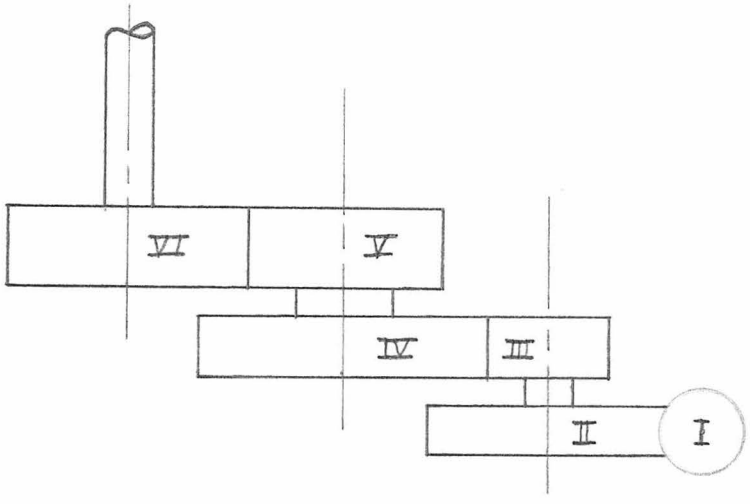
80 x 3.25 = 260 lb. in. torque required on the roll.

$HP \text{ required} = \frac{2\pi T\ n}{33{,}000} = \frac{6.28 \times 260 \times 7.1}{12 \times 33{,}000} = .0293$

To allow for gear friction and possible rough usage, use

$HP = .03 \times 2 = .06$ = 1/15 HP motor approximately

2. GEAR CALCULATIONS



Gear Pitch Diameters: I-0.68"; II- 2.4"; III- 0.778";
IV- 3.5"; V- 1.2"; VI- 2.7"

2. GEAR CALCULATIONS (CONTINUED)

Number of teeth: II - 48; III - 14; IV - 63; V - 12; VI - 27

Gear no. I is a double threaded worm; ratio 24 to 1, threaded length of 0.857"

Load capacity of worm gearing (reference 21 pp. 401,402)

$HP = \frac{n}{R} K Q m$

n = rpm of worm = 1725
R = gear ratio = 24 to 1
K = pressure constant (table 58, p.402 reference) = .0125 (C = 1.53)

$Q = \frac{R}{R+2.5} = .905$

$m = \frac{450}{450 + V + \frac{3V}{R}} = .573$

V = peripheral velocity of worm at pitch line = $\frac{\pi \times .66 \times 1725}{12} = 298$ ft./min.

$HP = \frac{1725}{24} \times .0125 \times .905 \times .573 = .466$

Tooth size of worm gear

C = 1.53" C = center distance between worm & gear in inches.

$C^{.875} = 1.451$ worm pitch diam. (p.d.) = $\frac{1.451}{2.2} = .66$

b = face width of gear = $\frac{1.451}{3} = .484$"

$F = \frac{\pi s b y}{p_d}$

p_d = diametral pitch

$V = \frac{72 \times \pi \times 2.4}{12} = 45.2$ ft./min.

$F = \frac{33{,}000}{15 \times 45.2} = 48.7$ lbs.

$p_d = \frac{\pi s b y}{48.7}$

s = safe working stress for non-metallic material (reference 22).

$= 6000 \left(\frac{150}{245.2} + .25\right) = 5170$ psi.

y = .129 (table 2 reference 22)

$p_d = \frac{3.14 \times 5170 \times .484 \times .129}{48.7} = 20.8$ use 20.0

2. GEAR CALCULATIONS (CONTINUED)

Length of threaded worm (p. 404, reference 21)

$$L = .157\ (4.5 + \frac{48}{50}) = .857"$$

Spur Gearing - tooth strength Gears no. III & IV

Tensile strength of 1020 steel = 70,000 psi

From table 47, page 360, reference 21, a factor of safety of 5 for steady load on gears of a train beyond the first mesh is assumed since the non metallic worm gear and the rubber clutch half absorb the shocks.

$\frac{70,000}{5} = 14,000$ psi $= s_o$ $\qquad b = \frac{10}{p_d}$ (p. 361 reference)

$\frac{1725}{24} = 72$ rpm (gear III); $\qquad V = \frac{72 \times \pi \times .78}{12} = 14.7$ft/min.

$$s = 14,000\ (\frac{600}{600 + V}) = 13,670$$

$$F = \frac{\pi s b y}{p_d} = \frac{10 \pi s y}{p_d^2}\ ; \quad F = \frac{33,000}{15 \times 14.7} = 150 \text{ lbs.}$$

$\frac{p_d^2}{y} = \frac{31.4 \times 13,670}{150} = 2860$; y for 14 tooth, 20° stub involute = .108 (table 46, page 359, reference)

$p_d^2 = .108 \times 2860 = 309$; $\quad p_d = 17.6$

use $p_d = 18$ and $b = \frac{11}{p_d}$; pitch diam. $= \frac{14}{18} = .778"$ (Gear III)

$b = .612"$; $\quad 18 \times 3.5 = 63$ teeth on gear IV

ratio $= \frac{63}{14} = 4.5$ to 1

2. GEAR CALCULATIONS (CONTINUED)

Tooth Strength - Gears no. V & VI

$\frac{72}{4.5}$ = 16 rpm (gear V) ; $V = \frac{16 \times \pi \times 1.2}{12} = 5.02$ ft./min.

$s = 14{,}000 \left(\frac{600}{605}\right) = 13{,}870$ psi; $F = \frac{33{,}000}{15 \times 5.02} = 438$ lbs.

$F = \frac{\pi s\, b\, y}{p_d} = \frac{10.5\, \pi s y}{p_d^2}$; y for 20 stub involute (12 teeth) = .099

$\frac{p_d^2}{y} = \frac{33 \times 13{,}870}{438} = 1045$

$p_d^2 = 1045 \times .099 = 103.3$; $p_d = 10.15$ use 10

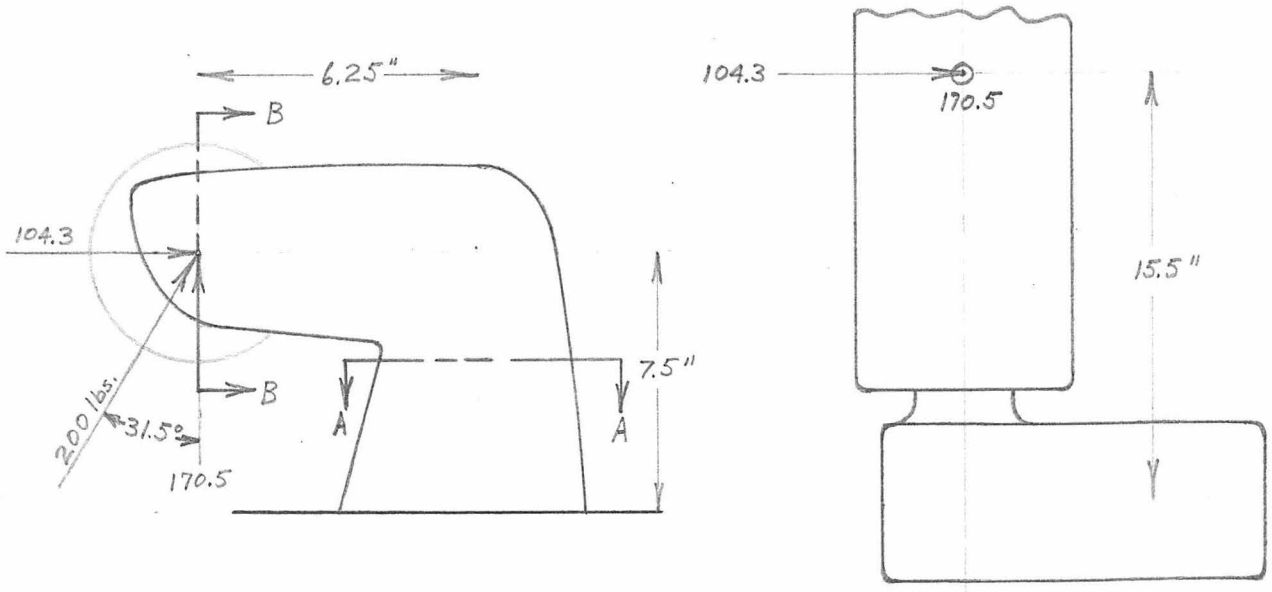
$\frac{12}{10} = 1.2$" PD (gear V) ; b = 1.035"

2.7 x 10 = 27 teeth on gear VI; ratio = $\frac{27}{12} = 2.25$

Check on roll rpm

$$\frac{27}{12} \times \frac{63}{14} \times 24 = 243 \text{ to } 1 \; ; \quad \frac{1725}{243} = 7.1 \text{ rpm}$$

3. GEAR HOUSING CALCULATIONS



3. GEAR HOUSING CALCULATIONS (CONTINUED)

Bending stress at the table top:

$M = 104.3 \times 7.5 + 170.5 \times 6.25 = 1850$ lb. in.

At point A -A $\frac{I}{c} = \frac{b_1 d_1^3 - b_2 d_2^3}{6d_1}$; $d_1 = 5.5"$; $d_2 = 5.0"$

$b_1 = 5.5"$; $b_2 = 5.0"$

$$\frac{I}{c} = \frac{5.5 \times 167 - 5 \times 125}{33} = 8.94 \text{ in}^3$$

$$s = \frac{Mc}{I} = \frac{1850}{8.94} = 207 \text{ psi}$$; Yield stress in tension for aluminum = 25,000 psi

Torsion at critical sections:

critical section for 104.3 lb. force = 5.5" square (A - A)

$$s = \frac{T}{2t(a - t)(b - t)}$$

reference 23 p. 5-50

critical section for 170.5 lb. force = 5.125 x 4.5" (B - B)

$$s_{s_{(B-B)}} = \frac{170.5 \times 15.5}{.5(5.125-.25)(4.5-.25)} = \frac{2645}{10.36} = 255 \text{ psi}$$

$$s_{s_{(A-A)}} = \frac{104.3 \times 15.5}{.5(5.25)^2} = \frac{1618}{13.75} = 117.8 \text{ psi}$$

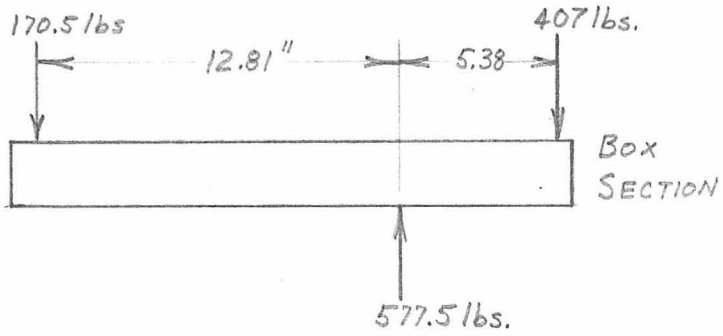
Maximum bending $= \frac{1618}{6.89} = 235$ psi

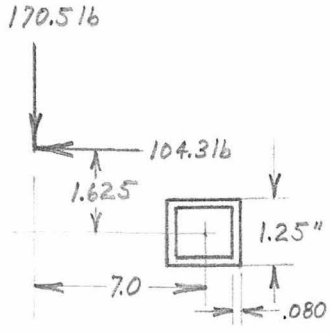
Combined stresses (p 13 reference 21)

$$s_{s_{def}} = \sqrt{\frac{235^2}{4} + \frac{3(255)^2}{4}} = 250 \text{ psi}$$

$$s_{t_{def}} = \sqrt{235^2 + 3(255)^2} = 500 \text{ psi}$$

4. IRONER TABLE CALCULATIONS





Max. bending moment = 170.5 x 12.81 = 2187 lb. in.

$$\frac{I}{c} = \frac{b_1 d_1^3 - b_2 d_2^3}{6 d_1} \quad ; \quad d_1 = 1.25"; \; d_2 = 1.09"; \; b_1 = 1.25"$$

$$b_2 = 1.09"$$

$$\frac{I}{c} = \frac{2.44 - 1.42}{7.5} = .136 \text{ in}^3$$

$$s = \frac{2187}{.136} = 16{,}100 \text{ psi}$$

ultimate tensile = 60,000psi

yield strength = 38,000psi

ultimate shear = 65,000psi

Transverse shear (max.)

$$s_s = \frac{407}{.374} = 1088 \text{ psi}$$

Torsion in box section

$$s = \frac{170.5 \times 7 + 104.3 \times 1.625}{.16(1.37)} = 6230 \text{ psi}$$

Maximum combined stresses:

s_s total = 6230 + 1088 = 7318 psi

$$s_{s_{def}} = \sqrt{\frac{16{,}100^2 + 3(7318)^2}{4}} = 10{,}250 \text{ psi}$$

$s_{t_{def}}$ = 20,500 psi

4. IRONER TABLE CALCULATIONS (CONTINUED)

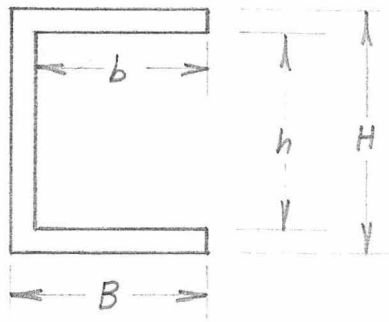
At the point of connection of the box section and the gear housing, the box section is reduced to an angle.

Hence reinforcement will be required.

$\frac{I}{c}$ of box section = .136 in^3

$\frac{I}{c}$ of a channel = $\frac{BH^3 - bh^3}{6H}$

(page 21, reference 21)



A channel of 16 gauge steel gives

B = 1.00"

H = 2.00"

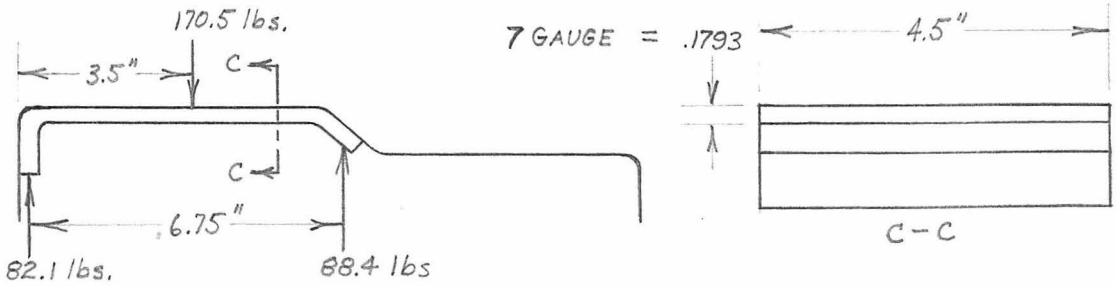
h = 1.88"

b = 0.94"

$\frac{I}{c} = \frac{8 - 6.23}{12} = .1475\ in^3$

$s = \frac{2187}{.148} = 14{,}830$ psi

Reinforcement above cam plate



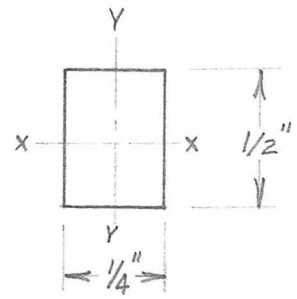
$\frac{I}{c_{(c-c)}} = \frac{bh^2}{6}$ (page 20, reference 21) = $\frac{4.5 \times .032}{6} = .024\ in^3$

$s = \frac{287}{.024} = 11{,}960$ psi

Toggle Links

with a minimum section

$\frac{I}{c_{X-X}} = .0104\ in^4$; $\frac{I}{c_{Y-Y}} = .00521\ in^4$



4. IRONER TABLE CALCULATIONS (CONTINUED)

Toggle links (continued)

Links take 200 lbs compression with possible 1/2" eccentricity.

$M = 200 \times 1/2 = 100$ lb. in. ; $s = \frac{100}{.0104} = 9{,}600$ psi

$A = .125\ in^2$; $s = \frac{200}{.125} = 1600$ psi

s total = 9600 + 1600 = 11,200 psi

Links take 30 lb. in. bending about y - y

$$s = \frac{30}{.0052} = 5{,}775 \text{ psi}$$

$$s_s = \frac{10}{1/8} = 80 \text{ psi}$$

Actuating rod from foot pedal

Euler formula (pinned ends) (page 26, reference 21)

$F = \frac{\pi^2 EI}{l^2}$ Using a 1/4" tube with .030" walls

$I = \frac{\pi}{64}(D_o^4 - D_i^4) = .0001275\ in^4$

$D_o = .25"$; $D_i = .190"$; $l = 22"$

$$F = \frac{9.86 \times 30 \times 10^6 \times .000125}{484} = 77.7 \text{ lbs.}$$

rod actually takes 10 lbs.

ESTIMATE OF COSTS

Material	Wt. lb.	Unit Cost
Gear Housing	5.1 @ .22/lb.	1.12
Main Shoe	3.0 @ .22/lb.	.66
Ruffle Shoe	0.5 @ .22/lb.	.12
Main Shoe Support	0.5 @ .22/lb.	.12
Sheet Steel	100.0 @ .07/lb.	7.00

Indirect - Dies and Special Tools

Gear Housing	$ 10,000		
Main Shoe	$ 5,000		
Ruffle Shoe	$ 2,000		
Table Top	$ 2,000		
Upper Front	$ 2,000		
Top	$ 2,000		
Upper Sides	$ 500		
Shoe Support	$ 500		
	$ 24,000	on 100,000 units	.24

Labor & Overhead

Cabinet	Operation	Time - sec.	
	Die operations	16 @ .05 per	.80
	Spot Weld	256	
	Paint	70	
		326 @ .06/min. x 3	.98
Table			
	Die operations	2 @ .05 per	.10
	Spot Weld	256	
	Paint	40	
		296 @ .06/min. x 3	.89
Top			
	Die operations	2 @ .05 per	.10
	Paint	20 @ .06/min. x 3	.06
Lower Front			
	Die operations	8 @ .05 per	.40
	Paint	20 @ .06/min. x 3	.06
Upper Front			
	Die operations	2 @ .05 per	.10
	Paint	20 @ .06/min. x 3	.06
Upper Sides			
	Die operations	2 @ .05 per	.10
	Paint	20 @ .06/min. x 3	.06
Assembly			
	Roll	128	
	Lower Front	60	
	Hinges	128	

ESTIMATE OF COSTS continued

Assembly	Item	Labor & Overhead Time - sec.	Unit Cost
	Fold Link	240	
	Gear Housing	600	
	Shoes	600	
	Toggle	240	
		1996 @ .06/min. x 3	6.00
Miscellaneous Parts			
	Motor		5.00
	Gears		1.50
	Switches		.20
	Springs		.01
	Cord		.30
	Forming Board		.50
	Roll padding and cover		.80
	Heating elements		2.00
	Thermostats		1.60
TOTAL MANUFACTURING COST			$ 30.88

APPENDIX E REFERENCES

1. Caroline E. Aber, Notes on the Market for Household Electric Ironers, Research Department, Redbook Magazine, (November 4, 1948), pp. 1-3, 5-6, 7, 10.

2. Anonymous, Electrical Merchandising, Ironers, (January, 1949), Vol. 81, No. 1, pp. 52, 53, 62, 63.

3. Anonymous, Sunset Magazine, Lane Publishing Co., (January, 1949), pp. SP42-648-3C, SP42A-648-3C.
This data is not to be released to the trade in any form. It is for the confidential use of sales and advertising executives only.

4. Anonymous, The Market For Washing Machines, Ironers and Clothes Dryers, Research Division, Meredith Publishing Company, (January 24, 1948), pp. 9, 15, 16.

5. Anonymous, Homemaking and Appliances, Crowell-Collier Research Department, (1945), pp. 6-9, 51.

6. Anonymous, Modern Plastics, Markets...Present and Future, (May 1947), Vol. 24, No. 9, pp. 94-97.

7. Anonymous, Survey of Current Business, The Business Situation, (October 1948), Vol. 28, No. 10, pp. 1-11.

8. Anonymous, Federal Reserve Bulletin, Expenditures & Incomes in the Postwar Period, (November 1948), Vol. 34, No. 11, pp. 1329-38.

9. Arno H. Johnson, Harvard Business Review, Market Potentials, 1948, (January 1948), Vol. 26, No. 1, pp. 11-31.

10. Anonymous, Monthly Labor Review, 1948 Survey of Consumer Finances, (November 1948), Vol. 67, No. 5, pp. 515-16.

11. Clarke L. Fauver, Federal Reserve Bulletin, Financial Position and Buying Plans of Consumers, July 1948, (November 1948), Vol. 34, No. 11, pp. 1355-1359.

12. Anonymous, Sales Management, Consumers Growl and Get Tough in Face of High Prices, (Sept. 15, 1948), Vol. 61, No. 6, pp. 37-9.

13. Anonymous, Electrical Merchandising, The Outlook for 1949, (January 1949), Vol. 81, No. 1, pp. 49, 268.

14. Anonymous, Business Week, Builders' Goal: Cheaper Houses, (March 5, 1949), No. 1018, p. 21.

15. Anonymous, Survey of Buying Intentions, Redbook Market Research Department, (July 1947), p. 10,30.

16. Thornton B. Moore, The Outlook for the Electrical Appliance Industry, United States Department of Commerce, (October 1, 1948), p. 2.

17. Anonymous, Los Angeles Times Continuing Home Audit, Los Angeles Times Research Department, (October 1945 - April 1946). The Los Angeles Times does not authorize publication or reproduction of any part of this report without written permission, and specifically prohibits the use of this material in the promotion of any product or company.

18. Marguerite Fenner, Electrical West, It's a Woman's Intuition, Plus -, (March 1947), Vol. 98, No. 3, pp. 81-83.

19. Anonymous, Postwar Ironing Temperatures, Good Housekeeping Institute, (1945), pp. 5, 10.

20. Arthur E. Fitzgerald, Basic Electrical Engineering, (1945), pp. 268, 269.

21. Norman, Ault, and Zarobsky, Fundamentals of Machine Design, (1938), pp. 13, 21, 359-61, 401-4.

22. Anonymous, Celoron Silent Gears, Continental Diamond Fibre Company, pp. 3, 4.

23. Ovid W. Eshbach, Handbook of Engineering Fundamentals, (1936), pp. 5-22, 5-50.