THE DESIGN
OF AN INDOOR
ELECTRIC BARBECUE STOVE

THESIS BY

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ABSTRACT

A COMPACT ELECTRIC BARBECUE UNIT HAS BEEN DESIGNED FOR INDOOR USE. THIS BARBECUE HAS BEEN DEVELOPED FOR A MASS MARKET.

A MARKET SURVEY WAS CONDUCTED TO DETERMINE POSSIBLE DISTRIBUTION CHANNELS AND THE POTENTIAL MARKET FOR SUCH A PRODUCT. A STUDY WAS MADE OF COMPETITIVE PRODUCTS TO EVALUATE THEIR DESIGN FEATURES. IN AN EFFORT TO SELECT THE BEST POSSIBLE MEANS OF BARBECUING, COOKING PROCEDURES WERE INVESTIGATED. A DETAILED STUDY WAS ALSO MADE OF POSSIBLE HEAT SOURCES FOR THE UNIT WITH SPECIAL EMPHASIS ON COOKING WITH RADIANT HEAT IN THE NEAR INFRA-RED END OF THE SPECTRUM.

THE FINAL DESIGN HAS BEEN DIRECTED TOWARD THE LARGE POTENTIAL MARKET DESIRING BARBECUED FOODS PREPARED IN THE KITCHEN WITHOUT THE MESS OF CHARCOAL AND SMOKE. THE INDOOR BARBECUE UNIT CONSISTS OF A SIMPLE TUBULAR FRAME FROM WHICH ARE SUSPENDED TWO INFRA-RED BAKING LAMPS. MEAT IS PLACED BETWEEN THE LAMPS ON A ROTATING MOTOR-DRIVEN SPIT WHICH IS ATTACHED TO THE TUBULAR FRAME. THE COOKER CAN BE USED FOR BAKING, BROILING, OR BOILING, BY REMOVING THE SPIT AND ROTATING THE ENTIRE FRAME NINETY DEGREES.

THE MULTIPLE FUNCTION OF THE UNIT IS HIGHLY SUCCESSFUL, AND THE GLEAMING COMBINATION OF CHROME AND WHITE ENAMEL IS MOST PLEASING AESTHETICALLY.

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Background

THE ORIGINAL CONCEPT OF THIS PROJECT WAS TO DESIGN AN EFFICIENT TYPE OF SMALL ELECTRIC STOVE FOR USE IN APARTMENTS AND SMALL LIVING UNITS. PRELIMINARY INVESTIGATION INDICATED THAT THERE WAS A NEED FOR SUCH A SPACE SAVING DEVICE. A DETAILED STUDY PROVED THAT THIS ORIGINAL PREMISE WAS INCORRECT. THE SMALL STOVE AND ROASTER MARKET IS REPRESENTED BY SEVERAL WELL DESIGNED PRODUCTS WHICH ARE FILLING THE EXISTING DEMAND.(1)*

WHILE INVESTIGATING CONSUMER PREFERENCE FOR METHODS OF COOKING FOODS, SEVERAL HOME ECONOMISTS SUGGESTED THAT THERE MIGHT BE A MARKET FOR AN INEXPENSIVE ELECTRIC STOVE THAT COULD BE USED TO BARBECUE FOODS.(2) CONSUMER ACCEPTANCE FOR SUCH A UNIT WAS STUDIED, AND ALL INDICATIONS POINTED TO A FAVORABLE RECEPTION FOR AN INDOOR BARBECUE UNIT WHICH WAS PORTABLE AND COULD BE USED IN THE KITCHEN, ON

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*HEREAFTER NUMBERS IN PARENTHESES THROUGHOUT THIS THESIS WILL REFER TO REFERENCE DATA FOUND IN APPENDIX SECTION.

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PATIOS, IN RUMPUS ROOMS, ON BOATS, AND IN TRAILERS. BECAUSE THIS WAS A NEW FIELD AND OFFERED GOOD POSSIBILITIES FOR ORIGINAL THINKING AND ENGINEERING, IT WAS SELECTED AS THE THESIS PROBLEM.

Scope and Discussion

THIS STOVE WOULD HAVE TO BE SMALL IN SIZE, LIGHT IN WEIGHT, INEXPENSIVE TO THE CONSUMER, AND YET BE SO DESIGNED THAT LARGE ROASTS COULD BE BARBECUED IN A MINIMUM OF TIME.

THE FIRST APPROACH TO THE PROBLEM INVOLVED UTILIZATION OF STANDARD COOKING EQUIPMENT AND ADAPTING IT FOR A ROTATING SPIT FOR BARBECUING. INVESTIGATION OF EXISTING COOKING EQUIPMENT INDICATED THAT PRESENT DAY STOVES ARE HIGHLY INEFFICIENT. MOST STOVES ROAST MEAT BY CONVECTED HEAT. SUCH A SYSTEM REQUIRES THAT THE AIR WHICH IS HEATED FOR THE COOKING BE ENCLOSED IN AN EXPENSIVE AND WELL-INSULATED CABINET. EVEN USING HIGH GRADE INSULATING MATERIALS, A GREAT DEAL OF THE HEAT IS LOST THROUGH THE WALLS OF THE STOVE. GREATER LOSSES OCCUR WHEN THE OVEN DOOR IS OPENED FOR BASTING, AND VALUABLE TIME IS WASTED WHILE THE INSIDE OF THE STOVE AND ALL THE AIR IN THE STOVE IS

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HEATED TO THE REQUIRED TEMPERATURE.

In stoves where cooking is accomplished by a radiant coil, inefficiency is also great. Little thought has been given to directional reflectors for these radiant coils, and no consideration has been given to the proper wave length of infra-red for the best and quickest cooking. Stoves which cook with radiant heat utilize low color heating elements. It is an established fact that low color elements, which are at the far end of the infra-red spectrum, heat the air in a stove before penetrating the foods being cooked.(3) Much of the roasting in such a system is actually accomplished by convection and is not truly radiation. It has been further established that energy at the other end of the infra-red spectrum, the near infra-red, will penetrate foods in the path of the heat without heating the surrounding air. Therefore, it seems that utilization of a near infra-red heating source would be far more efficient than the type of equipment used on stoves today.

INTRODUCTION

THIS THESIS REPORTS ON INVESTIGATION OF NEAR INFRA-RED SOURCES FOR RADIANT COOKING AND DESCRIBES THE PROBLEMS ENCOUNTERED IN ENGINEERING, DESIGN, AND MERCHANDISING OF A RADIANT COOKER FOR BARBECUING FOODS.

MARKET SURVEY

Distribution Channels

Distribution of cooking appliances is complex. The cooking appliance field may be divided into three categories which include products of large name brand manufacturers, products of large independent manufacturers, and products of small manufacturers. The distribution in each of these categories varies greatly.

The first group includes such manufacturers as General Electric, Hotpoint, and Westinghouse. Apportionment of products manufactured by these companies is maintained by the manufacturer directly. These products are allocated to retail outlets from distribution points located in all large cities.

With the second group distribution is more complex. These manufacturers usually disperse their products through large jobbers. The jobbers, in turn, are responsible to the manufacturer for allocation of the products to retail stores. In many cases the large jobber will sell to a small jobber who will then sell to the retail store.

MARKET SURVEY

THE THIRD GROUP IS MADE UP OF SMALLER MANUFACTURERS, WHO ATTEMPT TO ELIMINATE HEAVY EXPENSES OF DISTRIBUTION BY SELLING DIRECT TO THE RETAILER. SINCE MERCHANDISING OF THIS TYPE WILL WORK ONLY IN SPECIALIZED INSTANCES, SUCH OPERATIONS ARE DIFFICULT TO EXECUTE SUCCESSFULLY. THE MANUFACTURER MUST HAVE A LARGE SALES FORCE TO CONTACT RETAILERS, AND THE PRODUCT ITSELF MUST BE ONE WHICH IS EASY TO SELL AND DOES NOT REQUIRE SALES EXPLANATION OR CAREFUL INVENTORY CONTROL.

THE INDOOR BARBECUE UNIT DOES NOT FIT INTO THIS CATEGORY BECAUSE IT EMBODIES SOME REVOLUTIONARY COOKING FEATURES, WHICH MUST BE EXPLAINED TO THE CONSUMER. THE INTRODUCTION OF THIS UNIT WILL HAVE TO BE CAREFULLY CONTROLLED AND GUIDED. THIS CAN BE DONE PARTIALLY BY THE MANUFACTURER, BUT SOME SOURCE NEARER TO THE RETAILER WILL HAVE TO IMPLEMENT THE MANUFACTURER'S PROGRAM, NAMELY THE JOBBER. THEREFORE, THE DISTRIBUTION OF THE INDOOR BARBECUE WILL BE SIMILAR TO PRODUCTS IN GROUP TWO, THAT IS MANUFACTURER TO JOBBER TO RETAILER.

MARKET SURVEY

THE JOBBER WILL FIND THAT THERE ARE MANY DIFFERENT TYPES OF RETAIL OUTLETS FOR THIS BARBECUE COOKER. IN ORDER TO DETERMINE JUST WHAT RETAILERS MIGHT BE INTERESTED, BUYERS FROM VARIOUS STORES WERE CONTACTED. THE PROPOSED PRODUCT WAS DISCUSSED, AND THEIR REACTIONS TABULATED.(4) FROM THESE DISCUSSIONS IT WAS FELT THAT THE JOBBER WOULD HAVE LITTLE DIFFICULTY DISTRIBUTING THE BARBECUE UNIT TO DEPARTMENT STORES, APPLIANCE STORES, HARDWARE STORES, AND SPORTING GOODS STORES.

IT IS IMPORTANT TO NOTE AT THIS POINT THAT THESE BUYERS BELIEVED THAT THERE WOULD HAVE TO BE A WELL PLANNED PROMOTIONAL PROGRAM IN INTRODUCING THE PRODUCT. THEY STATED ALMOST UNIVERSALLY THAT ALONG WITH NEWSPAPER ADVERTISING STORES WOULD HAVE TO RUN DEMONSTRATIONS OF THE UNIT IN OPERATION UNTIL ITS REPUTATION HAD BECOME ESTABLISHED.

IN DISCUSSION WITH THESE BUYERS, IT WAS GRATIFYING TO NOTE THAT THEY WERE HIGHLY IN FAVOR OF THE PROJECT AND FELT THAT THE COMPETITION IN THE FIELD AT PRESENT WAS NEGLIGIBLE.

TOWN AND COUNTRY BARBECUE

FIG. 2

MARKET SURVEY

Competitive Products

Competition for the indoor barbecue unit may be divided into two categories. The first is the directly competitive field in which similar types of indoor barbecue units are sold. The second is indirectly competitive, and consists of products which although not identical in function may be considered by the prospective purchaser as a substitute. Fortunately there is only one product which falls into the first class. This competitor is the Town and Country Rotisserie.

The Town and Country Rotisserie is manufactured by the Cal-Det Products Co. of Los Angeles and sells for approximately $190.00, depending on the geographical location of the point of sale. The unit is well engineered, and attractive in appearance. (See Figure 2) Briefly, the cabinet is a double walled, insulated, stainless steel shell. The front is enclosed by heat resistant glass observation doors. A fractional horsepower motor is mounted in the case, and drives a stainless steel spit at six RPM. The

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HEAT SOURCE IS A CARBORUNDUM CO. SINTERED CARBON ROD MOUNTED IN THE TOP OF THE CABINET. BELOW THE SPIT IS AN ADJUSTABLE SHELF TO BE USED FOR GRILLING AND BROILING OF FOODS WHEN THE SPIT IS REMOVED.

AFTER CAREFUL STUDY, TWO MAJOR FAULTS IN THE TOWN AND COUNTRY UNIT ARE APPARENT. FIRST, THE PRICE IS MUCH TOO HIGH FOR A MASS MARKET, AND SECOND, THE CARBON HEATING ELEMENT IS EXTREMELY FRAGILE AND CAN BE DESTROYED EASILY BY JARRING. IT SHOULD BE NOTED AT THIS JUNCTURE, THAT THE TOWN AND COUNTRY UNIT, LIKE THE STOVES DISCUSSED IN THE INTRODUCTION, UTILIZES A LOW COLOR HEATING ELEMENT. THIS ELEMENT COOKS PARTIALLY BY CONVECTION AND HENCE REQUIRES A WELL INSULATED CABINET.

STUDY OF INDIRECT COMPETITION IS MORE COMPLEX. CAREFUL CONSIDERATION OF ALL TYPES OF PORTABLE COOKING EQUIPMENT INDICATES THAT THE OVEN ROASTER IS THE ONLY APPLIANCE THAT CAN BE CONSIDERED AS INDIRECT COMPETITION TO THE INDOOR BARBECUE.(5) OVEN ROASTERS ARE MANUFACTURED BY SEVERAL MAJOR APPLIANCE MANUFACTURERS. SINCE THE WESTINGHOUSE CO. SELLS 56%

DELUXE ELECTRIC ROASTER

18-QUART CAPACITY

Roasts, bakes, stews, cooks a complete meal for a large family all at one time. No special wiring necessary—may be plugged in any a-c electric wall outlet. Supplied with ovenware dish set.

FIG. 3

MARKET SURVEY

OF THE TOTAL OVEN ROASTER OUTPUT, DETAILED STUDY OF THE WESTINGHOUSE OVEN ROASTER WAS MADE.(6) (SEE FIGURE 3) THE FOLLOWING CONCLUSIONS WERE REACHED:

1. TO ELIMINATE THE OVEN ROASTER TYPE APPLIANCE AS COMPETITION, THE INDOOR BARBECUE MUST HAVE AN ENTIRELY DIFFERENT FUNCTION. THE PRIMARY OPERATION TO BE ADVERTISED SHOULD BE THAT OF BARBECUING FOODS CLEANLY AND EFFICIENTLY INDOORS.
2. THE INDOOR BARBECUE SHOULD INCORPORATE SECONDARY FEATURES WHICH ARE NOT AVAILABLE IN OVEN ROASTERS, SUCH AS VERY RAPID COOKING, AND EASE OF CLEANING.
3. IF POSSIBLE THE INDOOR BARBECUE, LESS ACCESSORIES, SHOULD BE IN THE SAME GENERAL PRICE FIELD AS THE OVEN ROASTERS.

TO SUMMARIZE, THERE IS LITTLE REAL COMPETITION FOR A WELL DESIGNED INDOOR BARBECUE, PROVIDED IT INCORPORATES A GOOD STURDY HEATING ELEMENT AND IT IS PRICED SOMEWHERE AROUND $75.00.

MARKET SURVEY

Potential Market

> "It is extremely difficult to obtain exact knowledge of the demand for a commodity or even close approximations to it. The general discussions of demand by economists do not provide any simple formulas which are easy to apply to the facts of a complex and changing world. Some judgement about demand is so important for many business decisions, however, that any aid is welcome. The economists' generalizations are obviously no substitute for the experienced businessman's intimate knowledge of the conditions in his particular trade, but give the student a useful frame within which he can fit business facts."*

Forecasting is one of the most difficult problems facing a manufacturer with a new product. In order to establish his price as well as his tooling and production facilities, the manufacturer is forced to estimate the possible demand for the new product.

Both experienced business men and trained economists recognize that demand for a product cannot be studied without some associated price structure. Businessmen are aware of the basic principle that the larger the quantity put on the market, the lower

*Malcolm P. McNair and Richard S. Meriam, Problems in Business Economics, (New York, McGraw-Hill Book Co., 1941), p. 82.

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THE PRICE; OR THE LOWER THE PRICE, THE LARGER THE QUANTITY SOLD.

IN ATTEMPTING TO FORECAST POSSIBLE SALES THE MANUFACTURER MUST STUDY THE MARKET FOR HIS PRODUCT WITH A SPECIFIC PRICE IN MIND, SINCE THE PRICE IS SO DIRECTLY RELATED TO THE NUMER TO BE SOLD. A RETAIL SELLING PRICE SHOULD BE ESTIMATED BASED UPON COST OF PRODUCTION, DISTRIBUTION, AND PROFIT.

IN THE CASE OF THE INDOOR BARBECUE UNIT, THE APPROXIMATE SELLING PRICE WILL BE AROUND $75.00. WITH THIS INFORMATION AT HAND A POLL WAS TAKEN IN ORDER TO ESTIMATE THE NUMBER OF PEOPLE IN LOS ANGELES COUNTY WHO WOULD BE INTERESTED IN PURCHASING SUCH A COOKING UNIT AT THIS PRICE.

INDIVIDUALS IN THE SIXTEEN MAJOR ECONOMIC AREAS OF LOS ANGELES COUNTY, AS SELECTED BY THE LOS ANGELES COUNTY REGIONAL PLANNING BOARD, WERE POLLED.(7) SIXTEEN PERCENT OF THOSE INTERVIEWED STATED THAT THEY WOULD BE INTERESTED IN SEEING THE BARBECUE UNIT IN OPERATION AND MIGHT THEN DECIDE TO BUY ONE. THREE PERCENT OF THE TOTAL STATED THAT THEY HAD WANTED SUCH

MARKET SURVEY

A PRODUCT, AND WOULD CERTAINLY PURCHASE ONE IF THE PRICE WERE AS LOW AS $75.00.(8) PROJECTING THE THREE PERCENT FIGURE OVER THE POPULATION OF THE COUNTY, THE ESTIMATED DEMAND WOULD BE APPROXIMATELY 11,000 UNITS.(9) IN ORDER TO CHECK THE ACCURACY OF THIS FIGURE, UNIT SALES OF AN ALLIED PRODUCT, THE WESTINGHOUSE ROASTER, WERE CHECKED.

ALTHOUGH THE WESTINGHOUSE REPRESENTATIVE WOULD NOT GIVE AN EXACT FIGURE ON SALES IN LOS ANGELES COUNTY, HE DID SAY THAT BETWEEN 15,000 AND 20,000 WESTINGHOUSE ROASTERS WERE SOLD IN 1948. SINCE THE WESTINGHOUSE PRODUCT MAKES UP 56% OF THE TOTAL ROASTER OVEN SALES, IT IS SAFE TO ASSUME THAT APPROXIMATELY 35,000 UNITS WERE SOLD IN LOS ANGELES COUNTY. ALLOWING FOR THE FACT THAT THE INDOOR BARBECUE UNIT IS NEW, AND WILL REQUIRE A PERIOD OF TIME TO PROMOTE, THE 11,000 UNIT FIGURE CAN BE ACCEPTED AS AN ESTIMATE OF UNIT SALES FOR THE FIRST YEAR.

ASSUMING THAT THE DEMAND IN THE TEN LARGEST METROPOLITAN AREAS OF THE COUNTRY WAS APPROXIMATELY THE

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SAME, A TOTAL PRODUCTION FOR THE FIRST YEAR WOULD BE SOMEWHERE AROUND 100,000 UNITS. FUTURE DISCUSSION IN THIS THESIS WILL BE PREDICATED ON AN INITIAL RUN OF 100,000 UNITS PRODUCTION FOR THE FIRST YEAR.

CONSUMER SURVEY

PRODUCT REQUIREMENTS

> "FACTS GAINED THROUGH RESEARCH AS TO THE PRODUCT REQUIREMENTS OF THE CONSUMER AND THE WAY HE LIKES TO BUY PRODUCTS, AS WELL AS TO THOSE OF THE TRADE AND THE WAY THEY LIKE TO SELL PRODUCTS, MAY BE THE STARTING POINT FOR MARKETING PLANS AND DEVELOPMENT."*

ONE OF THE MOST SUCCESSFUL METHODS OF DETERMINING CONSUMER REQUIREMENTS FOR A PRODUCT IS BY DIRECT INTERVIEW. WHEN THE POLL WAS TAKEN TO ESTIMATE THE DEMAND FOR THE INDOOR BARBECUE UNIT, SOME INQUIRIES WERE MADE IN AN ATTEMPT TO DETERMINE WHAT REQUIREMENTS THE CONSUMER WOULD HAVE FOR SUCH A PRODUCT. BRIEFLY, THESE REQUIREMENTS WERE AS FOLLOWS:

1. RAPID COOKING
2. EASE OF CLEANING
3. PORTABILITY
4. NO SMOKE OR FUEL
5. BARBECUE TASTE
6. LOW PRICE, ABOUT $75.00

*BEN NASH, DEVELOPING MARKETABLE PRODUCTS AND THEIR PACKAGING, (NEW YORK, MCGRAW HILL BOOK CO., 1945), P. 52.

CONSUMER SURVEY

7. Operation on 110 volts

8. Simplicity of operation

9. Simple method of spit attachment

Consultation with distributors and dealers confirmed the correctness of these requirements for merchandising the barbecue. These merchants suggested several additional features which would assist in distribution which are as follows:

1. Design for knock-down shipment in small package provided the assembly is simple.

2. The package should include a detailed instruction book with recipes and information on construction and operation of the unit.

DESIGN

Design Requirements

The following design requirements are a combination of factors which, if incorporated in the design, should produce the type of indoor barbecue desired by consumers, distributors, dealers, and a manufacturer.

1. Efficient source of heat in the near infra-red zone of the spectrum, if possible.
2. Utilization, primarily as a barbecue unit with a rotating spit, but also designed for use as a grill, baking unit, and for boiling.
3. Simple, inexpensive case design which affords ease of cleaning, portability, and attractive appearance.
4. The unit should operate on 110 volts, 60 cycles A.C., 1350 watts, and meet underwriters' regulations for all states.
5. The barbecue should be designed for simple tooling, eliminating all expensive dies, if possible.

DESIGN

Selection of Heating Source

Considerable effort was expended in determining a specific heat source which would be most efficient for this type of cooking. Before discussing the various heating elements investigated, however, it is important to review briefly some of the basic problems involved in selecting a source of radiant heat for cooking.

The infra-red zone, the main source of heat in radiant types of heating or cooking, extends from 7000 Angstrom units to 1,000,000 Angstrom units in the spectrum.(10) The lower range which is near the visible light area is known as near infra-red; the other end of the spectrum is known as the far infra-red wave lengths. With heat sources emitting a major portion of their output at low temperatures in far infra-red, much of the radiation is immediately absorbed by the air and will never reach the food as radiant energy. It is essential that the air which is heated be carefully controlled and restricted by a well insulated oven.

DESIGN

ON THE OTHER HAND, HEAT ENERGY FROM THE NEAR INFRA-RED SECTION OF THE SPECTRUM ACTS QUITE DIFFERENTLY. WHEREAS FAR INFRA-RED IS ABSORBED BY MANY MATERIALS INCLUDING GLASS, WATER AND AIR, THE NEAR INFRA-RED IS NOT. FOOD PLACED DIRECTLY IN THE LINE OF NEAR INFRA-RED RAYS ABSORBS ALMOST ALL OF THE HEAT WITH LITTLE LOSS. IT IS VERY IMPORTANT TO KEEP THIS FACTOR IN MIND TO UNDERSTAND WHY THE DECISION WAS MADE ON THE TYPE OF HEATING ELEMENT USED FOR THE BARBECUE UNIT.

SINCE LOW COST IS OF PRIME IMPORTANCE IN MARKETING THIS ITEM AND NEAR INFRA-RED WAVE LENGTHS HEAT FOOD DIRECTLY AND DO NOT REQUIRE WELL INSULATED OVENS, IT IS LOGICAL THAT A SOURCE WHICH GENERATES HEAT IN THE NEAR INFRA-RED RANGE BE USED.

IN INVESTIGATION OF INFRA-RED THERAPY, THIS INTERESTING QUOTATION WAS FOUND WHICH LED TO THE FINAL SELECTION OF A NEAR INFRA-RED HEAT SOURCE.

> "MOST PHYSICIANS HAVE BEEN UNFAMILIAR WITH A FACT THAT IS COMMON KNOWLEDGE AMONG ILLUMINATING ENGINEERS, I.E. THAT RADIATION FROM LUMINOUS SOURCES, AS TUNGSTEN OR CARBON FILAMENT BULBS, PENETRATES HUMAN TISSUE TO A GREATER DEPTH THAN RADIATION FROM NON-LUMINOUS SOURCES,

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> AS INFRA-RED COILS OR PLATES. SOMEHOW THE ERRONEOUS IDEA HAS BECOME PREVALENT AMONG PHYSICIANS THAT RADIATION FROM THESE NON-LUMINOUS INFRA-RED COILS PENETRATES TO GREAT DEPTHS. ACTUALLY, RAYS FROM THE FAR PORTION OF THE INFRA-RED SPECTRUM, AS PRODUCED BY THE NON-LUMINOUS OR BLACK BODY RADIATORS, PENETRATE IN APPRECIABLE AMOUNTS TO A DEPTH OF LESS THAN 1 MM.
>
> "THE GREATEST PENETRATION OF RADIANT HEAT CAN BE OBTAINED FROM THE SO-CALLED INFRA-RED GENERATOR, WHICH PRODUCES CONSIDERABLE AMOUNTS OF RADIATION IN THE NEAR PORTION OF THE INFRA-RED SPECTRUM. TYPICAL EXAMPLES OF THE LUMINOUS TYPE OF INFRA-RED GENERATOR ARE THE TUNGSTEN FILAMENT AND CARBON FILAMENT LAMPS."*

WITH THIS INFORMATION, IMMEDIATE INVESTIGATION WAS BEGUN INTO THE POSSIBILITY OF USING INFRA-RED HEATING LAMPS FOR THE PURPOSE OF COOKING.

GENERAL ELECTRIC, WESTINGHOUSE, AND SYLVANIA ELECTRIC WERE CONTACTED. ALL THREE OF THESE MANUFACTURERS SUPPLY INFRA-RED LAMPS FOR COMMERCIAL DRYING PURPOSES. GENERAL ELECTRIC, HOWEVER, HAD MORE INFORMATION ON THE SUBJECT OF COOKING WITH INFRA-RED HEAT LAMPS THAN THE OTHER MANUFACTURERS.

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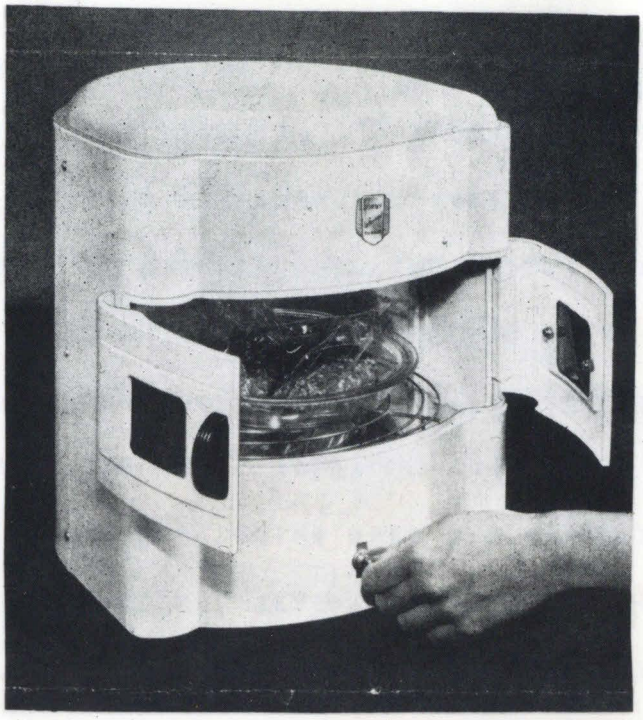
*FRANK H. KRUSAN AND EARL C. ELKINS, "PHYSICAL THERAPY: LIGHT," MEDICAL PHYSICS, OTTO GLASSER, EDITOR. (CHICAGO, THE YEAR BOOK PUBLISHERS, INC., 1944), PP. 1057-8.



DORBY INFRA-RED COOKER

FIG. 4

DESIGN

According to the General Electric Lamp Sales Division of Los Angeles,[11] a small manufacturer in Chicago is using a commercial type baking lamp for heat source in a small grilling unit. A brochure on this unit was obtained, and the use of the lamps studied in this particular case, The data sheet for the unit, named the Dorby Infra-Red Cooker, [12] showed that the lamps were being used successfully for cooking. Therefore, several of the PAR 500 watt lamps were obtained from General Electric at Nela Park, Cleveland, Ohio.

These lamps were used in extensive tests to determine the advisability of using them for the heating element in a barbecue unit.* The tests indicated that this lamp with some minor modifications is a fine source of radiant heat for cooking. The only fault seemed to be a tendency toward hot spots in cooking. Changes to circumvent this condition are being made by the manufacturer by a slight modification of the reflector design.

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*See Appendix, pp. 83 for details of tests.

GENERAL ELECTRIC CO. PAR 500 WATT
INFRA-RED LAMP

FIG. 5

DESIGN

THE ADVANTAGES OF THE PAR 500 WATT INFRA-RED HEAT LAMP FOR COOKING ARE DESCRIBED IN THE FOLLOWING PARAGRAPHS.

1. THIS PARTICULAR LAMP IS IDEAL FOR EMITTING HEAT WHICH IS DEEPLY ABSORBED IN PROTEINS. ACCORDING TO MISS JEAN BATH, ASSOCIATE PROFESSOR OF BIOLOGY AND FOOD CHEMISTRY AT THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES, THE BEST WAVE LENGTH FOR PENETRATION AND ABSORPTION OF INFRA-RED IN PROTEIN MATTER IS AROUND 18,000 ANGSTROM.(10) OF COURSE, IT IS IMPORTANT TO REMEMBER THAT THE ABSORPTIVE QUALITIES OF DIFFERENT PROTEINS VARY WITH WATER CONTENT AND DENSITY, BUT IN GENERAL IT IS ACCEPTED THAT SOMEWHERE IN THE RANGE BETWEEN 13,500 AND 21,000 A. MOST OF THE DEEP PENETRATION OCCURS. THIS DATA IS PURE HYPOTHESIS, HOWEVER, AS THERE IS NO LABORATORY DATA AVAILABLE ON THE COOKING OF FOODS WITH THIS LAMP. MISS BATH BASED HER OPINION ENTIRELY UPON EXPERIMENTATION WITH

DESIGN

INFRA-RED IN ALLIED BIOLOGICAL AND AGRICULTURAL FIELDS.

2. SINCE THE PEAK PERFORMANCE OF THIS LAMP IS AROUND 18,000 A., THE ENERGY, OF COURSE, IS IN THE SO-CALLED NEAR INFRA-RED RANGE. THE ADVANTAGES OF NEAR INFRA-RED HAVE ALREADY BEEN DISCUSSED GENERALLY. IN APPLYING THE ADVANTAGES TO THE DESIGN OF A STOVE OR BARBECUE UNIT, IT IS IMMEDIATELY OBVIOUS THAT CONSIDERABLY LESS EFFORT NEED BE EXPENDED FOR DESIGN OF A WELL INSULATED STOVE ENCLOSURE. IN FACT, THE QUESTION ARISES WHETHER A STOVE ENCLOSURE IS REQUIRED AT ALL.

3. IN ADDITION TO THE POSSIBILITY OF ELIMINATING THE CONVENTIONAL STOVE ENCLOSURE, IT SHOULD BE REMEMBERED THAT THE REFLECTOR SPOTLIGHT IS A HIGHLY EFFICIENT UNIT. THE LOSSES OF ENERGY THROUGH THE GLASS AND OUT THE BACK OF THE SILVERED REFLECTOR ARE NEGLIGIBLE. BECAUSE OF THE DESIGN OF THE REFLECTOR AND THE INHERENT QUALITIES OF NEAR INFRA-RED, A VERY HIGH PER-

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CENTAGE OF THE ENERGY EMITTED IS ABSORBED INTO THE FOOD IN THE FORM OF HEAT.

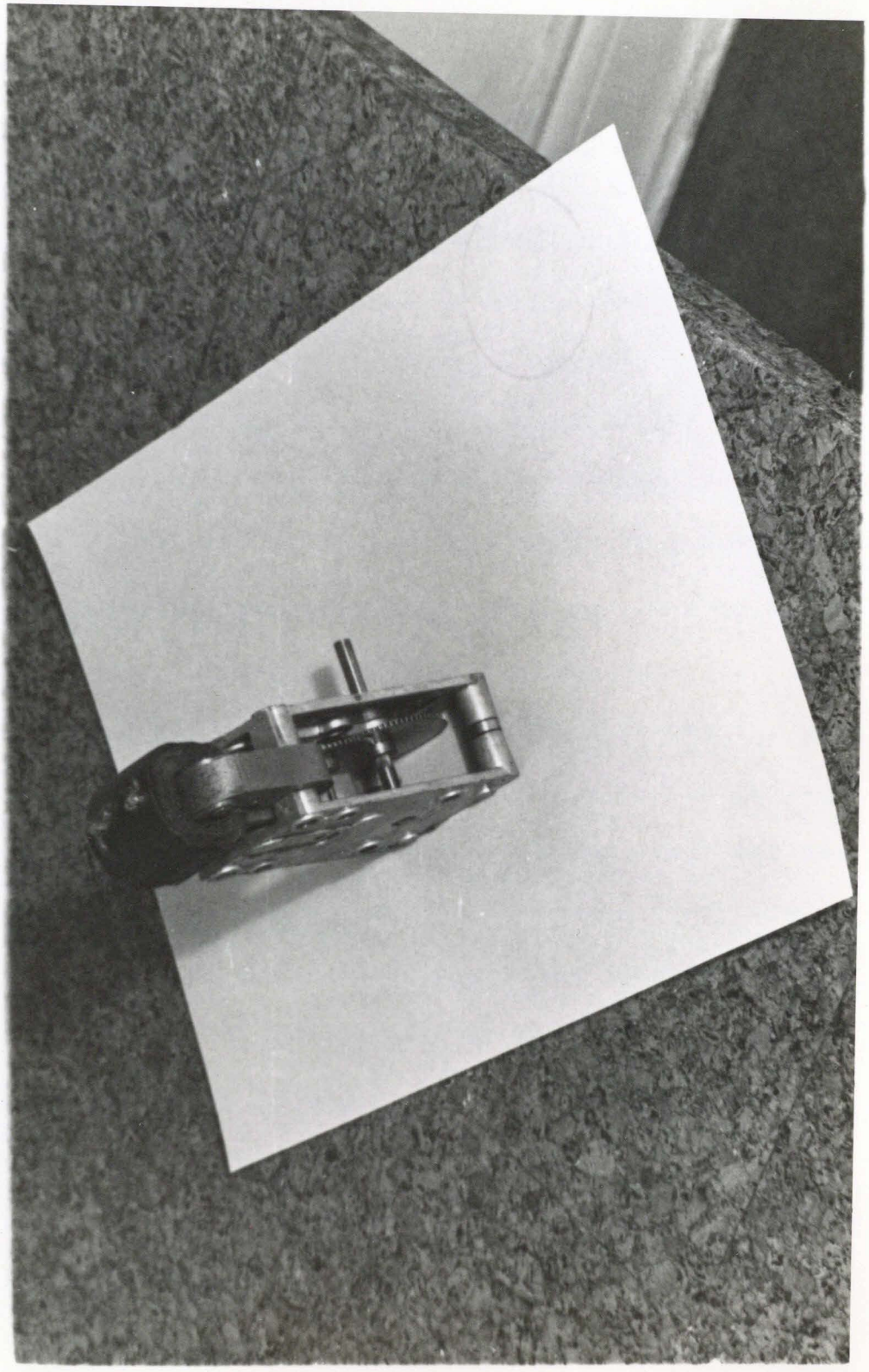
4. ANOTHER GREAT ADVANTAGE OF THIS HEAT SOURCE WHICH WILL BE APPRECIATED BY THE HOUSEWIFE IS THAT WHEN FOODS ARE COOKED IN PYREX DISHES, WHICH DO NOT ABSORB HEAT, THE DISHES REMAIN COOL AND EASY TO HANDLE. ALSO, FOODS MAY BE WRAPPED IN CELLOPHANE BAGS AND COOKED. FROZEN FOODS MAY BE LEFT IN THEIR CELLOPHANE WRAPPER WHILE BEING HEATED. THIS FACTOR ALONE WOULD GIVE ANY STOVE OR BARBECUE UNIT GREAT SALES APPEAL, AS POTS AND PANS WILL NOT HAVE TO BE SCRUBBED AFTER COOKING.

5. SANITATION IS ONE OF THE MAJOR CONSIDERATIONS WHEN DESIGNING A STOVE OR COOKING UTENSIL OF ANY TYPE. THE QUESTION ALMOST EVERY HOUSEWIFE ASKED IN THE SURVEY WAS, "IS IT EASY TO KEEP CLEAN?" THE ANSWER TO THIS IS SIMPLE. A DAMP RAG OR STEEL WOOL WILL REMOVE ALL DIRT AND FOOD PARTICLES INSTANTLY. IN THIS RESPECT, THIS LAMP IS FAR AHEAD OF SUCH ELE-

MENTS AS CAL-ROD, GLOWER, OR GLOBAR.

6. ANOTHER ADVANTAGE OF THE PAR 500 WATT LAMP IS ITS DURABILITY AND LONG LIFE. ALTHOUGH THE REFLECTOR LAMP WITH THE PYREX LENS WILL NOT WITHSTAND BEING DROPPED, IT IS EXTREMELY RESISTANT TO NORMAL FORMS OF SHOCK. IT WILL NOT CRACK OR BREAK WHEN SPATTERED BY GRAVY, AND WILL WITHSTAND AN INADVERTENT BLOW WHILE TENDING THE FOODS. THE LIFE OF THESE LAMPS IS RATED IN EXCESS OF 6000 HOURS. ASSUMING THAT THE STOVE IS USED ONE HOUR A DAY EVERY DAY IN THE YEAR, THE LAMPS WOULD CONTINUE TO FUNCTION FOR OVER NINE YEARS.

TO SUMMARIZE, THE PAR REFLECTOR SPOT LIGHT WAS SELECTED AS A SOURCE OF HEAT BECAUSE IT IS A GOOD SOURCE OF NEAR INFRA-RED, IT FACILITATES INEXPENSIVE STOVE CONSTRUCTION, IT MAKES POSSIBLE CLEAN COOKING IN PYREX AND CELLOPHANE, IT IS EASY TO KEEP CLEAN, IT IS STURDY AND SHOCK RESISTANT, IT IS HIGHLY EFFICIENT, AND IT HAS A VERY LONG LIFE.



EMC No. 300 C MOTOR

FIG. 6

DESIGN

Motor Drive

Since this is a multi-purpose unit and must barbecue as well as grill and boil, some type of motor driven spit is required. Investigation of motor drives used on outdoor barbecue units showed a marked preference for a small gear reduction motor manufactured by the Merkle Korff Gear Co., Chicago. Because of its popularity in the field, one of these motors was installed on Experimental Model II. The motor proved to be entirely satisfactory for the work to be done, but its bulk and weight made for serious limitations in incorporating it in the final design. Through further investigation a similar gear reduction motor was found which performed the same function, but was considerably less bulky. This motor, Model 300 C, is a product of The Electric Motor Corp., Racine, Wisconsin.(14) It has sufficient torque to swing a large roast, and rotates at approximately 4 RPM. This unit proved to be completely satisfactory under test conditions.

DESIGN

Wiring and Controls

Lamp Switches: The initial testing of the lamps involved construction of a test mock-up for cooking.* These tests proved that the full heat from the two lamps was too high for cooking many foods. Tests were made using one lamp alone, and it was found that in certain cases, namely baking, the heat from one lamp was still too intense. Surfaces of baked foods dehydrated too rapidly and crusted. However, by putting the two lamps in series, this problem was alleviated. Foods baked at this low temperature were satisfactory in appearance and taste. Calculations of the heat output with the lamps in series showed that this minimum heat was about 99,489 calories per hour, discounting a small loss in the glass lamp lens. Heat obtained using one lamp alone was about 431,208 calories per hour, and the heat from the two lamps in parallel was about 1,316,634 calories per hour.(15)

In order to obtain the series, parallel arrangement with the option of one lamp at full rating

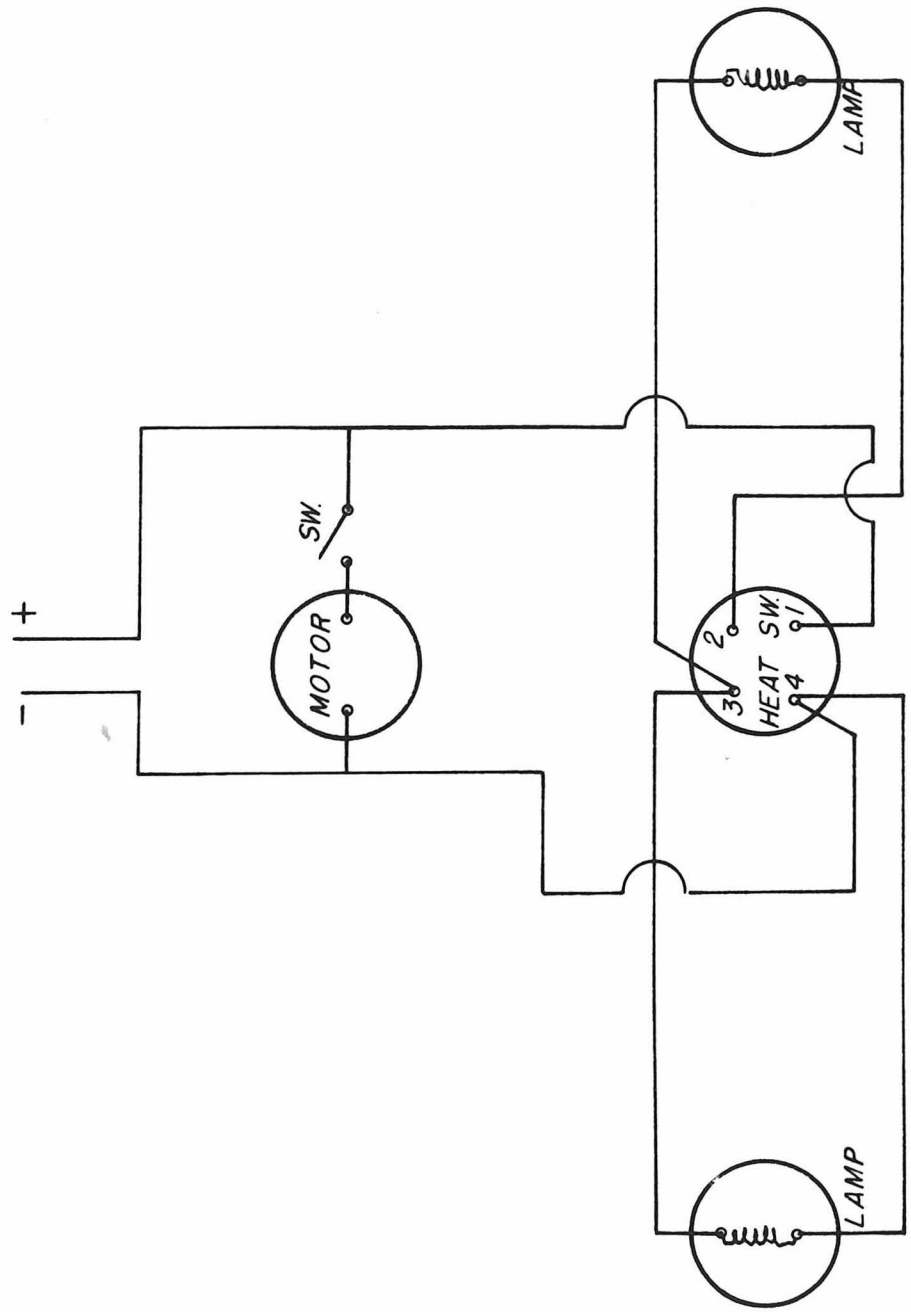
*See figure 8, p. 35.

DESIGN

A SIMPLE SERIES-PARALLEL HEATER SWITCH WAS USED. THIS INEXPENSIVE SWITCH IS COMPLETELY SATISFACTORY FOR THE BARBECUE UNIT.

MOTOR SWITCH: THE SWITCH WHICH CONTROLS THE BARBECUE ROTATION MOTOR WILL BE A SIMPLE SINGLE POLE, SINGLE THROW, TOGGLE SWITCH. THIS SWITCH WILL BE MOUNTED ON THE MOTOR HOUSING WITH AN APPROPRIATE ON-OFF PLACARD.

WIRING: THE WIRING WILL BE IN ACCORDANCE WITH THE WIRING DIAGRAM, FIGURE 7, ON THE FOLLOWING PAGE. THE WIRE USED WILL BE A RUBBER COATED TWO WIRE MULTI-STRANDED NO. 8 MOTOR LEAD WIRE.(16)

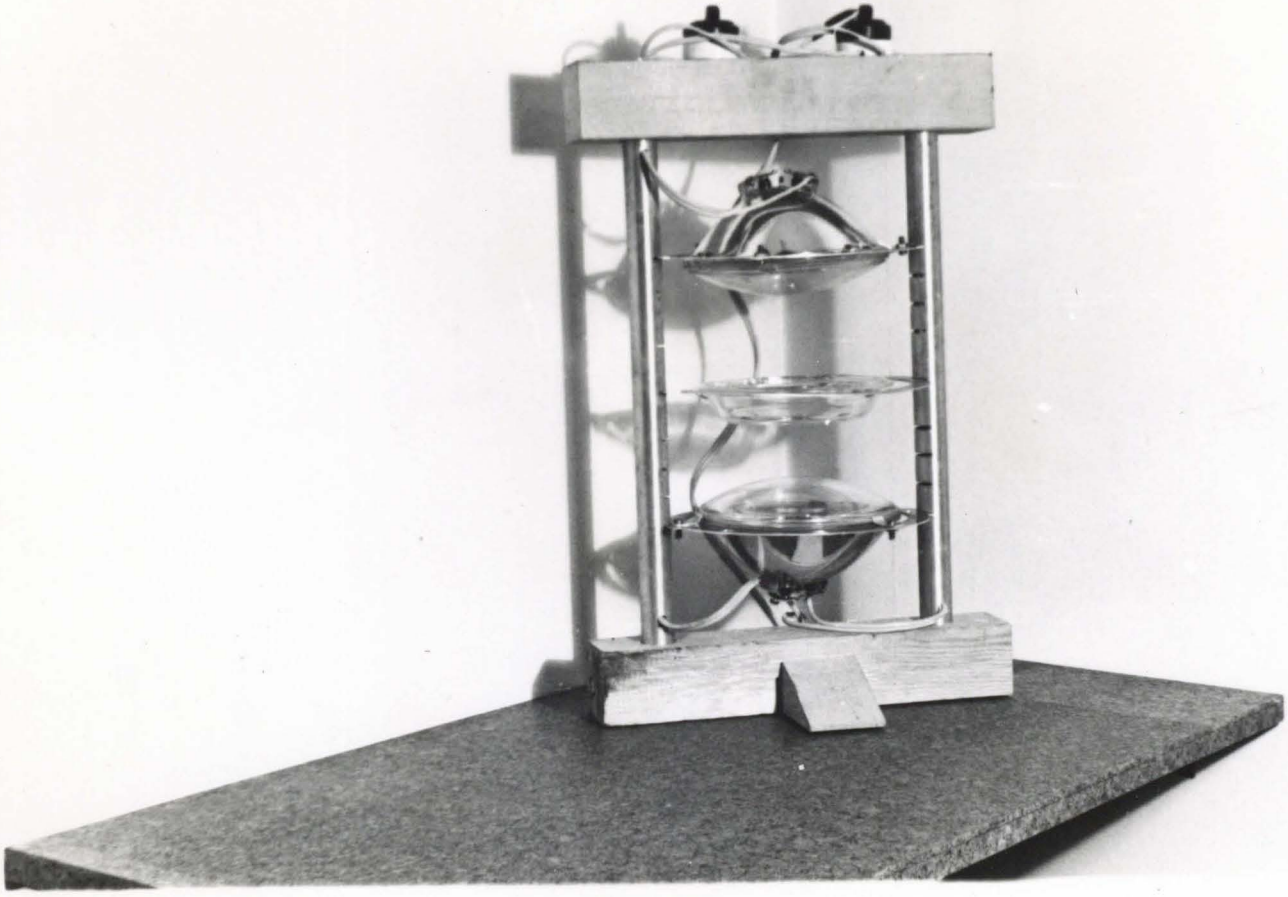


WIRING DIAGRAM

FIG. 7

FIG. 8

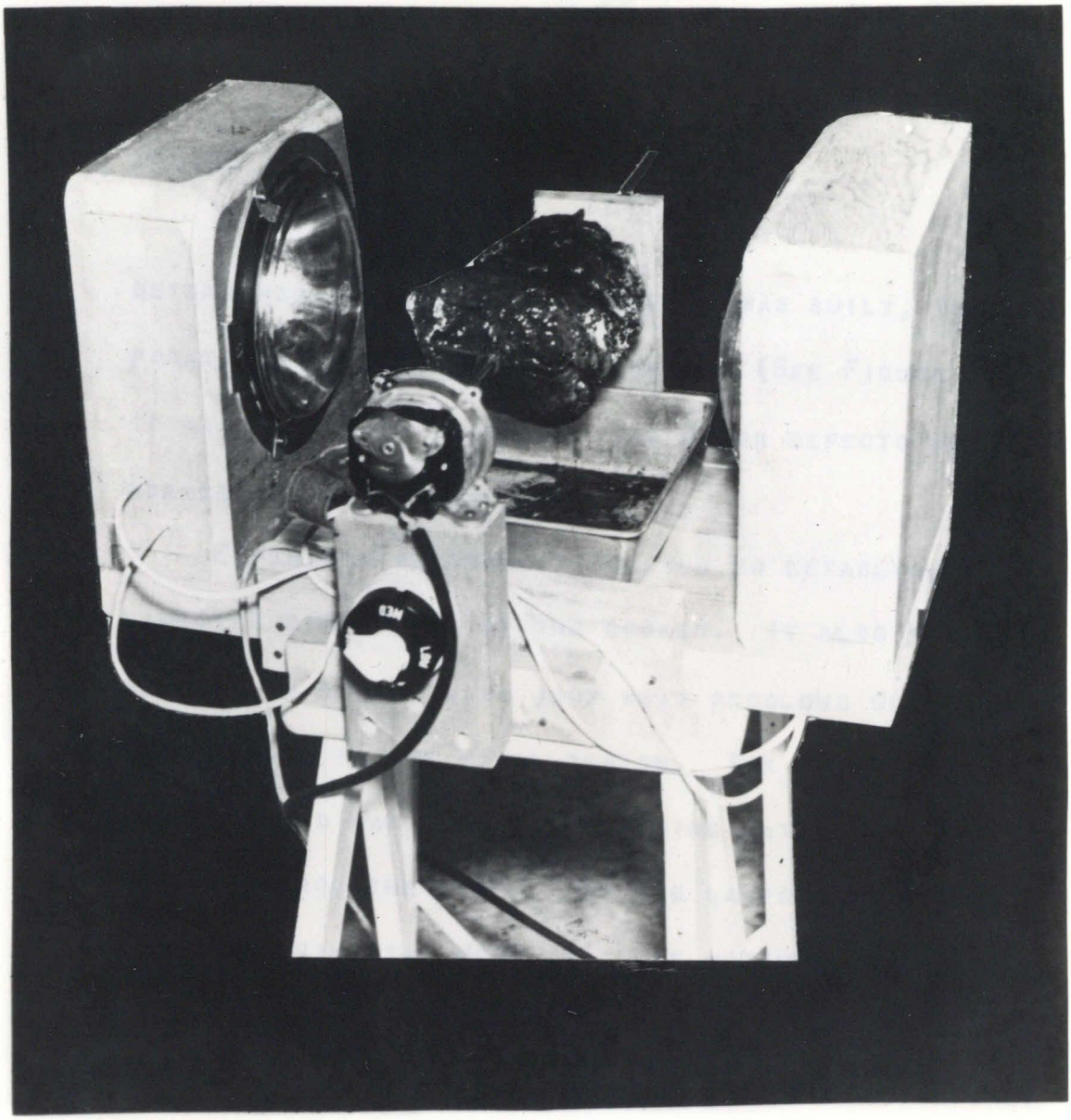
EXPERIMENTAL MODEL I



DESIGN

Arrangement of Components

With the major components of the unit selected, the actual detailed design was begun. Earlier sections of this report have stressed the fact that near infra-red is not absorbed by air or glass. This fact can be utilized successfully in the case design of the unit. Theoretically, if these facts are correct, there is no need to confine the heat of the lamps by an insulated shell. In fact, all that should be necessary is some sort of rack from which the lamps are hung. A mock-up of this type was made and tested. In this experimental model, No. 1, the lamps were hung on a tubular rack vertically, facing each other. (See figure 8) Food was placed in a pyrex dish between the lamps. The food cooked very rapidly, and the pyrex dish was cool at the end of the cooking period, indicating that most of the heat was absorbed by the food. Further testing established the optimum distance the lamps should be separated for general cooking. This was approximately twelve inches. With this distance



EXPERIMENTAL MODEL II

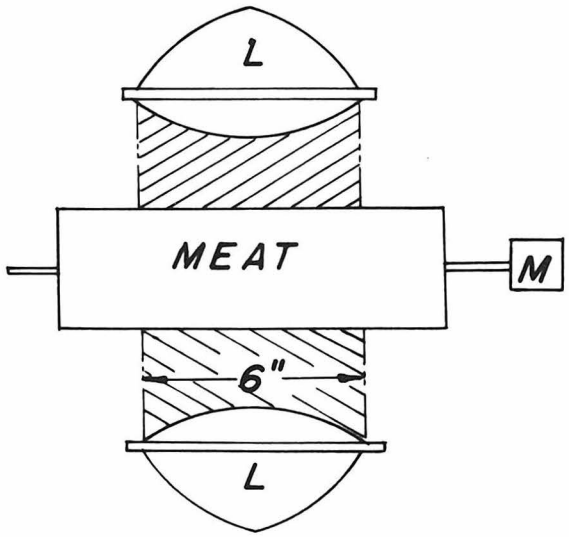
FIG. 9

DESIGN

DETERMINED, EXPERIMENTAL MODEL II WAS BUILT, INCORPORATING THE ROTATING SPIT FEATURE (SEE FIGURE 9). IT WAS WITH THIS UNIT THAT THE MAJOR DEFECTS WERE WORKED OUT OF THE DESIGN.

EXPERIMENTAL MODEL II SERVED TO ESTABLISH THE LIMITING DIMENSIONS OF THE COOKER. IT ALSO WAS HELPFUL IN DETERMINING JUST WHAT PROBLEMS WOULD BE ENCOUNTERED IN THE FINAL DESIGN. THE MAJOR PROBLEM TO BE SOLVED WAS THAT OF OBTAINING LATERAL SPREAD OF THE HEAT FROM THE LAMPS. IF THE LAMPS WERE PLACED AS IN EXPERIMENTAL MODEL II, THE MAXIMUM LATERAL SPREAD WOULD BE APPROXIMATELY SIX INCHES. IT IS OBVIOUS THAT SIX INCHES WOULD BE SUFFICIENT FOR ONLY A LIMITED NUMBER OF MEAT CUTS. DISCUSSIONS WITH BUTCHERS ESTABLISHED THE FACT THAT IF THE COOKER WERE TO BE AT ALL EFFECTIVE, THE COVERAGE WOULD HAVE TO BE AT LEAST TWELVE INCHES.

THERE WERE SEVERAL DESIGN ALTERNATIVES TO ALLEVIATE THIS SITUATION. THE LAMPS COULD BE PLACED AS IN THE EXPERIMENTAL MODEL II, SEE FIGURE 10, OR SIDE BY SIDE ON ONE SIDE OF THE MEAT AS SHOWN IN FIGURE 11.

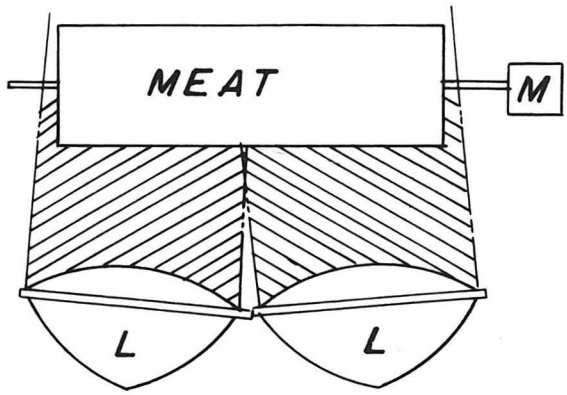


L = LAMP

M = MOTOR

SCHEMATIC – PLAN VIEW

FIG. 10



L = LAMP

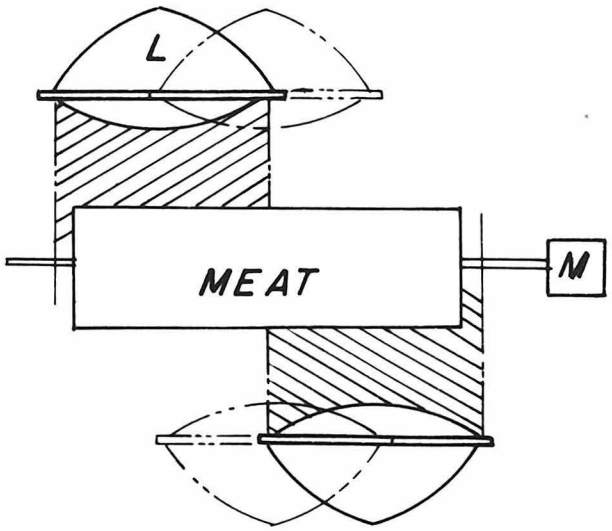
M = MOTOR

SCHEMATIC — PLAN VIEW

FIG. 11

L = LAMP

M = MOTOR



SCHEMATIC – PLAN VIEW

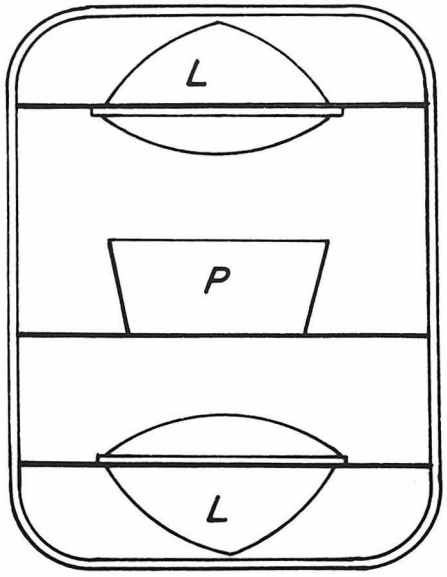
FIG. 12

DESIGN

ANOTHER POSSIBILITY WOULD BE TO PLACE THE LAMPS ACROSS FROM EACH OTHER AS IN EXPERIMENTAL MODEL II, BUT ADJUSTABLE LATERALLY AS IN FIGURE 12.

BEFORE DECIDING ON WHICH ARRANGEMENT TO USE, THE OTHER POSSIBLE FUNCTIONS OF THE STOVE HAD TO BE RECONSIDERED. IN ADDITION TO THE USE OF THE UNIT AS A BARBECUE, THE DESIGN REQUIREMENTS CALLED FOR THE ADDITIONAL FUNCTIONS OF BROILING, GRILLING, BOILING, AND BAKING. THE LAMPS HAD TO BE REARRANGED FOR THESE PROCESSES ELIMINATING THE USE OF THE MOTOR DRIVEN SPIT. SEVERAL ARRANGEMENTS WERE TRIED AND DISCARDED. IN EACH OF THE CASES, THE LAMPS HAD TO BE REMOVED FROM THE HOUSING AND ATTACHED IN SOME OTHER POSITION. THIS INVOLVED EXPENSIVE ELECTRICAL QUICK DISCONNECT EQUIPMENT AS WELL AS ADDITIONAL ATTACHMENT FIXTURES FOR EACH POSITION.

IN ORDER TO OVERCOME THESE DISADVANTAGES A SCHEME WAS DEVISED IN WHICH THE LAMPS REMAINED STATIONARY AND THE ENTIRE ASSEMBLY WAS ROTATED FOR THESE ADDITIONAL FUNCTIONS (SEE FIGURES 13 AND 14). THIS METHOD PROVED TO BE THE MOST SAT-



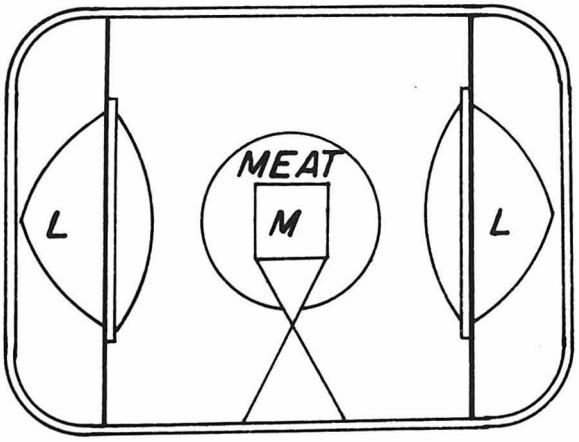
L = LAMP

P = PYREX DISH

SCHEMATIC — SIDE VIEW

VERTICAL POSITION

FIG. 13



L = LAMP

M = MOTOR

SCHEMATIC — SIDE VIEW

HORIZONTAL POSITION

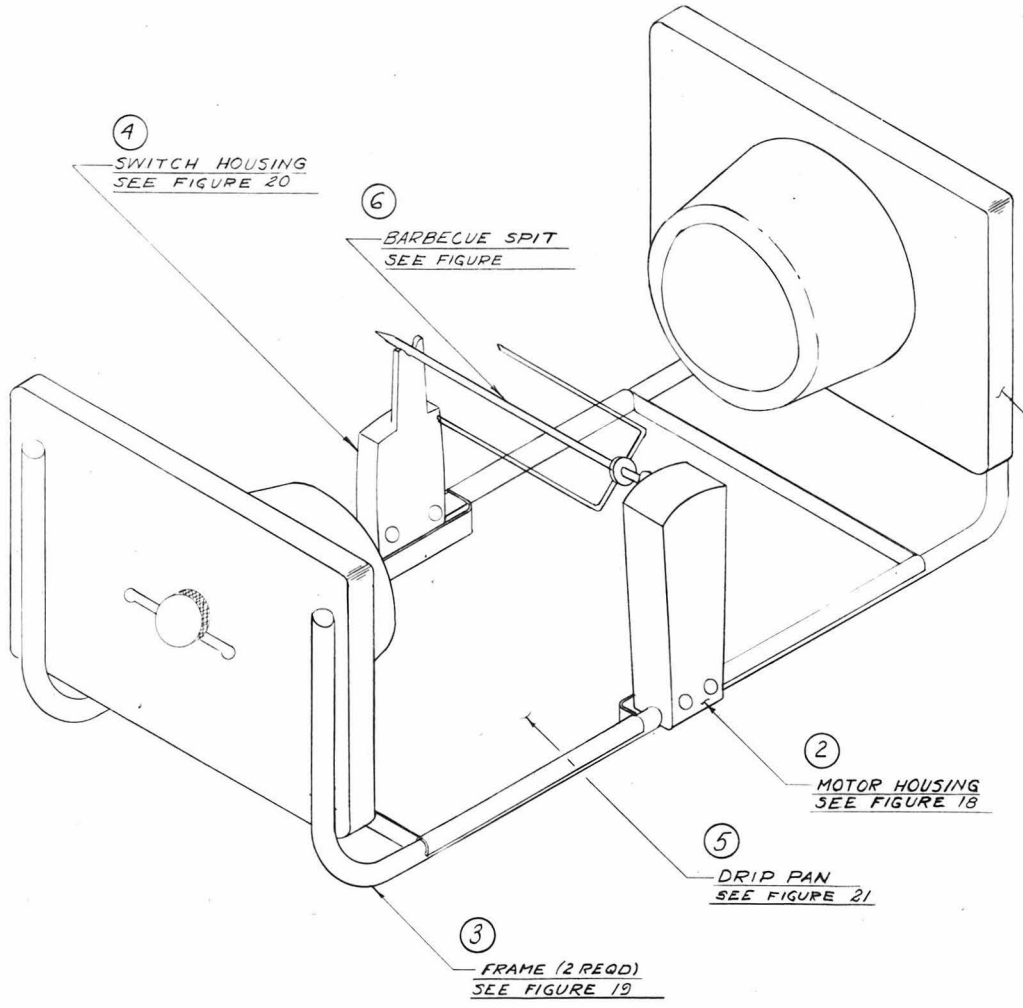
FIG. 14

DESIGN

ISFACTORY AS IT TOOK NO MECHANICAL SKILL ON THE PART OF THE OPERATOR AND MADE FOR THE MOST INEXPENSIVE TYPE OF INSTALLATION.

EXPERIMENTATION ON EXPERIMENTAL MODEL I PROVED THAT VERTICAL ARRANGEMENT OF THE LAMPS WAS IDEAL FOR THE COOKING FUNCTIONS OF BROILING, GRILLING, AND BOILING.

WITH THIS ARRANGEMENT OF THE LAMPS ESTABLISHED FOR BROILING, ETC., IT FOLLOWED THAT THE SYSTEM DEPICTED IN FIGURE 14 SHOULD BE USED WHEN THE UNIT WAS BEING UTILIZED FOR BARBECUING. LATERAL MOVEMENT OF THE LAMPS COULD BE ENGINEERED SIMPLY AND INEXPENSIVELY, AND ELIMINATED THE DISADVANTAGES OF REMOVAL OF THE LAMPS FROM THE HOUSING.



PART NO.	NAME	NO. RQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT

ALL DIMENSIONS IN INCHES
LIMIT ON DIMENSIONS — UNLESS OTHERWISE NOTED
ANGULAR ± ½°
FRACTIONAL ± 1/32
DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES

125 ROUGH MACHINE FINISH
250 SMOOTH MACHINE FINISH
40 ROUGH GRIND
16 FINISH GRIND
8 FINE GRIND, LAP
4 POLISH

FINISH

HEAT TREAT

CALIFORNIA INSTITUTE OF TECHNOLOGY

DRAWN BY R SCHWARZ
TRACED BY
CHECKED BY
APPROVED BY
DATE
SCALE 1/4
COURSE NO.
SECTION NO.
DWG. NO.

FIGURE 15

ISOMETRIC ~ ASSEMBLY

DESIGN

Construction Details

The details of the selected arrangement were studied with reference to production, costs, materials, and sales. In a design of this nature it is impossible to divide these factors and deal with them separately. Although low cost was of great importance, quality of materials, sales and aesthetic appeal had to be integrated in the design. As in most engineering and design problems, the final result is a compromise between the Utopitan solution and one which is practical and can be produced considering the design limitations of the project. The following text and photographs describe the best solution to the problem of construction bearing in mind that some compromises had to be made.

Figure 15 on the preceding page depicts the final design with a breakdown of the major parts. The parts are referenced by number and will be discussed in the next section.

Reference No. 1, Figure 15, the lamp housing assembly, consists of two sub-assemblies, the backing

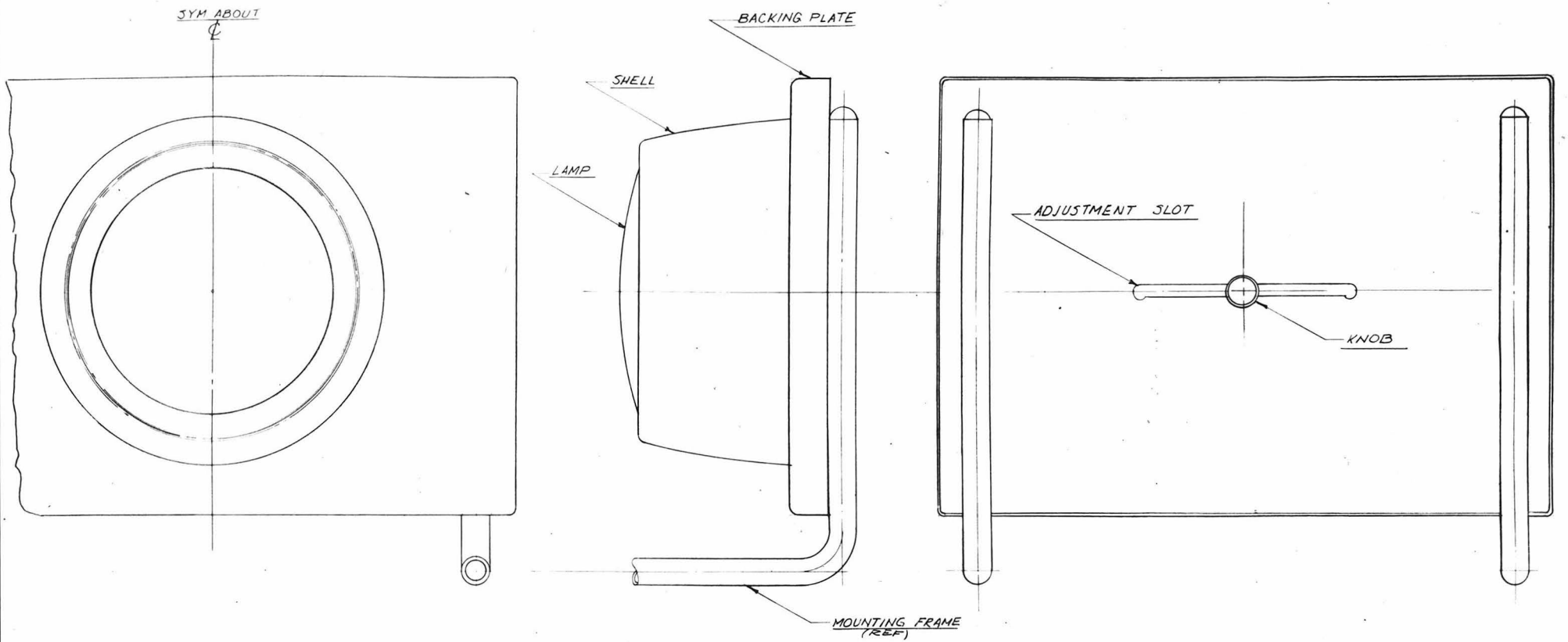


FIGURE 16

PART NO.	NAME	NO. RQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT

ALL DIMENSIONS IN INCHES
LIMIT ON DIMENSIONS — UNLESS OTHERWISE NOTED
ANGULAR ± ½°
FRACTIONAL ± 1/32
DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES

- 125 ROUGH MACHINE FINISH
- 125 SMOOTH MACHINE FINISH
- 40 ROUGH GRIND
- 16 FINISH GRIND
- 2 FINE GRIND, LAP
- ¼ POLISH

FINISH

HEAT TREAT

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ASSY.-LAMP HOUSING

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COURSE NO.
SECTION NO.
DWG. NO.

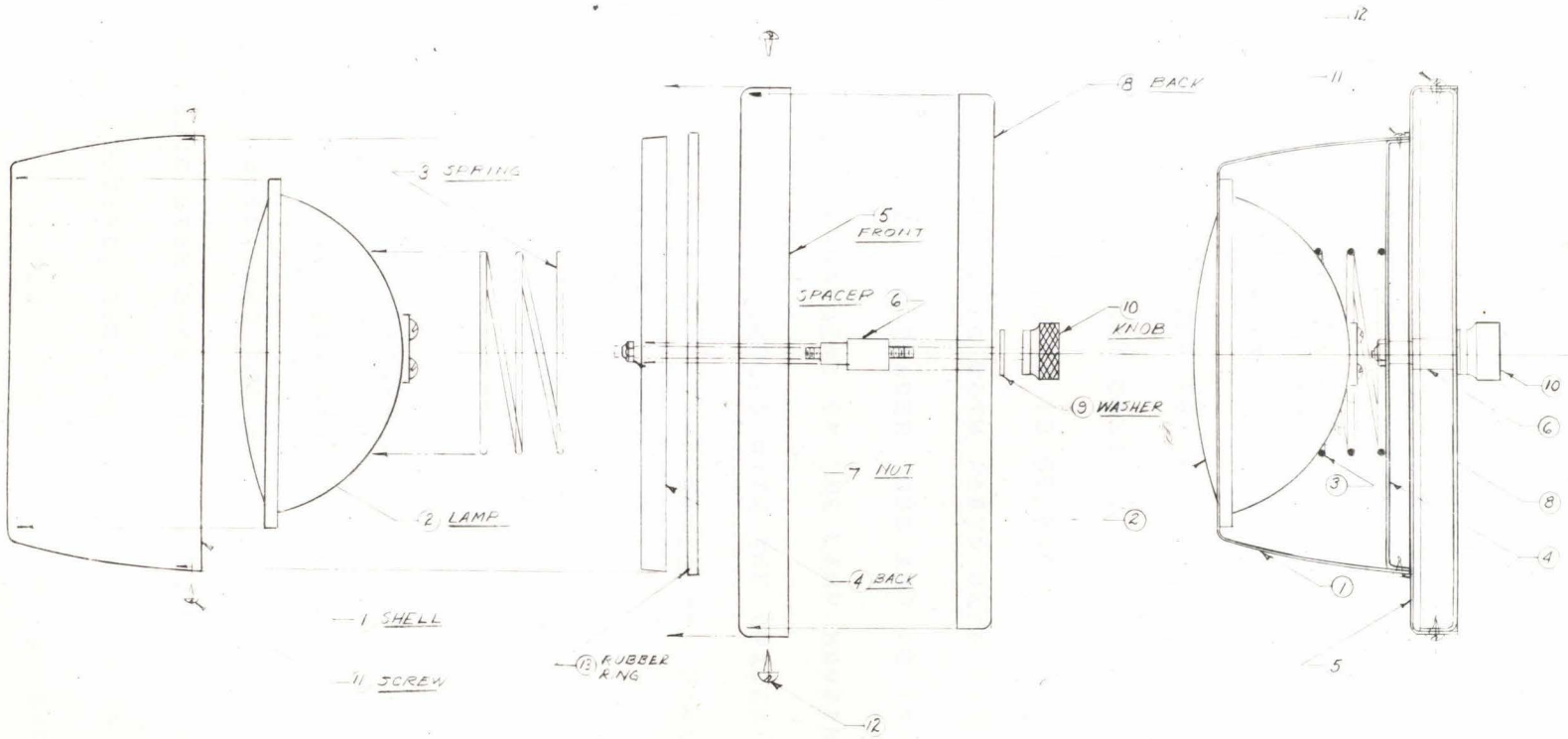

FIGURE 17

PART NO.	NAME	NO. REQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT

ALL DIMENSIONS IN INCHES — ANGULAR ± ½°
LIMIT ON DIMENSIONS — FRACTIONAL ± 1/32
UNLESS OTHERWISE NOTED — DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES
125 ROUGH MACHINE FINISH
125 SMOOTH MACHINE FINISH
40 ROUGH GRIND
16 FINISH GRIND
2 FINE GRIND, LAP
½ POLISH

FINISH

HEAT TREAT

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EXPLODED VIEW - LAMP HOUSING

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SECTION NO.
DWG. NO.

DESIGN

PLATE, AND THE LAMP HOUSING. FOR DETAILS OF THE CONSTRUCTION OF THESE PARTS, SEE FIGURES 16 AND 17.

THE BACKING PLATE CONSISTS OF THREE PARTS, THE BACK, THE FRONT, AND A SPACER TUBE. THE BACK AND FRONT ARE DRAWN PARTS AND ARE CONSTRUCTED FROM ENAMELING IRON AS THESE PARTS HAVE TO BE PORCELAIN ENAMELLED. A SLOT IS STAMPED IN BOTH PARTS BEFORE DRAWING. THIS SLOT ACCOMMODATES THE SPACER TUBE AND IS INCORPORATED FOR LATERAL ADJUSTMENT OF THE LAMP HOUSING. THE FRONT AND BACK ARE ASSEMBLED WITH THE SPACER TUBE IN PLACE AND JIG DRILLED ALONG THE EDGES FOR PARKER KALON SELF TAPPING SCREWS.

THE LAMP HOUSING CONSISTS OF FOUR PARTS: THE LAMP, THE SHELL, THE RETAINING SPRING, AND THE BACK. THE SHELL IS DEEP DRAWN FROM SIXTEEN GAUGE COPPER AND THEN IS CHROMIUM PLATED. THE RETAINING SPRING IS FORMED FROM SPRING STEEL WIRE, AND THE BACK IS A SHALLOW DRAWN SIXTEEN GAUGE DISH MADE FROM 1020 MILD STEEL. TO ASSEMBLE THE HOUSING, THE LAMP IS INSERTED IN THE SHELL, AND THE BACKING PLATE IS PLACED IN THE BACK OF THE SHELL WITH THE SPRING BEARING AGAINST THE

DESIGN

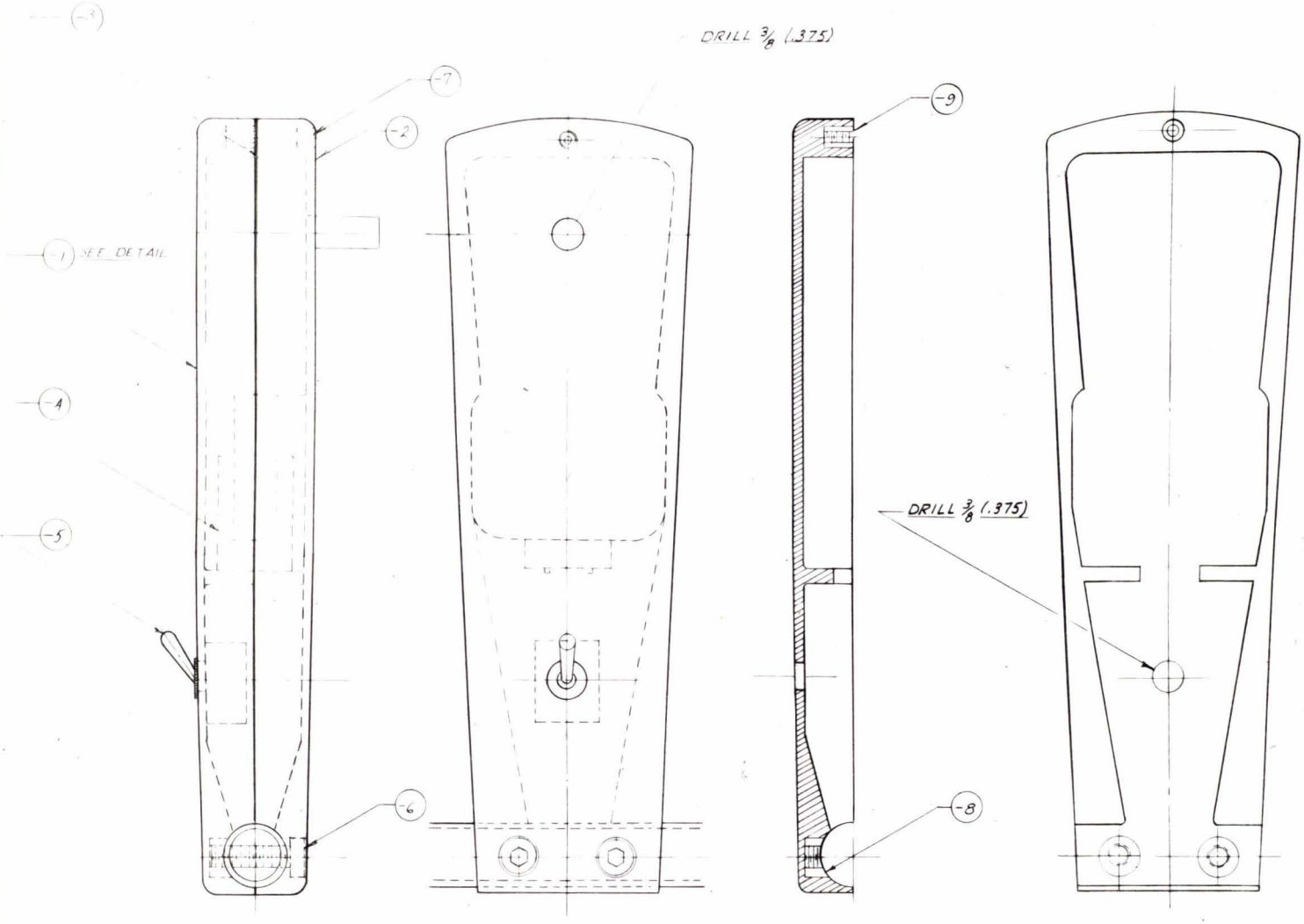
BACK OF THE LAMP HOLDING IT IN PLACE. THE BACK IS THEN SECURED TO THE SHELL BY PARKER KALON SELF TAPPING SCREWS.

REFERENCE NO. 2, FIGURE 15, IS THE MOTOR HOUSING. THE BACK AND FRONT ARE ALUMINUM DIE CAST PARTS AND HOUSE THE MOTOR UNIT AND SWITCH. THE ALUMINUM DIE CAST PARTS ARE FINISHED IN WHITE BAKED ENAMEL. SEE FIGURE 18 FOR DETAILS ON THIS ASSEMBLY.

REFERENCE NO. 3, FIGURE 15, THE MOUNTING FRAME, IS MADE FROM 3/4 INCH OUTSIDE DIAMETER, .060 WALL, 1020 SEAMLESS STEEL TUBE, FURNITURE GRADE. SEE FIGURE 19 FOR DETAILS. TWO FRAMES ARE REQUIRED PER ASSEMBLY.

REFERENCE NO. 4, FIGURE 15, IS THE SWITCH HOUSING. THE CONSTRUCTION OF THIS PART IS SIMILAR TO REFERENCE NO. 2. THE BACK AND FRONT ARE ALUMINUM DIE CASTINGS WHICH HOUSE THE HEATER SWITCH. SEE FIGURE 20 FOR DETAILS.

REFERENCE NO. 5, FIGURE 15, IS A STAINLESS



DETAIL -1

NOTES
(1) -1 & 2 IDENTICAL DIE CAST PARTS - REWORKED FOR ASSY.

PART NO.	NAME	NO. RQD	MATERIAL DESC.	MATERIAL SPEC	WEIGHT
-9	INSERT	1	STEEL	FOR 10-32 THD	
-8	INSERT	1	STEEL	FOR 1/4-28 TH	
-7	SCREW	1	STEEL	10-32 THD.	
-6	SCREW	1	STEEL	1/4-28 THD	
-5	TOGGLE SW.	1	SPST - G.E. Co		
-4	MOTOR (EMC)	1	ELEC. MOTOR CORP # 300		
-3	GASKET	1	NEOPRENE	.032 THK	
-2	BACK	1	MAKE FROM -1		
-1	FRONT	1	DIE CAST	ALUM. ALL	

ALL DIMENSIONS IN INCHES
LIMIT ON DIMENSIONS — UNLESS OTHERWISE NOTED
ANGULAR ± ½°
FRACTIONAL ± 1/32
DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES
125 ROUGH MACHINE FINISH
63 SMOOTH MACHINE FINISH
250 ROUGH GRIND
16 FINISH GRIND
8 FINE GRIND, LAP
4 POLISH

FINISH: 1 & 2 BAKED ENAM.

HEAT TREAT

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ASSY. - MOTOR HOUSING

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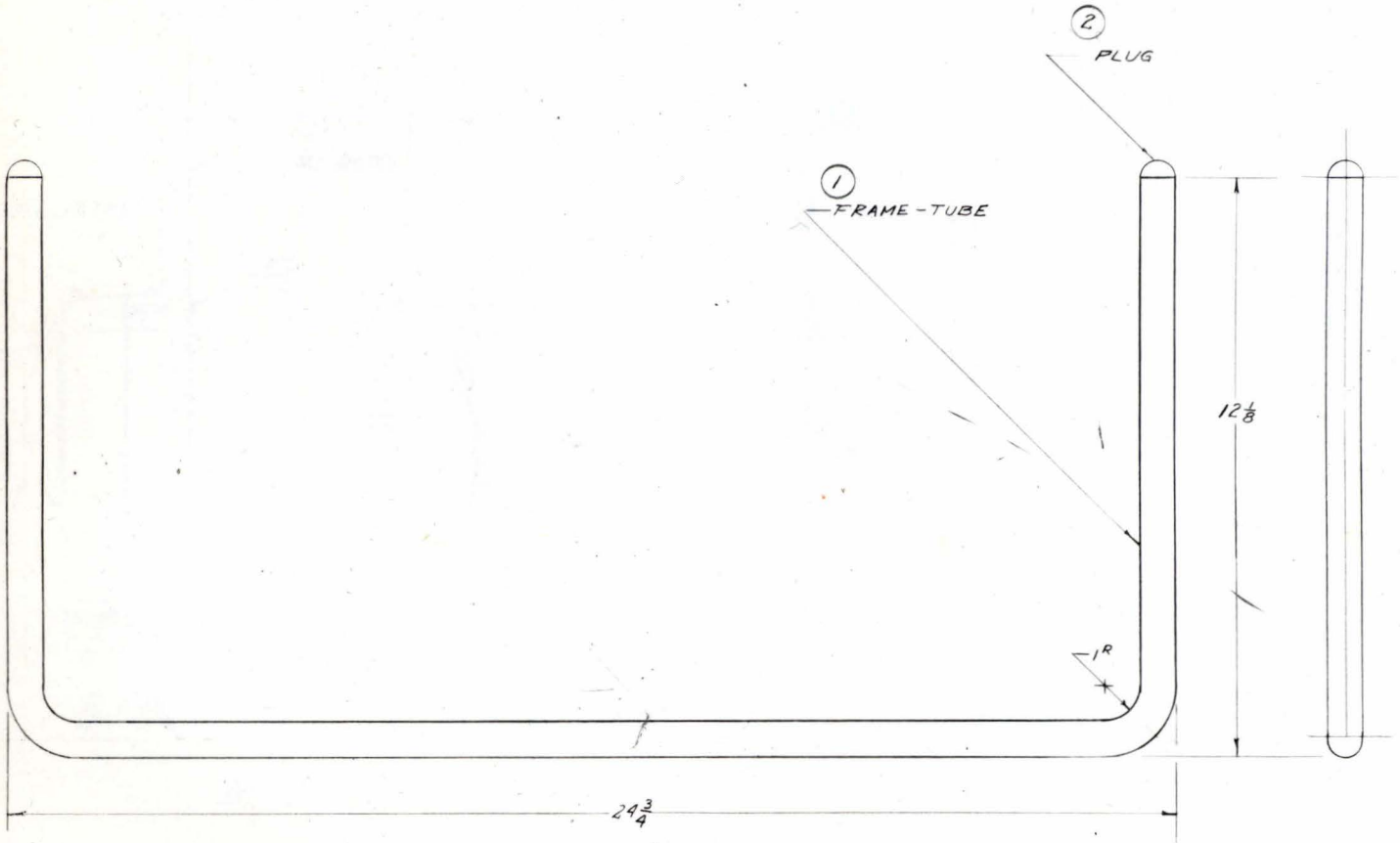
SCALE FULL
COURSE NO.
SECTION NO.
DWG. NO.

FIGURE 18



PART NO.	NAME	NO. REQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT
2	PLUG	2	1020 STL		
1	FRAME - TUBE	1	1020 STL	.060 WALL	

ALL DIMENSIONS IN INCHES — ANGULAR ± ½°
LIMIT ON DIMENSIONS — FRACTIONAL ± 1/32
UNLESS OTHERWISE NOTED — DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES

125 ROUGH MACHINE FINISH
125 SMOOTH MACHINE FINISH
250 ROUGH GRIND
125 FINISH GRIND
63 FINE GRIND, LAP
16 POLISH

FINISH: CHROM. PLATE

HEAT TREAT

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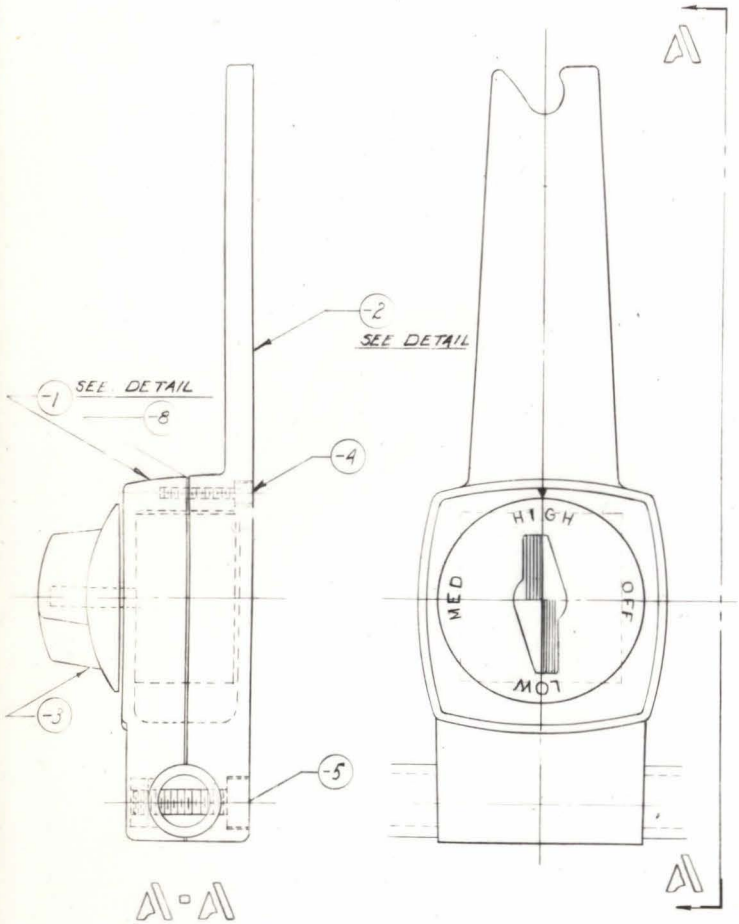
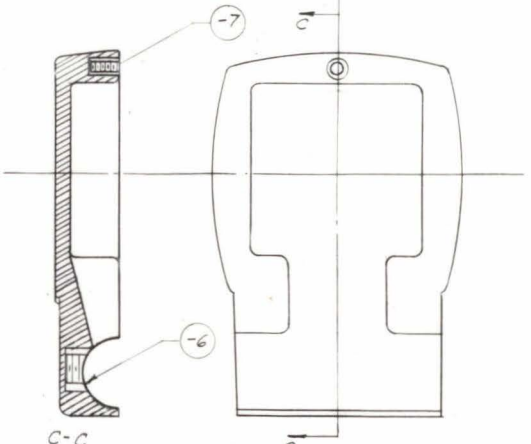
FRAME (2 REQD)

DRAWN BY
TRACED BY
CHECKED BY
APPROVED BY
DATE
SCALE
COURSE NO.
DWG. NO.
SECTION NO.

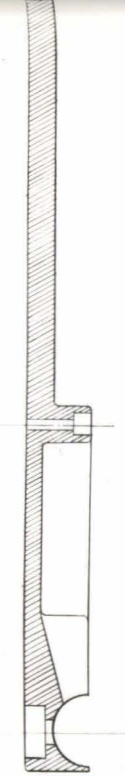
FIGURE 19

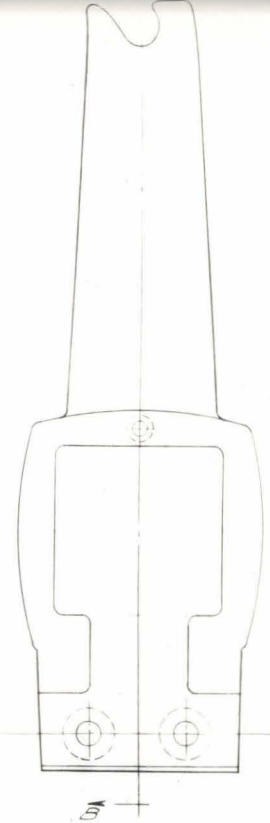


ASSEMBLY



DETAIL -1





DETAIL - 2

PART NO.	NAME	NO. RQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT
-8	GASKET	1	NEOPRENE	.032 TH	
-7	INSERT	1	STEEL	FOR 10-32 THD	
-6	INSERT	1	STEEL	FOR 1/4-28 THD	
-5	SCREW	2	STEEL	1/4-28 x 1 1/4 L.	
-4	SCREW	1	STEEL	10-32 x 1 1/4 L.	
-3	SWITCH	1	No 70241-1	ARROW	
-2	BACK	1	ALUM. ALLOY	DIE CAST.	
-1	FRONT	1	ALUM. ALLOY	DIE CAST.	

ALL DIMENSIONS IN INCHES
LIMIT ON DIMENSIONS — UNLESS OTHERWISE NOTED
ANGULAR ± ½°
FRACTIONAL ± 1/32
DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES
125 ROUGH MACHINE FINISH
63 SMOOTH MACHINE FINISH
250 ROUGH GRIND
32 FINISH GRIND
16 FINE GRIND, LAP
8 POLISH

FINISH: -1 & -2 BAKED ENAM.

HEAT TREAT

CALIFORNIA INSTITUTE OF TECHNOLOGY

ASSY.- SWITCH HOUSING

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TRACED BY
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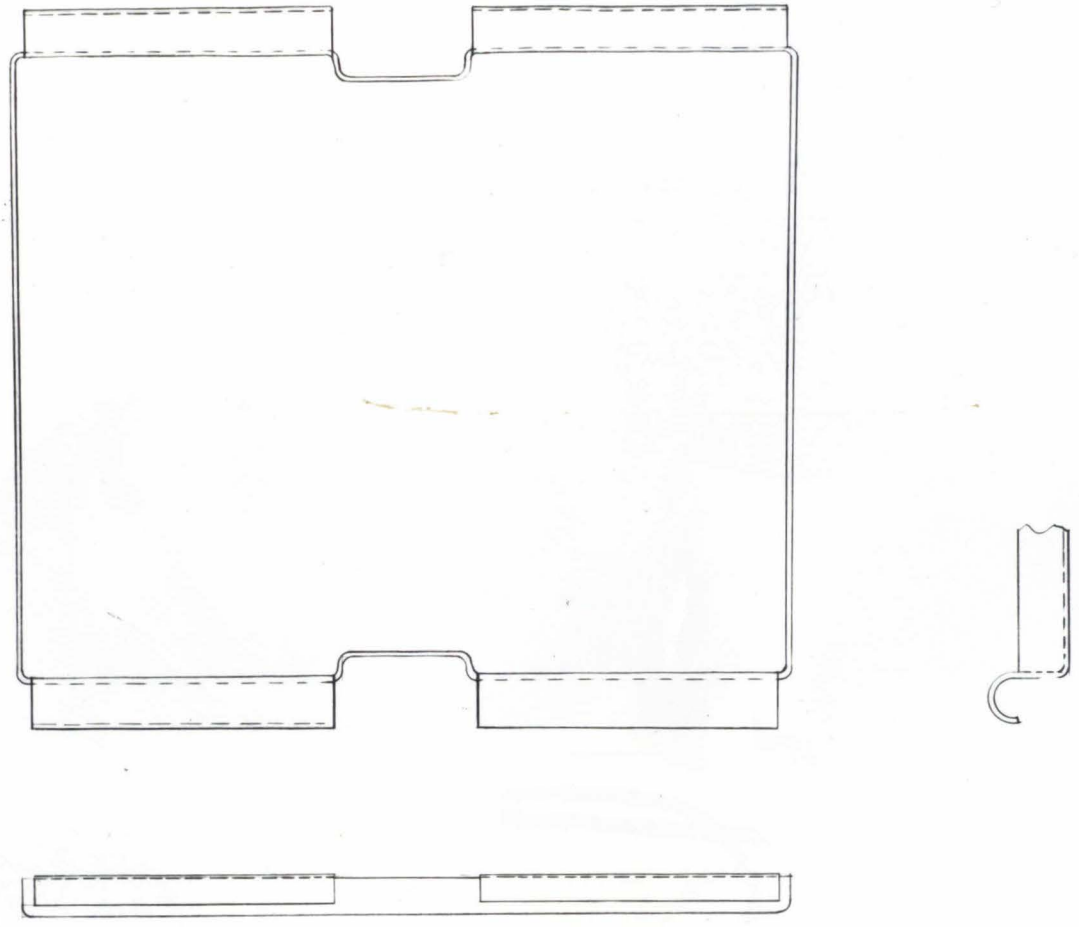
DATE
SCALE
COURSE NO.
SECTION NO.
DWG. NO.

FIGURE 20

DESIGN

STEEL REFLECTOR DRIP PAN. THE PAN IS FABRICATED FROM .062, 18-8 STAINLESS STEEL SHEET. SEE FIGURE 21.

FOR ASSEMBLY DETAILS OF ALL COMPONENTS SEE DRAWINGS IN THE APPENDIX, PAGE 97.



PART NO.	NAME	NO. RQD.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT
1	PAN	1	.020 THICK	MILD STEEL	

ALL DIMENSIONS IN INCHES
LIMIT ON DIMENSIONS — UNLESS OTHERWISE NOTED
ANGULAR ± ½°
FRACTIONAL ± 1/32
DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES
125 ROUGH MACHINE FINISH
63 SMOOTH MACHINE FINISH
40 ROUGH GRIND
32 FINISH GRIND
16 FINE GRIND, LAP
8 POLISH

FINISH: CHROM. PLATE

HEAT TREAT:

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DRIP PAN

DRAWN BY R. Schwarze Jr.
TRACED BY
CHECKED BY
APPROVED BY
DATE
SCALE
COURSE NO.
SECTION NO.
DWG. NO.

FIGURE 21

COMPONENTS FOR LAMP HOUSING ASSEMBLY

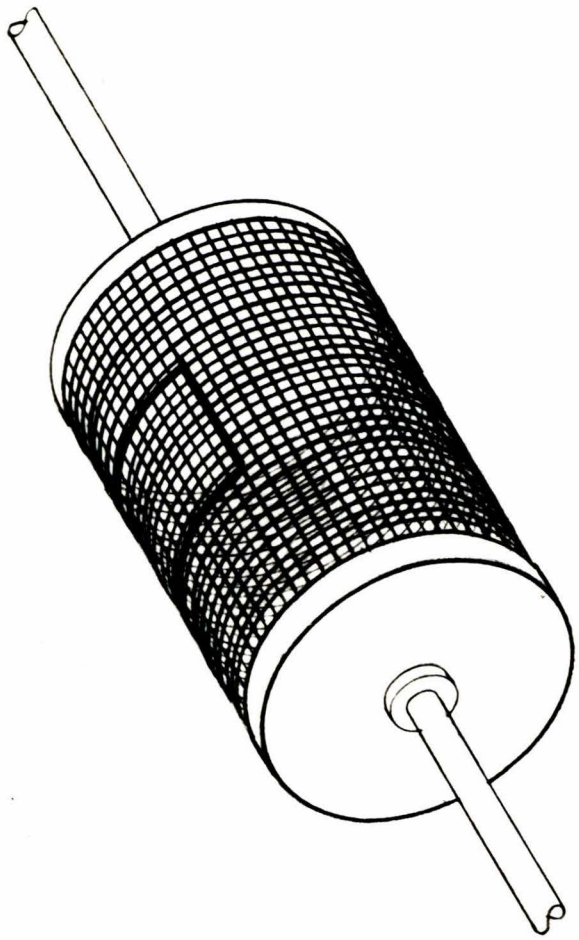
FIG. 22

DESIGN

ACCESSORIES

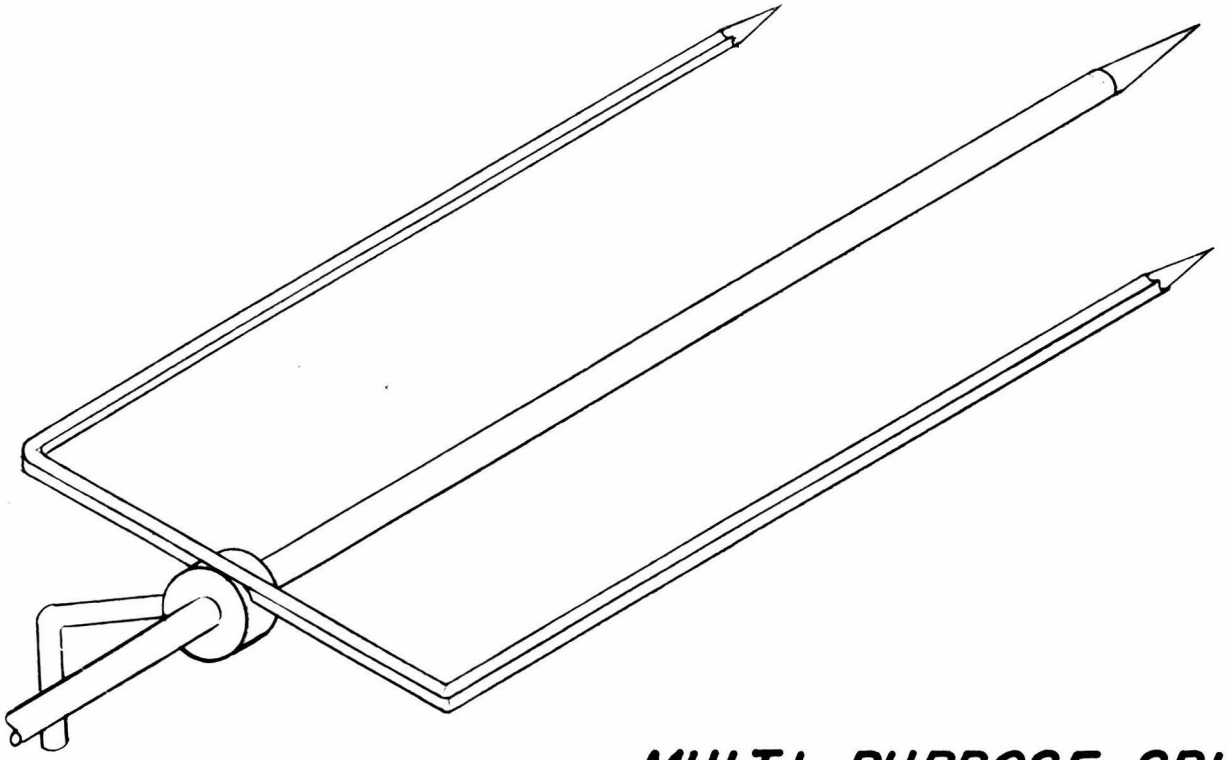
THE FOLLOWING SECTION INCLUDES SKETCHES OF ACCESSORIES WHICH MIGHT BE MERCHANDIZED WITH THE INDOOR BARBECUE UNIT.

1. CORN POPPER
2. MULTI-PURPOSE SPIT
3. POTATO ROASTER
4. GRILL RACK
5. ROTATING STEAK GRILL



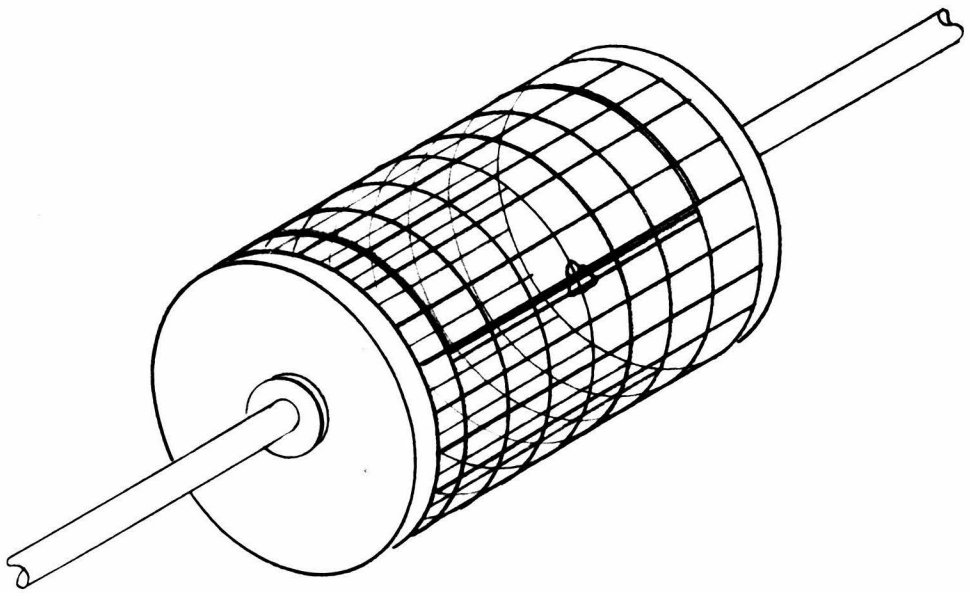
CORN POPPER

FIG. 23



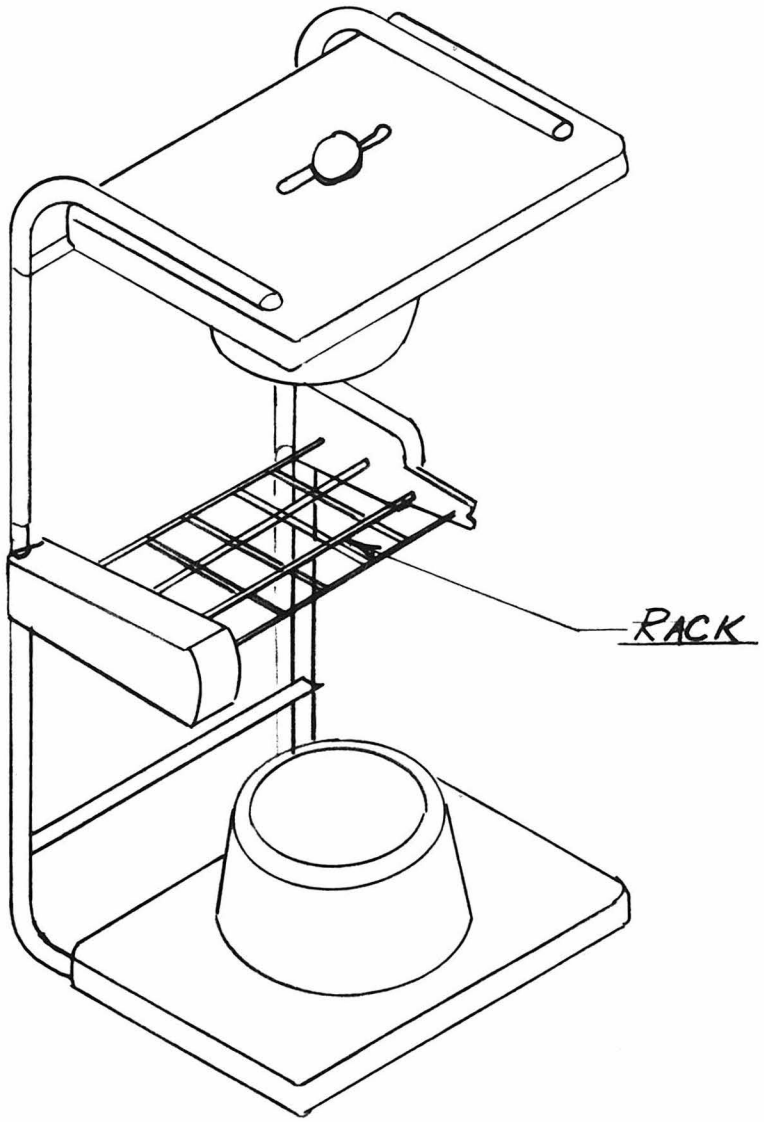
MULTI-PURPOSE SPIT

FIG. 24



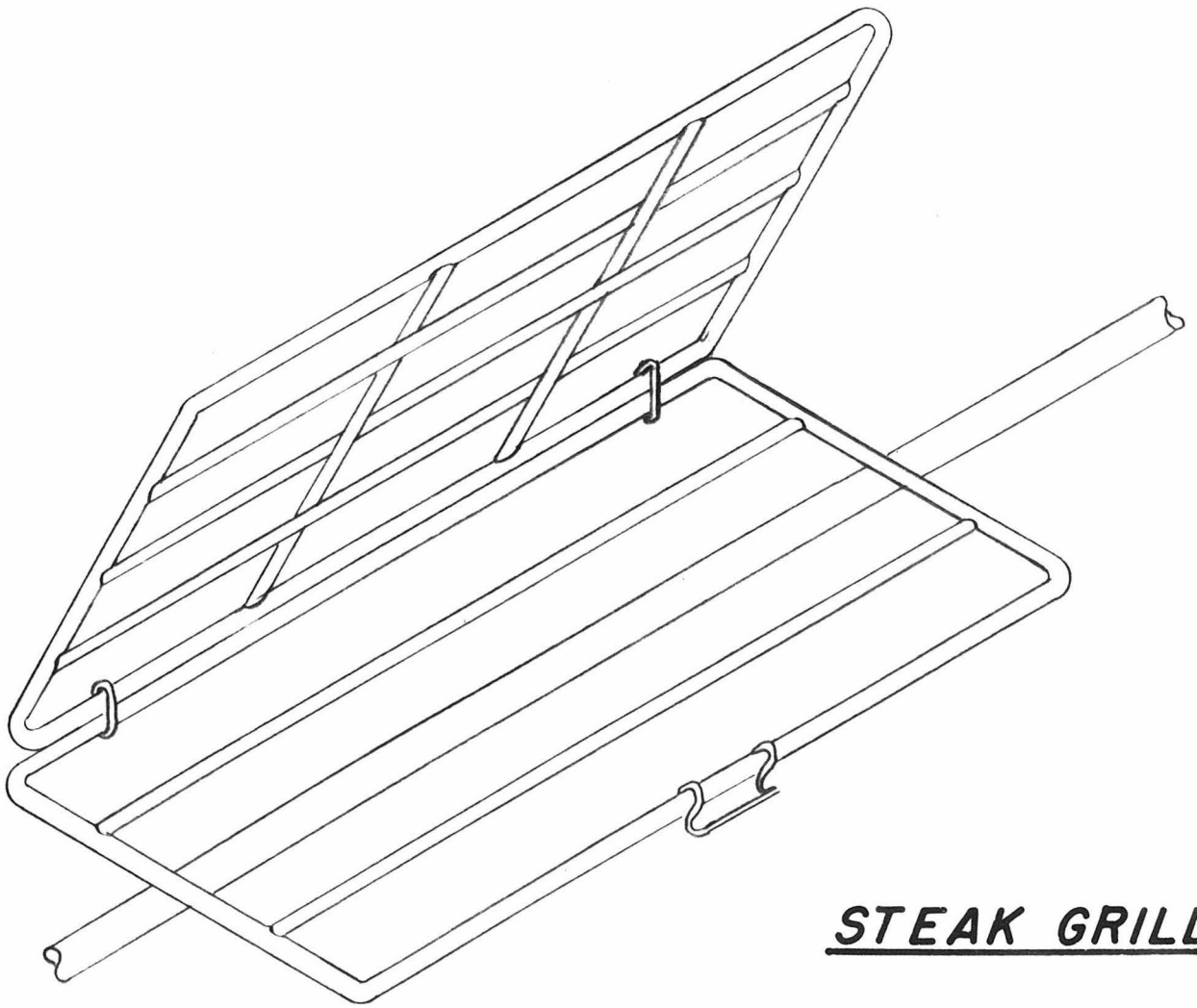
POTATO BASKET

FIG. 25



GRILL RACK

FIG.26



STEAK GRILL

FIG 27

DESIGN

Conclusions

An indoor barbecue cooker has been designed which meets the rigid requirements of manufacturers, distributors, retailers, and above all, the consumer.

For the manufacturer it opens up a new field in cooking appliances. It is especially advantageous to a manufacturer because of the low tooling costs and low assembly and labor costs.

Distributors and retailers will be anxious to handle the item because it is a new and fresh idea in the cooking appliance field and there is a demand for such an item. Distributors will find that if it is demonstrated, it will sell itself.

The consumer, for whom the unit was designed, will appreciate it because of its many advantages. Some of these are as follows:

1. Rapid cooking without excessive shrinkage.
2. No oven preheating; when you turn on the lamps, the food begins to cook.
3. Lightweight, portable design allows for use in many applications.

DESIGN

4. Flexibility of design makes any cooking task simple.
5. Delicious crusted meats can be cooked with all of the nutritious juices sealed in.
6. Clean barbecuing indoors.
7. A sanitary, easy to clean stove, with no grimy pots to wash when cooking foods in cellophane.
8. Rich, attractive appearance with gleaming chromium and porcelain enamel.
9. Efficient cooking from both sides; no need to turn foods over.

In conclusion, it is important to note that in the process of investigation many additional uses for infra-red baking lamps in cooking were discovered. The field is very new, and offers vast opportunities for investigation and experimentation. The applications for commercial appliances for baking and roasting are especially inviting since the initial cost of the cooking equipment is low, and the advantages of rapid cooking are very important to restaurants and

DESIGN

INSTITUTIONS. IN ADDITION, THE QUALITY OF COOKING IS UNIFORMLY GOOD BECAUSE OF THE CLOSE CONTROL OF TEMPERATURES, AND THE EASY ACCESS TO FOODS WHILE IN PROCESS.

IT IS BELIEVED THAT RESEARCH IN THE FIELD OF COMMERCIAL COOKING APPLIANCES UTILIZING THE INFRA-RED BAKING LAMP AS A HEAT SOURCE WOULD BE HIGHLY REWARDING.

APPENDIX

References

1. Discussions with the following organizations indicated that the approximate saturation point for the oven roaster market is approximately 350,000 units per annum. Estimates of existing production indicated that the saturation point has been reached.

   Reference data was received from:

   A. Los Angeles Times
   B. Los Angeles County Planning Board
   C. Westinghouse Corporation
   D. Gough Industries, Ltd.

2. Home economists referred to were:

   A. Agnes Fay Morgan, Ph.D., Professor of Home Economics, University of California, Berkeley.

   B. Ruth Okey, Ph.D., Professor of Home Economics, University of California, Berkeley.

3. C. E. Egeler, "Infrared Lamps in Industry," Bulletin LD-16, (General Electric, Engineering Division, Lamp Department, February, 1947).

   "Longer wavelength infrared, termed 'far' infrared, is absorbed by many materials which are transparent to visible light and 'near' infrared (infrared energy near the visible light spectrum), including glass, water, and air....With the heat sources emitting a major portion of their output at low temperatures much of the radiation will be absorbed immediately by the air and will never reach the work as radiant energy. However, if the design of the equipment permits control of this heated air, some of the energy may reach the work as convected heat."

APPENDIX

4. BUYERS CONTACTED WERE FROM THE FOLLOWING STORES:

   A. SEARS ROEBUCK CO.
   B. THE MAY CO.
   C. THRIFTY DRUG STORES, INC.

   CONCLUSIONS RESULTING FROM INTERVIEWS FOLLOW:

   A. THE UNIT SHOULD BE HIGHLY SUCCESSFUL IF PRESENTED TO THE PUBLIC PROPERLY. THE IDEA IS NEW AND FRESH AND WILL FILL A DEMAND.

   B. THE PRICE SHOULD BE ABOUT $75.00 TO REACH A MASS MARKET.

   C. ADVANTAGES SHOULD BE OBVIOUS TO THE CONSUMER AND SHOULD BE EASY TO DEMONSTRATE.

   D. THE UNIT SHOULD BE SHIPPED AND STORED KNOCKED DOWN AND SHOULD BE EASY TO ASSEMBLE.

   E. SINCE THE USE OF BAKING LAMPS FOR BARBECUING FOODS IS A REVOLUTIONARY IDEA AND WILL MEET SOME CONSUMER RESISTANCE, ALL EFFORTS SHOULD BE MADE TO MAINTAIN CONVENTIONAL KITCHEN COLOR SCHEMES; SUGGESTED COLORS ARE WHITE AND GREY.

   F. AN EXTENSIVE PROMOTIONAL CAMPAIGN WILL BE REQUIRED WHICH SHOULD INCLUDE DEMONSTRATIONS OF THE UNIT IN OPERATION.

5. INDIRECT COMPETITION CONSISTS OF:

   A. WESTINGHOUSE OVEN ROASTER
   B. NESCO OVEN ROASTER
   C. GENERAL ELECTRIC OVEN ROASTER
   D. GILL ELECTRIC STOVE
   E. EVERHOT OVEN ROASTER

APPENDIX

6. Detailed study of the Westinghouse Oven Roaster revealed the following:

The Westinghouse Oven-Roaster, Model No. RD-414, is averagely priced in the field. With the grill accessory, the unit costs $49.50. After cooking all types of food with the Westinghouse unit, the following advantages and disadvantages were noted:

Advantages:

A. It is possible to cook an entire meal at one time. Meat, potatoes, and vegetables can be cooked at one time in separate dishes.

B. Thermostatic control allows the cook to be independent of the task of cooking once the food is in the cooker.

C. Basting is unnecessary and a glass inspection window allows the cook to watch the foods without lifting the lid and losing heat.

D. Well insulated case keeps the kitchen cool and efficiently utilizes the heat energy.

E. Broiler grid allows for both grilling and frying.

F. Good design makes for easy cleaning and attractive appearance.

G. Time temperature chart for cooking foods is attached to the unit. It is very conveniently located, and saves reference to a more remote guide.

APPENDIX

DISADVANTAGES:

A. HANDLE DESIGN IS POOR. IT DOES NOT LOCK TO THE FRAME OF THE COOKER AS CLAIMED BY THE MANUFACTURER IN THE INSTRUCTION BOOK.

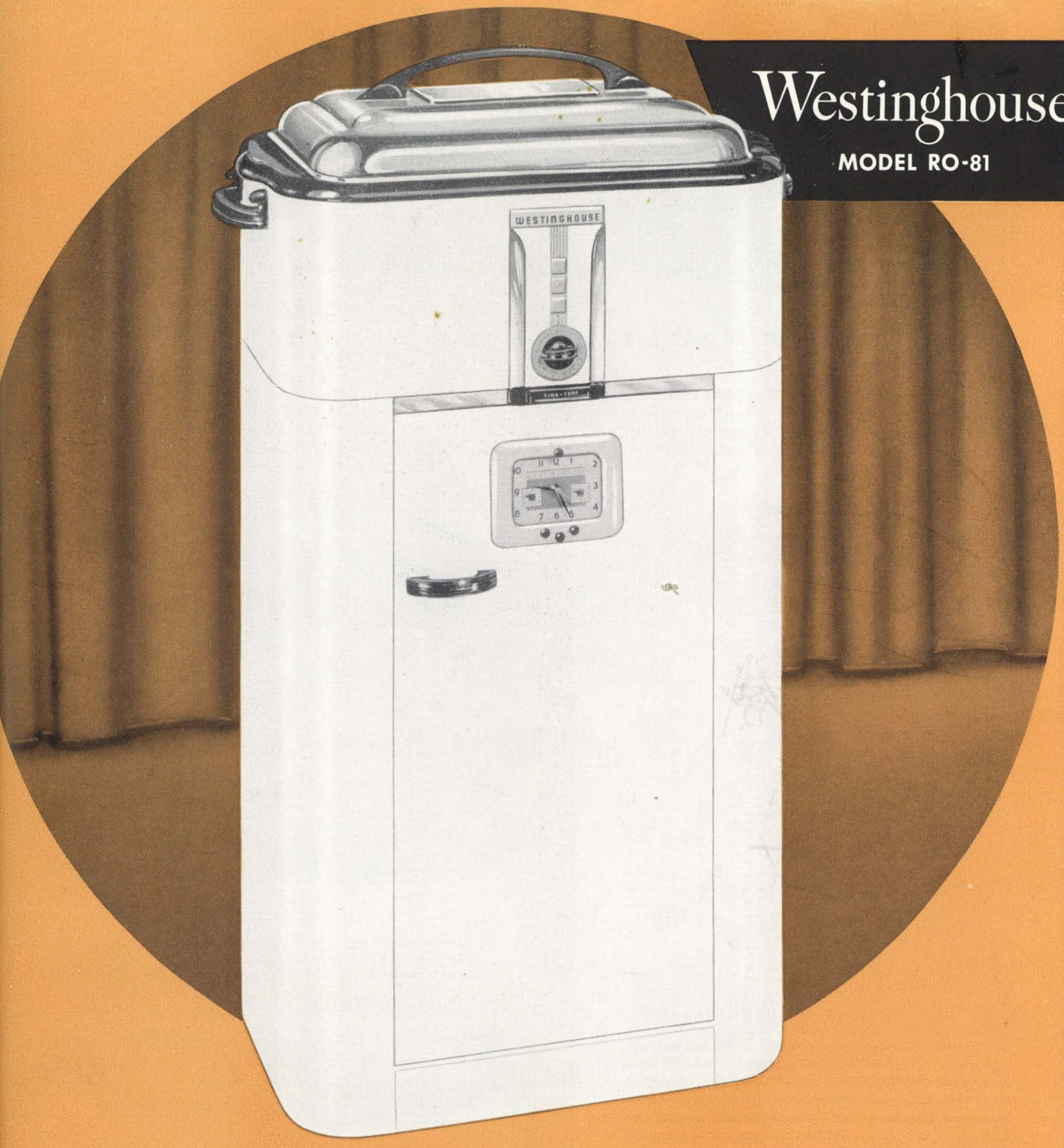
B. UNIT IS HEAVIER THAN NEED BE, AND IS NOT EASILY PORTABLE.

C. TIME TEMPERATURE CHART IS HIGHLY INACCURATE. COOKING TIMES ARE ACTUALLY AS MUCH AS 60% GREATER THAN AS INDICATED ON THE COOKING CHART.

TO SUMMARIZE, THIS UNIT IS WELL DESIGNED IN MOST RESPECTS. THE MAJOR DISADVANTAGE, LONG COOKING TIME, IS PARTIALLY ALLEVIATED BY THE FACT THAT FOODS BEING COOKED DO NOT REQUIRE WATCHING AND BASTING. THE COOK, THEREFORE, IS NOT SUBSERVIENT TO THE TASK OF COOKING.

Westinghouse

MODEL RO-81



Westinghouse *Roaster-Oven*

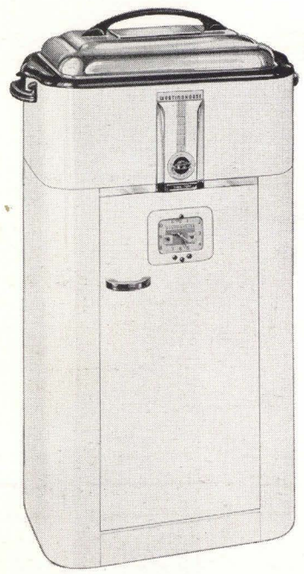
Thousands of satisfied users have an affection for the Westinghouse *Roaster-Oven* that surpasses their enthusiasm for any other electric kitchen appliance. No wonder! It gives virtually all the advantages of modern electric cooking at minimum cost . . . cleanliness, coolness, time saving, economy and complete oven meals. Capacity for 8 to 10 persons all at one time. More than that, roaster cooking is a *superior* form of cooking.

Why? Because the heating elements which are buried *within* all four walls and bottom of the Roaster-Oven, deliver *even* heat distribution *throughout* all parts of the oven interior. The aluminum, heat-reflecting lid assures even browning. No wonder pies and cakes are beautifully baked, of even texture and color . . . meat and fowl perfectly done throughout, and evenly browned.

DELUXE ELECTRIC ROASTER

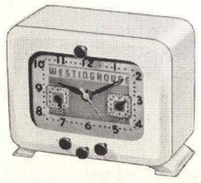
18-QUART CAPACITY

Roasts, bakes, stews, cooks a complete meal for a large family all at one time. No special wiring necessary—may be plugged in any a-c electric wall outlet. Supplied with ovenware dish set.



NEW CABINET WITH CASTERS

All metal construction; finished in white enamel. Specially designed so that Roaster-Oven fits flush with top. Equipped with casters for easy portability. Opening provided for built-in Timer Clock to make Roaster-Oven operation fully automatic. Hinged door. Two shelves inside to hold roaster dishes and Broiler-Grid. Height, 28½ inches; width, 14½ inches; length, 20⅛ inches. Standard package, one.



TIMER CLOCK

Electric Timer Clock makes Roaster-Oven operation fully automatic. Range of operation from 15 minutes to 11½ hours. Rated for 115-volt use, 1650-watts. Cat. No. TC-6, 60-cycle, a-c only. Standard package, one.

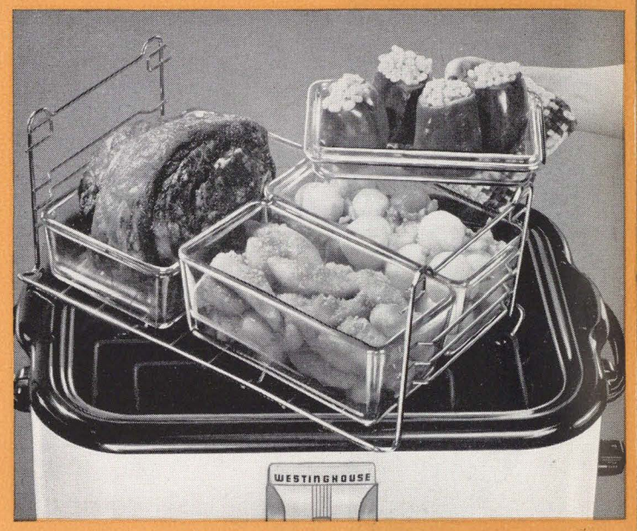
THE WESTINGHOUSE DE LUXE *Roaster-Oven* GIVES . . .

Better Meals.. Oh so Easy!

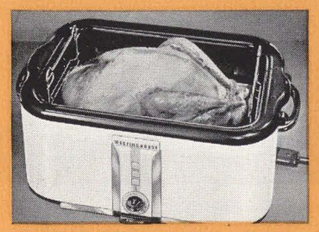
Save time, work and money by preparing a complete meal in one operation with the Roaster-Oven. Just put meat, potatoes, vegetables and hot dessert in the Roaster-Oven . . . and set the automatic heat control dial. No watching, no worrying, until the entire meal is done to perfection, ready to serve. It uses little more current than a modern electric iron.

For roasting, it's the last word. Turkey, chicken, ham, beef, lamb, pork or other meats—all preserve their rich flavor and natural juices. No "drying out"—thanks to the self-basting lid.

Rolls, bread, pies, cakes, cookies, biscuits . . . all bake perfectly in the Roaster-Oven. Accurate, automatic heat control assures uniform results—no guessing. Keeps the kitchen cool, saves heating up a large oven.

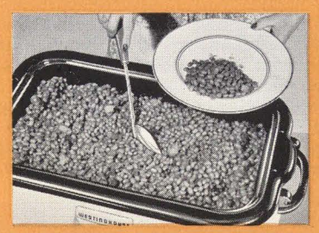


COMPLETE DELICIOUS MEALS—Complete meal in one operation . . . automatically, electrically. No watching, no worrying.

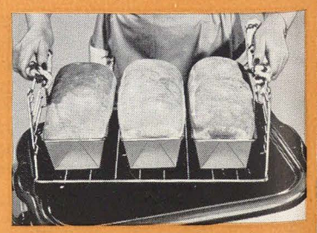


ROASTS FOWL OR MEATS—No drying out. Reduces shrinkage. Retains natural juices and flavors.

BUFFET SERVING—Roaster-Oven keeps foods hot and tempting. You can place it right on the serving table.



COOKS FOR LARGE GROUP—large quantities of food are easily prepared in the 18-quart inset pan.



BAKES BREAD, CAKES, PIES—using broiler rack, 2 large pies or 3 loaves of bread may be baked at one time.

ELECTRIC TIMER CLOCK—A FEATURE

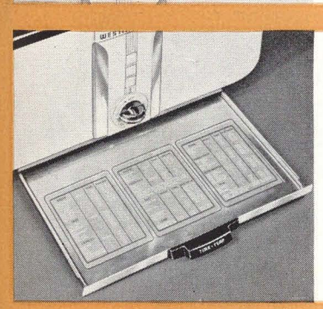
There are many exciting features about the Roaster-Oven, but no accessory is more practical or helpful than the *Timer Clock.* The Westinghouse is a *self-starting* electric clock. It automatically and accurately starts and stops cooking or baking time in the *Roaster-Oven;* from 15 minutes to 11½ hours.

The Timer can also be used to turn on and off other kitchen electric devices. For instance, it can be set to switch the coffee maker on and off . . . piping hot coffee for breakfast without lifting a finger. And throughout the day or night, as an electric clock, it is always an accurate kitchen timepiece.

LOOK AT THESE FEATURES

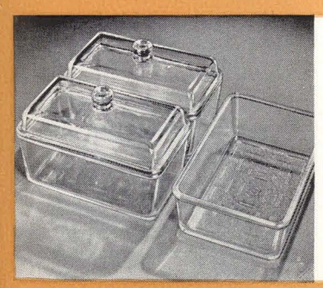
"LOOK-IN LID"

Heatproof glass panel eliminates lifting lid to "peek" at food while it's cooking—saves heat, flavor and vitamin-laden moisture. Glass panel is held firmly in place by two clamps and is easily removable for cleaning. Handle protects glass against breakage.



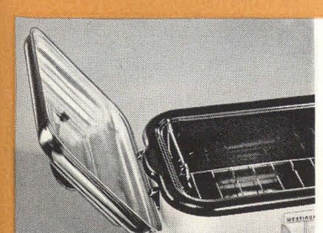
"TIME-TEMP SHELF"

This exclusive dual-purpose shelf gives the user the correct temperature setting and cooking or baking time at a glance. Eliminates guesswork and the problem of lost cookbooks. Slides easily in and out of the roaster base. Also serves as handy serving shelf.



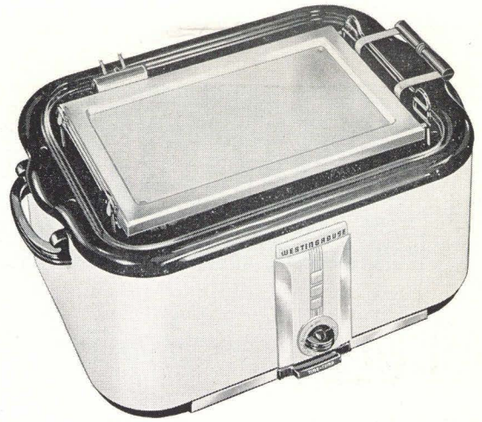
OVENWARE DISH SET

Smartly styled heatproof ovenware dishes—perfect for cooking, and most attractive for table service. Large, uncovered meat dish of 2¾ quarts capacity—plus two covered vegetable dishes of 2 quarts capacity each. Can be used for refrigerator storage.



BUILT-IN LID HOLDERS

A convenient, easy-to-use lid holder molded into each handle. Supports the lid firmly in place in either horizontal or upright position—for either right-hand or left-hand use. Leaves both hands free. Holds lid at angle to prevent any condensation from dripping.



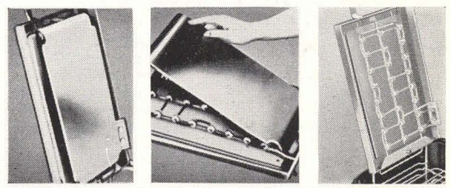
and for

BROILING • GRILLING
TOASTING • FRYING

The Multi-purpose Broiler-Grid

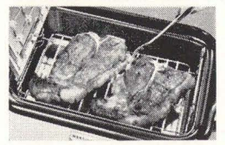
gives 4 EXTRA Cooking Dividends

Broiler-Grid unit includes frying grid with heating element and metal reflector. This unit is easily attached to the standard rack. The heating element is removed by releasing a spring clip. Grid may be washed like any other cooking utensil.

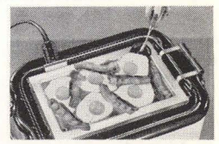


METAL REFLECTOR FOR FAST FRYING

Reflector (left) fits over heating element and reflects heat upward, greatly increasing frying speed. For broiling or toasting, reflector is easily removed (center) by simply loosening one screw. The heating element is then left free for perfect broiling from direct heat (right).



Broils—steaks, chops, ham, fish or vegetables.



Fries—bacon, eggs, pancakes, sausages, potatoes.

Toasts—six slices of bread or sandwiches at one time.

Grills—hamburgers, onions and other foods.

Westinghouse

Model RO-81 *Roaster-Oven*

WITH BROILER-GRID ATTACHMENT

SPECIFICATIONS

REMOVABLE TIME-TEMP SHELF: Gray enameled steel, with Bakelite handle. Slides easily beneath roaster base. Easily removable for cleaning. Time and temperature charts imprinted with wear-resisting decalcomanias.

LID: Polished aluminum. Heatproof glass panel held in place by two clamps . . . removable for cleaning.

REVERSIBLE BAKING AND BROILING RACK: Electrically welded steel, flat ribbon bars. Nickel-plated to prevent rusting and provide easy cleaning.

LIFTING RACK: Electrically welded steel, heavier and stronger than any similar type of rack. Frame, 5/16" thick. Nickel-plated to prevent corrosion.

HEATING ELEMENT: Improved zigzag type—high-grade, nickel-chromium resistance wire formed into flat zigzag element—gives fullest heat transfer to well, using less current. Cemented between two sheets of asbestos to give protection from air and moisture, causes of burnouts.

TRUE-TEMP HEAT CONTROL: Bimetallic type thermostat is highly sensitive to heat fluctuation, yet does not flutter on and off—eliminates radio interference, gives longer life. Thermostat is specifically designed for Roaster-Oven use—control dial is calibrated to match temperatures in standard range cookbooks. All parts treated to resist rust or corrosion.

SIGNAL LIGHT: Glows through glass in panel above dial. Flashes on and off with current, easily seen from any angle. Tested to last through life of Roaster-Oven. Pilot light easily replaceable.

FIBERGLAS INSULATION: Glass wool, the finest and most expensive type of heat deterrent. Does not absorb moisture.

BODY: Two-piece, electrically welded steel, reinforced with steel. This construction assures extra strength.

FINISH: Body first Bonderized to prevent rusting. Finished with two coats of baked-on Dulux enamel. Easy to clean.

HANDLES: Bakelite, attached to body by means of screws and lock washers. Lid holders molded into each handle. Tested to stand 90 lbs pull without loosening or strain. Open-type construction gives positive grip, maximum coolness.

CORD: Extra-long, heavy-duty, rubber-armored cord, tested and proved for long life. Can be washed. Soft rubber plug.

UNDERWRITERS' APPROVAL: Roaster-Oven approved by the Underwriters' Laboratories, Inc.

RECIPE BOOK: Fully illustrated, including complete use illustrations, furnished free with each Roaster-Oven.

OVER-ALL DIMENSIONS: Length, 23½", width, 15¾", height, 12 9/16"—Vitreous enamel inset—18 quarts capacity. Heatproof ovenware dishes—meat dish of 2¾ quarts capacity, two covered vegetable dishes of 2 quarts capacity each.

SHIPPING PACKAGE: Contains one Roaster-Oven complete with enamel inset pan, lifting rack (and trivet), adjustable baking and broiling rack, detachable rubber-armored cord and plug, heatproof ovenware dish set and recipe book.

Roaster-Oven (packaged unit) with Ovenware Dish Set

Cat. No.	A-C Only Volts	Watts	Approx. Shipping Weight Lbs.	Standard Ship. Qty.
RO-81	115	1320	44	2

Broiler-Grid

GRID: Heavy-gauge metal. Frying area, 12¾" long, 7¼" wide.

HEATING ELEMENT: Finest nickel-chromium wire. Scientifically designed to give uniform heat over entire surface. Insulated with porcelain bushings exactly the same as the famous Westinghouse Range removable oven units.

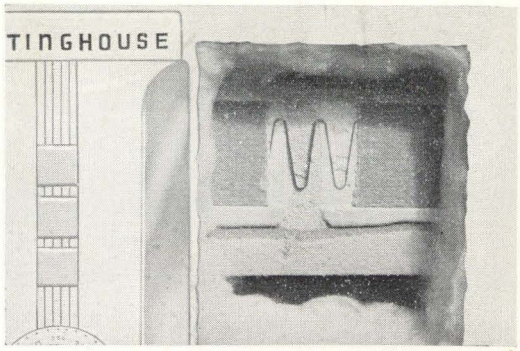
REFLECTOR: Made of .031 gauge steel, nickel-plated on both sides to prevent corrosion. Reflects heat back up to cooking surface to give faster frying—is removed for broiling. Attaches easily to Broiler-Grid with one screw.

One Package Containing Broiler-Grid

Cat. No.	A-C Only Volts	Watts	Approx. Shipping Weight Lbs.
RG-81	115	1620	4

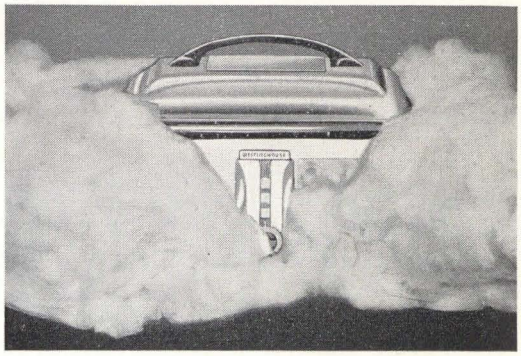
WESTINGHOUSE ELECTRIC CORPORATION
APPLIANCE DIVISION MANSFIELD, OHIO

8RS-0601 Printed in U.S.A.



SEALED-IN ELEMENT (1320 Watts)

Zigzag type—high-grade, nickel-chromium resistance wire all around sides and across bottom. Assures even heat distribution. Gives fullest heat transfer to well, using less current. Cemented between two sheets of asbestos for protection from air and moisture, the causes of burn-outs.



FIBERGLAS INSULATION

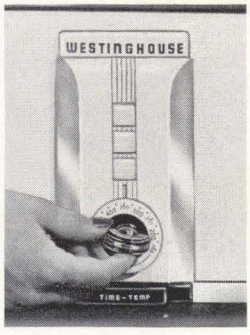
Glass wool, the finest and most expensive type of insulation. Sides and bottom of roaster completely insulated. Keeps the heat inside—keeps the kitchen cool. Does not absorb moisture. Saves current.

PORCELAIN INSET PAN

Inset pan finished in black, acid-resisting porcelain, is easily removed for cleaning. Large quantities of food may be cooked right in this pan. Extra large fowl or roast may be placed in shallow pan and inset pan inverted to serve as lid. Liquid capacity of the inset pan is 18 quarts.

REMOVABLE SIGNAL LIGHT

Pilot light is easily replaceable by removing dial and panel in front of roaster, held in place by a screw. Eliminates complicated bulb-replacement problem.



TRUE-TEMP HEAT CONTROL

Bimetallic type thermostat. Specifically designed for Roaster-Oven—control dial calibrated to match temperatures in standard cookbooks. All parts treated to resist rust or corrosion.

APPENDIX

7. THE SIXTEEN DISTRICTS CONSIDERED TO BE THE MAJOR ECONOMIC AREAS BY THE LOS ANGELES REGIONAL PLANNING BOARD ARE:

A. SAN FERNANDO VALLEY AREA
B. GLENDALE AREA
C. PASADENA AREA
D. POMONA-FOOTHILL AREA
E. ALHAMBRA AREA
F. NORTHEAST AREA
G. EAST AREA
H. CENTRAL AREA
I. WILSHIRE AREA
J. HOLLYWOOD AREA
K. BEVERLY HILLS-WESTWOOD AREA
L. SANTA MONICA AREA
M. ADAMS INGLEWOOD AREA
N. SOUTHEAST AREA
O. WHITTIER NORWALK AREA
P. SOUTH COAST AREA

8. TWENTY FAMILIES RESIDING IN HOMES OF TWO BEDROOMS OR MORE WERE INTERVIEWED IN EACH OF THE SIXTEEN ECONOMIC AREAS REFERRED TO IN NO. 7. IT WAS FOUND THAT SMALLER APARTMENTS AND HOMES WERE NOT INTERESTED IN COOKING ACCESSORIES OF THE MAGNITUDE OF THE INDOOR BARBECUE BECAUSE OF STORAGE SPACE LIMITATIONS.

OF THE 320 FAMILIES INTERVIEWED, 51 OR SIXTEEN PERCENT STATED THAT THEY WOULD LIKE TO SEE THE UNIT IN OPERATION, AND MIGHT BUY ONE IF PRICED AROUND $75.00. NINE FAMILIES INDICATED THAT THEY WOULD BUY THE UNIT AT THE $75.00 PRICE. THIS GROUP WAS VERY ENTHUSIASTIC. IT IS INTERESTING TO NOTE THAT SEVEN OUT OF THE NINE HAD ELECTRIC COOKING ACCESSORIES ALREADY.

A CHECK WITH THE SALES PROMOTION AND ADVERTISING DEPARTMENT OF THE WESTINGHOUSE CO. INDICATED THAT THIS THREE PERCENT FIGURE MIGHT WELL BE CORRECT FOR THE TOTAL POPULATION REGARDLESS OF DWELLING UNIT.

APPENDIX

9. JANUARY, 1949, POPULATION OF LOS ANGELES COUNTY WAS 3,918,477. THREE PERCENT OF THIS FIGURE IS APPROXIMATELY 11,725.

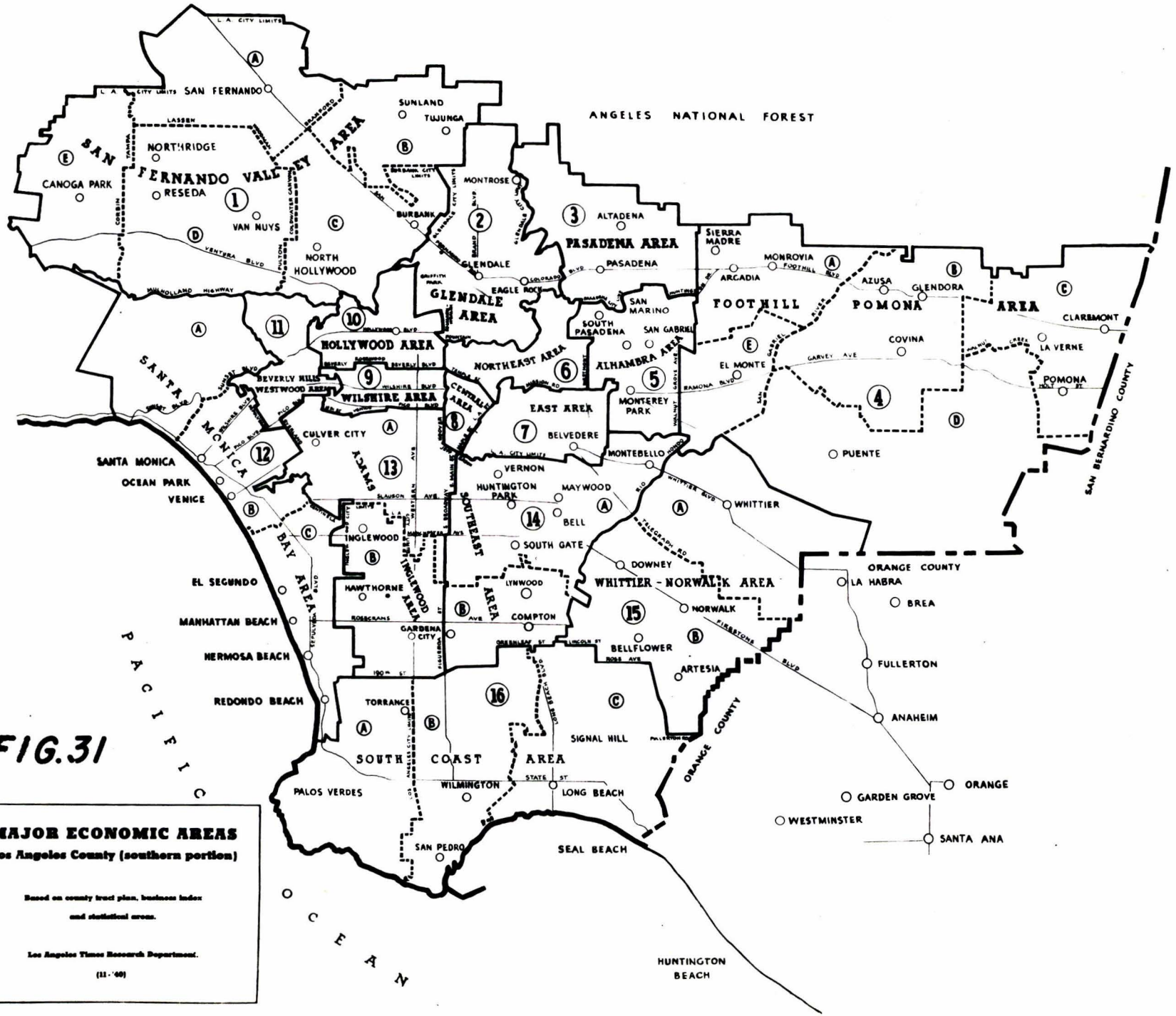


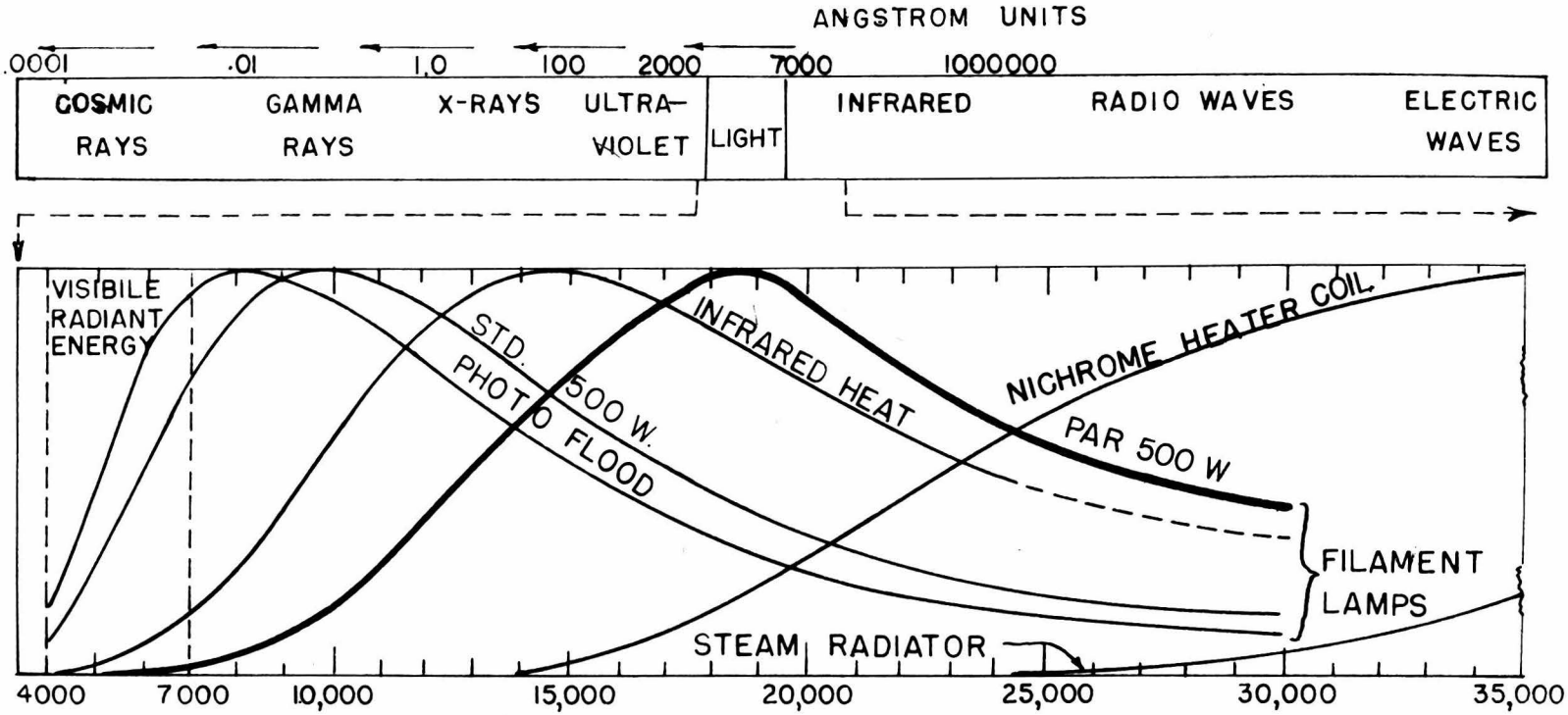
FIG. 31

MAJOR ECONOMIC AREAS
Los Angeles County (southern portion)

Based on county tract plan, business index and statistical areas.

Los Angeles Times Research Department.

(11-'60)



THESE CURVES SHOW THE DISTRIBUTION OF ENERGY OF VARIOUS WAVELENGTHS FROM SOURCES OPERATING AT DIFFERENT TEMP. THE HEATER COIL AND THE STEAM RADIATOR, WITH THEIR LONG-WAVE FAR INFRARED ENERGY ARE EFFECTIVE IN HEATING THE AIR AND BECAUSE OF THIS TRANSMIT. A GREAT DEAL OF THEIR BY HEAT BY CONVECTION. EACH OF THESE CURVES IS PLOTTED TO PEAK AT 100 IN ORDER TO SHOW AS CLEARLY AS POSSIBLE THE SPECTRAL ENERGY DISTRIBUTION OF A PARTICULAR SOURCE. THEREFORE, NO QUANTITATIVE COMPARISON WITH RESPECT TO THE ENERGY OUTPUT OF THESE SOURCES IS POSSIBLE WITH THE ABOVE CURVES. (DATA FROM GENERAL ELECTRIC CO., NELA PARK, OHIO.)

FIG. 32

REF. 10

APPENDIX

11. Mr. J. Walter Howard, General Electric Co., Lamp Sales Engineer, stated that a company was using the PAR 500 watt lamp for cooking. He stated that an article on this subject had been published in the General Electric Co. publication, The Magazine of Light.

12. From the Dorby Co. specification sheet:

"The DORBY INFRA RED COOKER is extremely compact - 15" high 12" wide, and 12" deep, weighs only 13 pounds. Finished inside and out in special, durable white baked enamel - easy to clean with just a damp cloth. Lamp reflector plates are triple-plated chrome finished. The special General Electric Infra-Red Lamps are rated at 5000 cooking hours - enough for years of daily meal making. The entire unit is made of heavy gauge steel, solidly constructed for long life, day in and day out. Operates on 110-120 volt AC or DC current. Comes complete with two 500 watt lamps, built in switch and 6 foot cord with plug."

APPENDIX

13. Jean Bath, Ph.D., Associate Professor of Biology and Food Chemistry, University of California at Los Angeles.

14. Electric Motor Corporation, Division of Howard Industries, Inc., Racine Wisconsin.

Specifications of motor used: Model No. 300C

Bearings - Porus bronze sleeve bearings, with felt oil resevoir for lubrication.

Frame - Sturdy, reinforced, die cast.

Mounting - Four mounting holes, tapped for 8-32 screws.

Finish - Natural zinc.

Rotation - Clockwise or counterclockwise. Not reversible.

Shaft - Diameter, $\frac{1}{4}$".

Weight - Approximately one pound.

Rev./Min.- Four

Voltage - 110, 60 cycles, A.C.

APPENDIX

15. Calculations

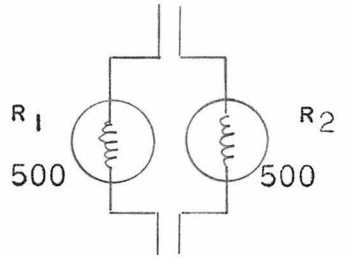
Given: two 500 watt lamps

To calculate:

A. With lamps in parallel
   1. Amperes
   2. Watts (effective)

B. With lamps in series
   1. Amperes
   2. Watts (effective)

A. Calculations with lamps in parallel



Where:

R_E = effective resistance
R_1 = resistance 1
R_2 = resistance 2
I = amperes
W = watts
E = volts

$$1/R = 1/R_1 + 1/R_2$$

$$I = W/E$$

$$I = 500/115$$

$$I = 4.34 \text{ amps for one lamp single}$$

APPENDIX

$E = IR$

$R = E/I$

$R = 115/4.34$

$R = 26.5$

$1/R_E = 1/26.5 + 1/26.5$

$R_E = 13.25$

$I = E/R = 115/13.25 = 8.68$ AMPERES FOR BOTH LAMPS

$W = 115 \times 8.68 = 1000$ WATTS

B. CALCULATIONS WITH LAMPS IN SERIES: (FROM LABORATORY CHECK)

$I = 3.5$

$R_E = 32.9$

$W = (3.5)\ (115) = 402.5$ WATTS

RESULTS

A. WITH LAMPS IN PARALLEL
   1. TOTAL AMPS = 8.68
   2. TOTAL WATTS = 1000

B. WITH LAMPS IN SERIES
   1. TOTAL AMPS = 3.5
   2. TOTAL WATTS = 402.5

APPENDIX

C. HEAT FROM SOURCES: (JOULE'S LAW)

H (IN CALORIES) $= 0.24\ I^2RT$

WHERE H = HEAT IN CALORIES
I = AMPERES
R = RESISTANCE
T = TIME IN SECONDS

A. WITH LAMPS IN PARALLEL

$H = .24\ (13.25)^2\ (8.68)\ (3600)$

$H = 1{,}316{,}634$ CALORIES/HR.

B. WITH LAMPS IN SERIES

$H = .24\ (3.5)\ (32.9)\ (3600)$

$H = 99{,}489.6$

C. WITH SINGLE LAMP SOURCE

WATTS = AMPS X VOLTS

$500 = I \times 115$

$I = 4.34$

$E = IR$

$R = E/I$

$R = 115/4.34$

$R = 26.5$

APPENDIX

C. WITH SINGLE LAMP SOURCE (CONT.)

$$H = .24\ (4.34)^2\ (26.5)\ (3600)$$

$$H = 431{,}208 \text{ CALORIES/HR.}$$

SUMMARY

A. HEAT FROM LAMPS IN PARALLEL = 1,316,634 CAL./HR.

B. HEAT FROM LAMPS IN SERIES = 338,860 CAL./HR.

C. HEAT FROM ONE LAMP = 431,208 CAL./HR.

APPENDIX

16. Determination of wire sizes

Assume:

1. Use copper wire
2. Approximately 20' of wire used from lamps to electrical outlet
3. $2\frac{1}{2}\%$ allowable potential line drop
4. Maximum amperage - 9 amps (See preceding calculations)

$2\frac{1}{2}\%$ drop = .025 x 120 = 3 volts across two line wires

From Ohm's Law -- $R = V/I$

Where: R = resistance in ohms
V = volts = 3
I = amperes = 9

$R = 3/9 = 0.33$ ohms

From Resistance Law -- $R = \rho I/A$

Where: R = resistance in ohms of lamps

ρ (rho) = resistivity of copper wire $(1.72 \times 10^{-6}) = 10.4$ Ohm CM per ft.

I = length of wire used

A = area of the wire in CM

$$A = \rho I/R = \frac{(10.4 \text{ ~~ohm~~ CM/~~ft~~}) (40 \text{ ~~ft~~})}{0.33 \text{ ~~ohms~~}}$$

$$= 1260.60 \text{ CM}$$

$$= \underline{\text{No. 8 AWG wire}}$$

TESTING

Background

Before any cooking tests were made, considerable research was undertaken in the field of cooking. The following paragraphs summarize the variety of reactions which occur simultaneously in cooking of foods.

1. Increased breakdown of cell tissue by enzyme action occurs as the food passes through the range of optimum temperature for each type of enzyme. This produces amino acids, polypeptides, and peptones from higher proteins. It also releases cell fluids. With starchy products, the starch is solublized and dextrins, polysaccharides, and some simple sugars are formed. Proteases and amylases are respectively responsible for these changes. The net effect is generally an increase in digestibility.

2. As the temperature rises the proteins begin to coagulate at temperatures approximating 140^{0} F., sugars and dextrins tend to carmelize or oxidize (at least on exposed surfaces) and hydrolysis of some of the breakdown products started in 1. continues with increased rapidity.

3. Further increases in temperature cause melting of the fat, oxidation of the surface fat, subsequent hydrolysis to fatty acids, condensation of the amino acids with sugars to form flavor producing melanin compounds, and if carried too far, charring of the food.

4. The degree of vitamin retention is always a function of the temperature and time of exposure. While the B vitamins in meat are generally quite stable, there is an advantage to rapid cooking at the lowest possible average temperature.

TESTING

5. FOODS CAN BE DAMAGED SERIOUSLY BY LEACHING OUT FLAVOR AND VITAMIN COMPONENTS. THE IDEAL IS TO TRAP THE NATURAL MOISTURE IN THE CELLS WITHOUT ADDING OR SUBTRACTING MUCH DURING COOKING. IN MEATS THIS IS BEST DONE BY THE SEARING PROCESS.

THIS INFORMATION WAS GATHERED WITH THE ASSISTANCE OF MR. DAVID R. SCHWARZ, SCHWARZ LABORATORIES, NEW YORK, NEW YORK.

WITH THIS INFORMATION IN MIND TESTS WERE BEGUN UTILIZING THE GENERAL ELECTRIC PAR 500 WATT INFRA-RED LAMPS AS A HEAT SOURCE.

PRELIMINARY INVESTIGATION PROVED THAT SOME SORT OF SWITCH WOULD HAVE TO BE INCORPORATED FOR DECREASING THE HEAT ONCE THE INITIAL SEARING HAD TAKEN PLACE IN THE COOKING OF MEATS, AND IN BAKING, THE LOWER HEATS WOULD HAVE TO BE USED INSTEAD OF THE HIGH HEAT. WITH THE USE OF THE SERIES-PARALLEL SWITCH DESCRIBED IN THE TEXT, SUFFICIENT VARIATIONS IN HEAT WERE POSSIBLE TO ACCOMPLISH ALL COOKING TASKS.

EXPERIMENTATIONS WERE MADE TO DETERMINE THE OPTIMUM DISTANCE FOR SEPARATION OF THE HEATING ELEMENTS FOR BARBECUING AND FOR GRILLING, ROASTING, AND BOILING. THIS DISTANCE WAS FOUND TO BE SOMEWHERE AROUND TWELVE INCHES.

AFTER THE PHYSICAL SIZE OF THE STOVE WAS DETERMINED, TESTS WERE RUN WITH DIFFERENT FOODS TO DETERMINE THE COOKING TIME REQUIRED TO OBTAIN THE BEST POSSIBLE RESULTS. IN JUDGING FOODS, TEXTURE, FLAVOR, JUICYNESS, SHRINKAGE, AND APPEARANCE WERE CONSIDERED. THE FOLLOWING SECTION GIVES THE COOKING TIME FOR VARIOUS FOODS AS DETERMINED BY ACTUAL TEST.

TESTING

Cooking Time

Food	Time (In Minutes) Rare	Medium	Well Done
Hamburgers - 4 oz. patties, ½" thick	2	3	4
Bacon - commercial slice thickness	1½	2	3
Steaks - 1" thick T-bone cut	2	4	6
Chicken - disjointed 3½ pound fryer			10
Lamb and veal chops ½" thick loin cut	3	4	6
Leg of lamb - barb. 6 pound leg		80	
Pork loin - barb. 5 pound			85
Pork Chops			7
Rolled beef roast eye cut - 5 pound barbecued		40	
Eggs - fried AA grade fresh	1	2	3
Eggs -scrambled AA grade fresh, four eggs	2	3	4
Vegetables - frozen	4	5	6
Vegetables - raw	4	5	6

TESTING

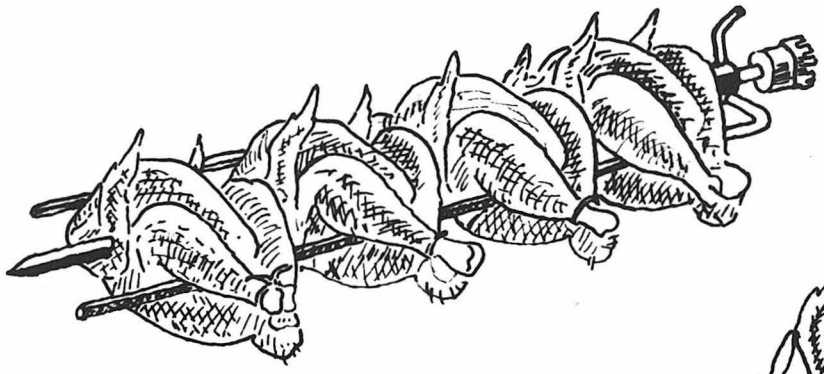
Food	Time (In Minutes) Rare	Medium	Well Done
Baked potatoes 4 oz. Idaho			25
Biscuits - frozen			10
Biscuits - not frozen			9
Pies frozen and homemade in 10" pie tin	6	8	12

TESTING

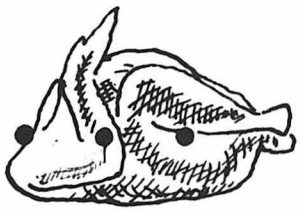
Barbecuing Foods

Tests on barbecuing indicated that it is very important to first sear the meat in very high temperatures as this seals the outer cellular structure, and withholds the meat juices. After the searing operation the heat may be turned down for minimum shrinkage, or the cooking may be done extremely rapidly at high heat with approximately 20% shrinkage. Tests with various barbecue sauces and smoke sauce were rather inconclusive as the final flavor is a matter of individual taste.

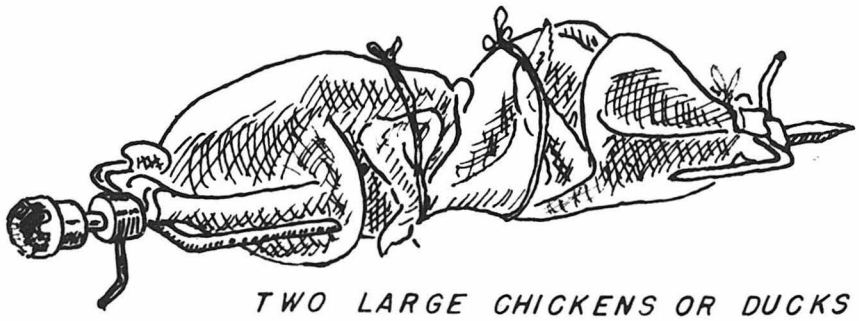
In barbecue experiments, various types of spits and rotating hardware were tried. The following sketches show possible methods of skewing meats for barbecuing.



CORRECT WAY TO SPIT SMALL FOWL

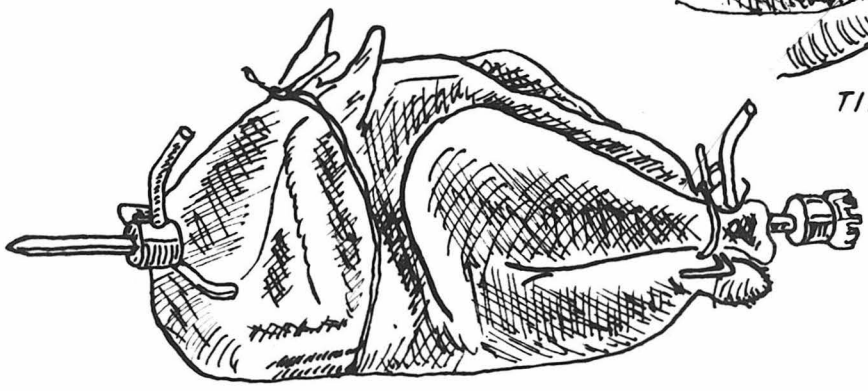


LOCATION OF FORK HOLES



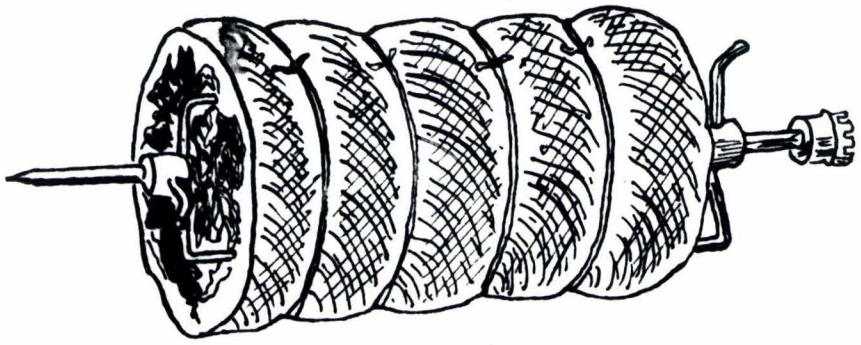
TWO LARGE CHICKENS OR DUCKS

TIE LEGS

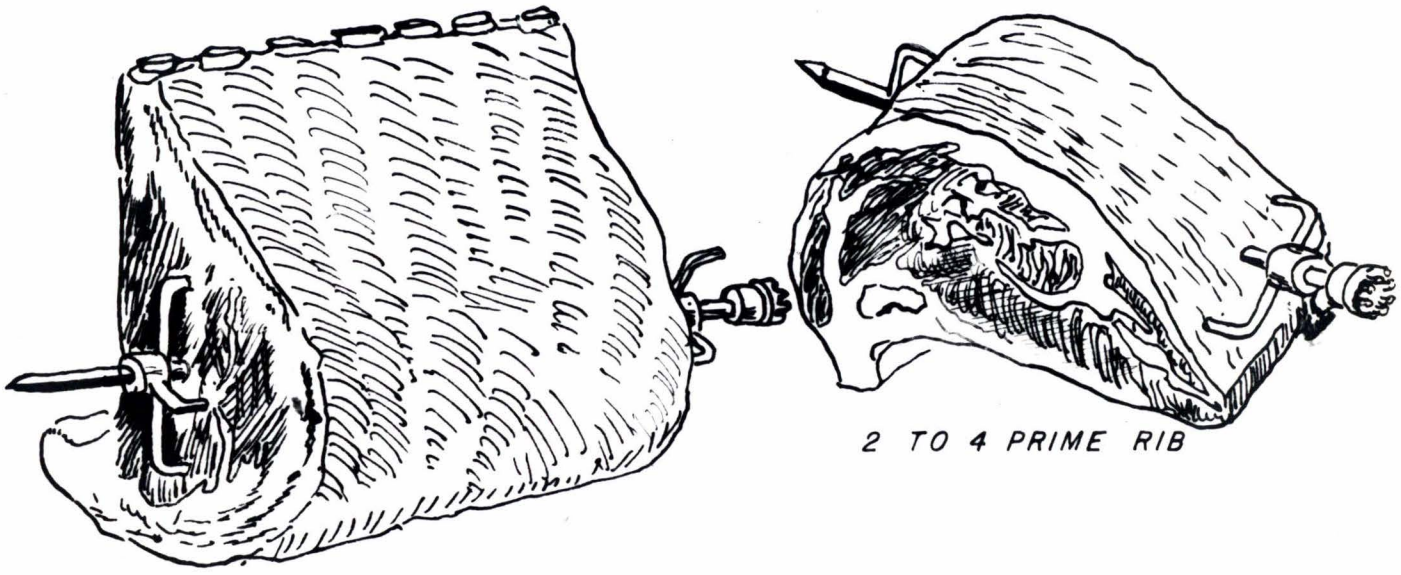


12 TO 18 POUND TURKEY

FIG. 34



ROLLED BEEF ROLLED BONED SHOULDER OF LAMB
WHOLE FILET



2 TO 4 PRIME RIB

4 TO 7 PRIME RIB

LEG OF LAMB, HAM, VEAL, ETC.

FIG. 33

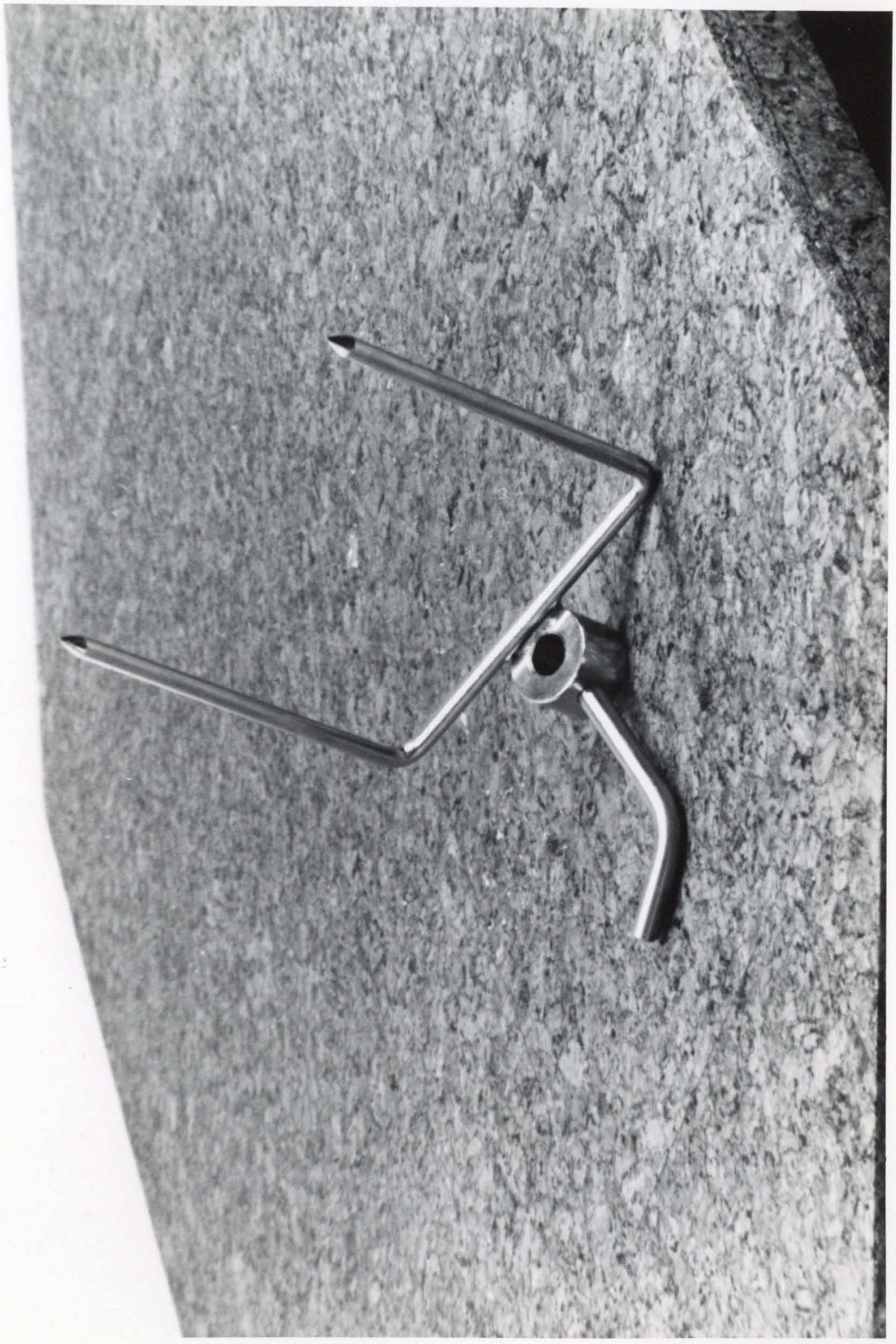


FIG. 35

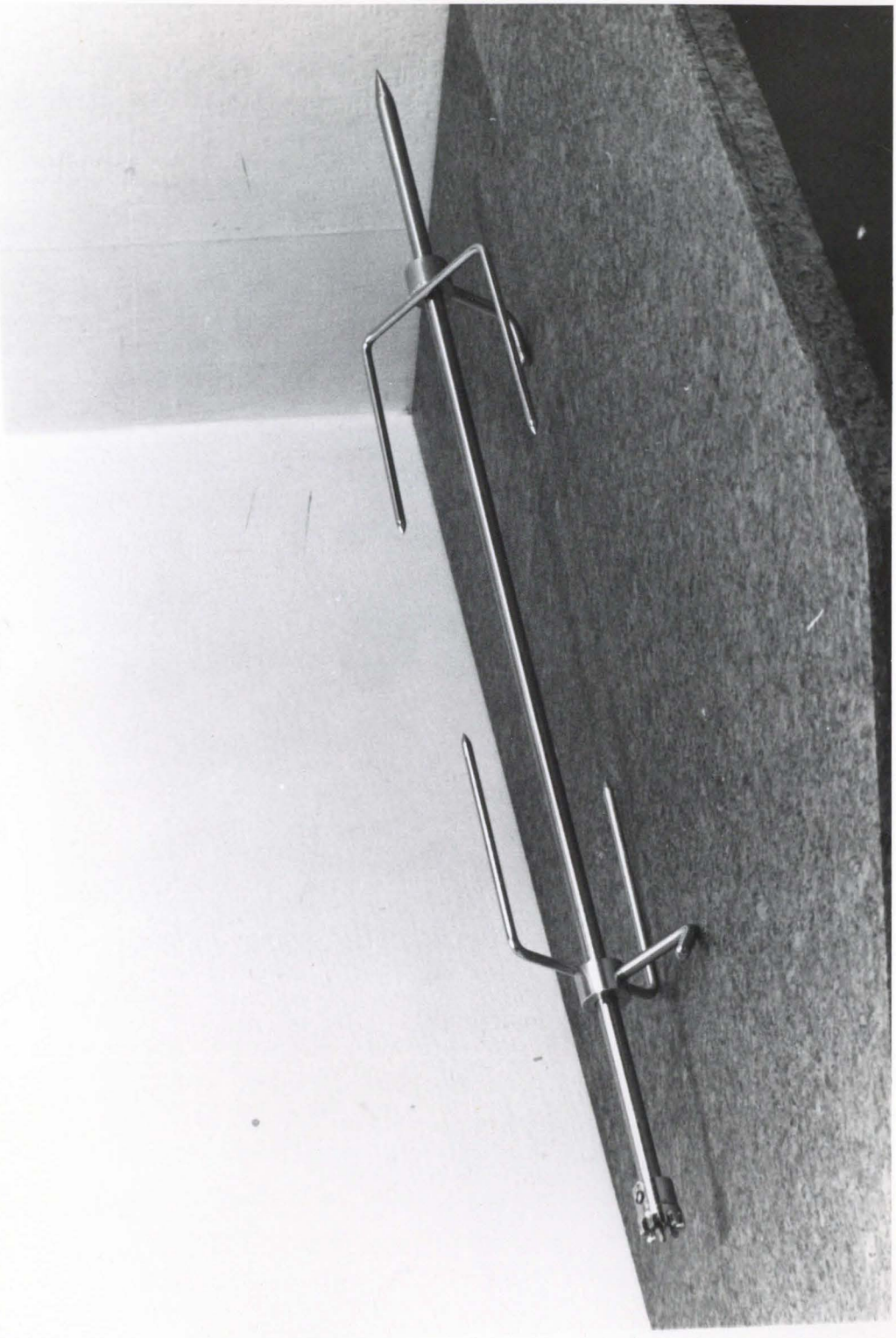


FIG. 36

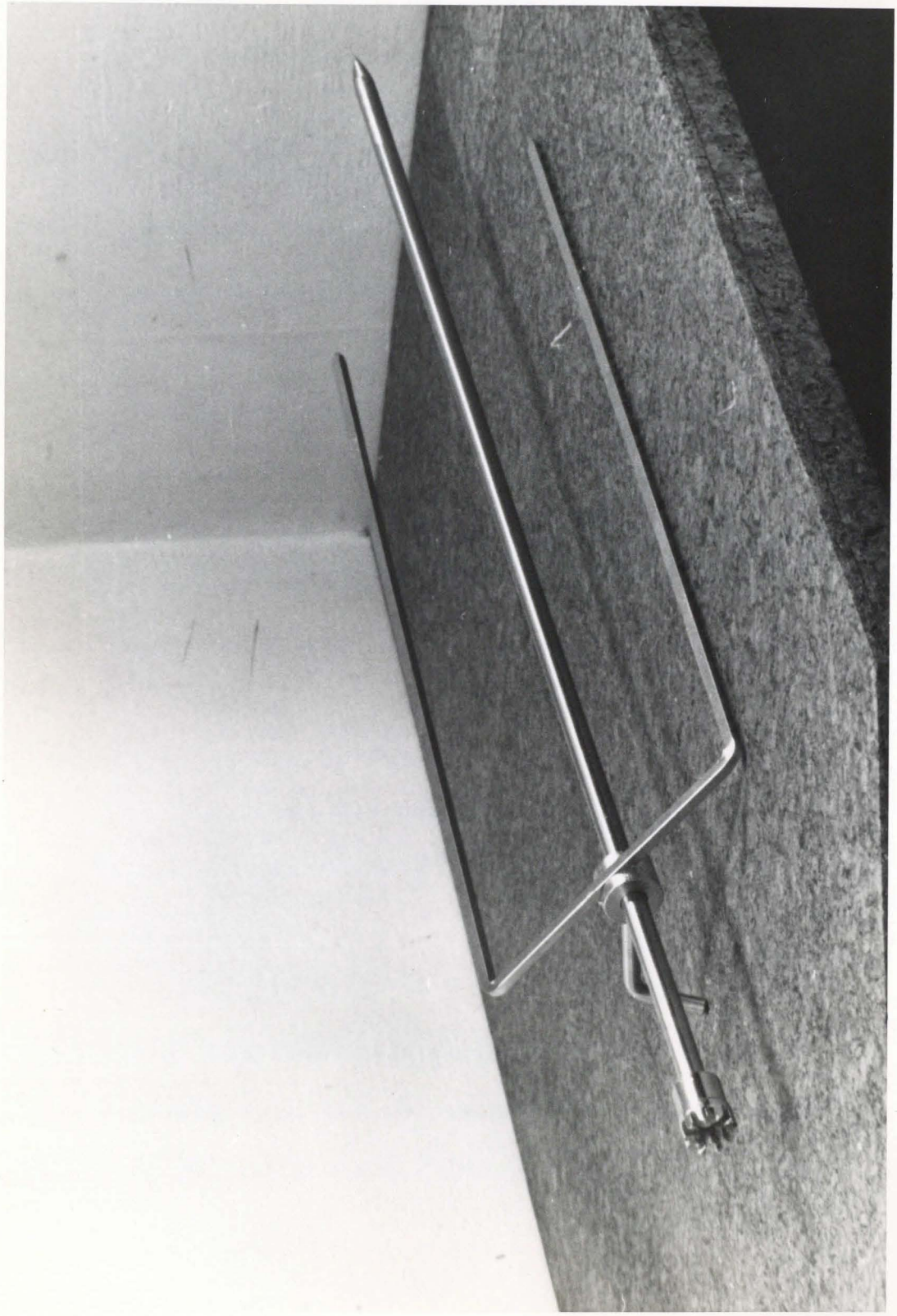


FIG. 37

COST ESTIMATE

THE FOLLOWING COSTS OF PARTS INCLUDE BURDEN, OVERHEAD, AND DIE COSTS PRORATED ON THE BASIS OF A PRODUCTION RUN OF 100,000 UNITS.

THE ESTIMATES ARE BASED ON ESTIMATES FROM MANUFACTURERS, MACHINE SHOPS, AND ELECTRICAL SUPPLIERS. THESE ESTIMATES MAY BE EXPECTED TO VARY FROM ACTUAL COSTS BECAUSE OF ERRORS IN JUDGMENT AND CHANGING ECONOMIC CONDITIONS, BUT THEY ARE A GOOD INDEX TO THE ACTUAL COST OF THE UNIT.

MOTOR	$ 2.50
HEATER SWITCH	.60
TOGGLE SWITCH	.20
FRAMES	1.00
BACKING PAN ASSEMBLY	1.25
MOTOR HOUSING	.55
SWITCH HOUSING	.50
SHELL	.75
LAMP	1.10
CORD	.60
MISCELLANEOUS	1.00
TOTAL	$10.05

MULTIPLYING THIS FIGURE BY FOUR SHOULD GIVE AN APPROXIMATE SELLING PRICE. THIS WOULD BRING THE PRICE UP TO APPROXIMATELY $40.00.

COST ESTIMATE

Because the product is new and an expensive promotional program will be required, the price has been set at $75.00, to be lowered when this market has been exhausted.

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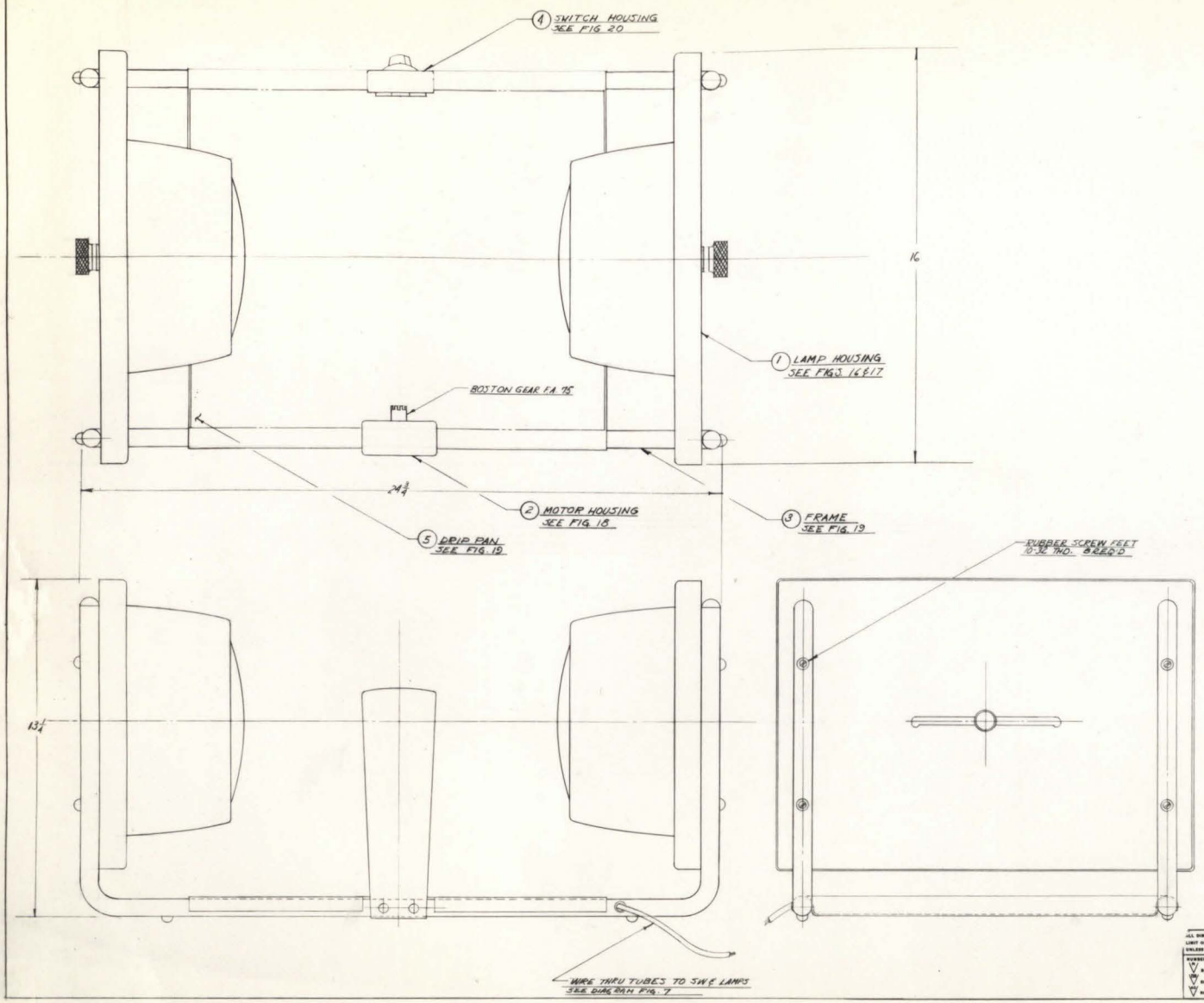

PART NO.	NAME	NO. REQ.	MATERIAL DESC.	MATERIAL SPEC.	WEIGHT

ALL DIMENSIONS IN INCHES — ANGULAR ± ½°
LIMIT OR DIMENSIONS UNLESS OTHERWISE NOTED — FRACTIONAL ± 1/64, DECIMAL ± .010

NUMBERS ARE SURFACE ROUGHNESS IN MICROINCHES

- ROUGH MACHINE FINISH
- SMOOTH MACHINE FINISH
- ROUGH GRIND
- FINISH GRIND
- FINE GRIND, LAP
- POLISH

FINISH

HEAT TREAT

CALIFORNIA INSTITUTE OF TECHNOLOGY

SCHEMATIC ASSEMBLY— INDOOR BARBECUE

DRAWN BY: R. SCHMITZ
TRACED BY:
CHECKED BY:
APPROVED BY:
DATE: SCALE:
COURSE NO.: DWG. NO.:
SECTION NO.: