# Eimac News

INDUSTRIAL EDITION

JANUARY 1945

**IN THIS ISSUE: Packaging vacuum tubes for overseas shipment.**

**Vacuum tube ratings.** **The Eimac nutrition program.**

INDUSTRIAL EDITION

# Eimac News

Volume 3

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Number 11

## IN THIS ISSUE

**JANUARY — 1945**

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## THE COVER PHOTO:

**Photo shows part of a rack of 15-E type miniature transmitting tubes being aged at 10,000 plate volts, one of a series of processes by which Eimac's high quality standards are attained.**

*EITEL-MCCULLOUGH, INC.*

SAN BRUNO Eimac TUBES CALIFORNIA

TO OUR READERS:

Because the manufacturer of transmitting-type vacuum tubes plays a critical role in the world of electronics, his relationship with the ultimate consumer must be on a more intimate plane than is required of any other supplier of the components of electronic equipment.

There are two good reasons for this relationship: First, because vacuum tubes do eventually wear out despite constant quality improvement, they must be replaced from time to time, thus causing a recurrent association between manufacturer and consumer. Second, in improving and redesigning his equipment for greater efficiency, the consumer will require corresponding changes in vacuum tube design. Conversely, developments in vacuum tube design initiated by the manufacturer will make possible improvements in electronic equipment powered by such tubes. All such changes require close contact all along the line, from laboratory to end-product.

This edition and subsequent issues of the "Eimac News" will portray the activities here at Eimac, not from a highly technical standpoint, but through the medium of simple behind-the-scenes glimpses of our operations, past, present and future, in an effort to further the relationship of this company to its customers, the users of transmitting vacuum tubes.

We hope this publication will help you to know some of the problems, the policies, and more important, the people of Eimac.

Cordially,

Bill Eitel

Bill Eitel

Jack McCullough

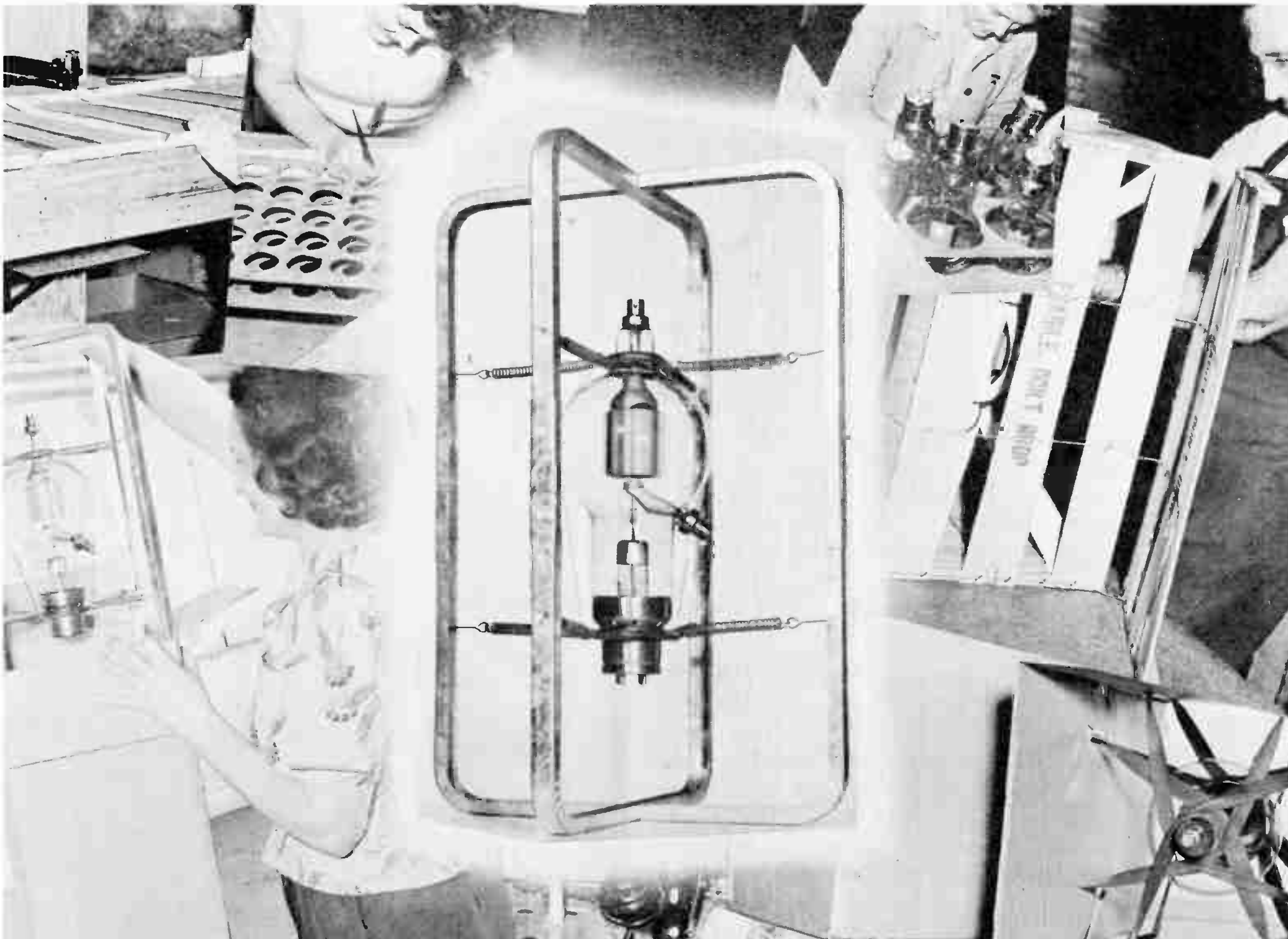
Jack McCullough

San Bruno, California
January 6, 1945

ARMY-NAVY "E" FLAG AWARDED SEPTEMBER 4, 1942

# The Eimac Spring Package

THE STORY OF AN IMPORTANT DEVELOPMENT IN THE ART OF SHIPPING ELECTRON VACUUM TUBES IN WARTIME



# New Packing Method Gets Tubes There Safely

## Steel Springs Resist Shock, Mildew And Corrosion; Replace Elastic

Stainless steel springs in a galvanized steel frame are now carrying Eimac 450-T type transmitting tubes safely through all kinds of wartime shipping and handling hazards.

Recently approved by the Signal Corps and the Navy, the new spring package represents a considerable advancement in vacuum tube packaging methods, overcoming nearly all the difficulties which have beset methods previously employed.

The package is a typical Eimac development—a practical answer to a pressing need. The war cut out the supply of rubber bands which originally suspended the large types of tubes within their wooden frames. Substituted elastic girdle material was adequate for domestic shipment, but it deteriorated when stored in warehouses, and suffered from attacks of heat, humidity and tropical fungi, when shipped overseas.

In short, packaging methods which were perfectly satisfactory for peace-time express shipments of tubes, were unable to cope with such exigencies as tossing a crate of tubes off a ship to float ashore through the surf in a landing expedition.

Salt spray, mildew, high humidity and rough handling raised tube losses on the battle fronts to such a serious degree in the summer of 1943 that the packaging question became a major issue in the vacuum tube industry.

Shipping Department Head Jerry Manley took it as a

*(Continued on next page)*

# The Eimac Spring Package—(continued)

personal reflection on his shipping technique. It cost him some sleep worrying about such material requirements as strength, longevity, resistance to corrosion, fungus, temperature and concussion.

Nobody knows now just where the idea of using springs first was planted, but Jerry one day found himself gathering up old springs of all kinds, including some rusty bed springs.

He had an X-shaped frame made of galvanized sheet steel to fit the corrugated cardboard cartons already in use, and hooked the springs inside the frame, attached to yokes holding the tube by top and bottom, free of contact with carton or frame.

Then he dropped the package five feet to the floor. The tube came right out through the bottom of the box, battered into junk. Jerry refused to be discouraged, however, realizing that the answer lay in finding the correct degree of spring tension, the correct spring length, the proper connecting links.

After a long series of trial-and-error experiments, Jerry came up with a completed package on which he was prepared to stake his reputation. In front of a group of Signal Corps engineers and inspectors, he climbed to the roof of the laboratory building and tossed a perfectly good 450-T in a spring box over the edge.

It hit with an awful bang, but the tube didn't break. It took the 20-foot drop without an iota of damage, although every internal part must have experienced a force in excess of 200 times its weight at rest.

That rather dramatic demonstration was convincing, inasmuch as the Army-Navy requirement for a drop test was only 36 inches of free fall.

Refinement of the package into terms of specific spring dimensions, deceleration calculations and the like, became an engineering problem at this point. A. M. Newhall, Mendel Rabinawitz and Gordon Shepherd, Eimac machine design engineers, worked out the data (set forth in detail at the conclusion of this article), and 10 of the spring packages were made up in accordance with the specifications they and Jerry produced. These 10 packages were tested exhaustively by the Signal Corps laboratories, and approved as a joint Army-Navy specification for all 450-T shipments, both domestic and foreign.

Recently the package has been adapted for shipping other tube types in the larger sizes.

The problem in packaging vacuum tubes is simply stated but not so simply executed. The filament structure must be protected from sudden jarring or bumping which might shatter the filament wire or move the stem out of line. And, of course, the glass envelope and the leads must be held clear of contact with the container.

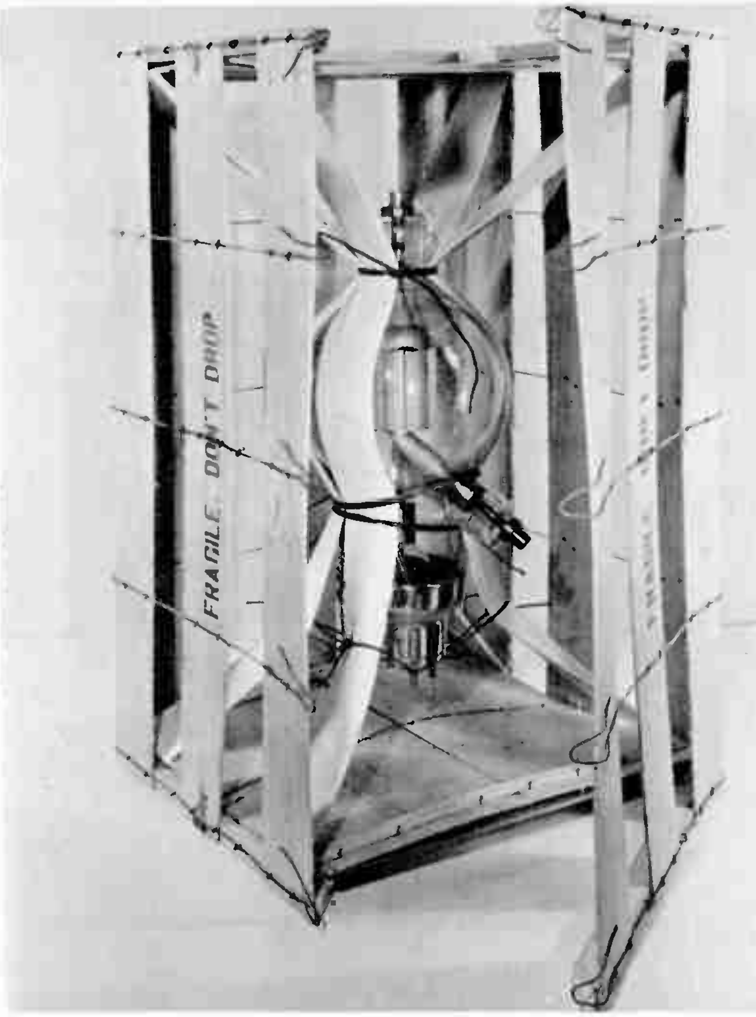
Small tubes are simply wrapped in cotton batting and stuffed in boxes. Their compact structure and light weight make this packing adequate for any ordinary condition.

Larger tubes, with their longer filaments and greater weight, require suspension, or slings, to keep them from

*(Continued on next page)*

**A 20-foot test didn't worry Jerry**


**Small tubes and relays are wrapped in cotton**




**Canvas slings were the first method**

## The Eimac Spring Package—(continued)

bumping top, sides or bottom, and to absorb shocks in handling.

Canvas slings were first employed for this purpose in 450-T shipping, then elastic girdle material, and finally springs, the ultimate answer to a long-standing need for complete protection. Even if the outer container should dissolve in the surf of a landing beach, or mildew completely away, the tube would remain safely suspended in its corrosion-proof frame, while the springs themselves will last well beyond any likely period of storage.

The selection of spring sizes and dimensions resolves into a problem of balancing the technically ideal system against the practical limits of space, convenience and cost.

An ideal spring suspension system would be one employing an infinite number of springs acting in all directions from the center of gravity of the tube. In such a case, the deceleration of the tube following a drop from a given height would be independent of the angle or position of the package when it landed on a rigid surface. However, practical design considerations such as cost, assembly time, physical configuration of the tube, etc., necessitate a departure from the ideal suspension system. Accordingly, the analysis of the practical

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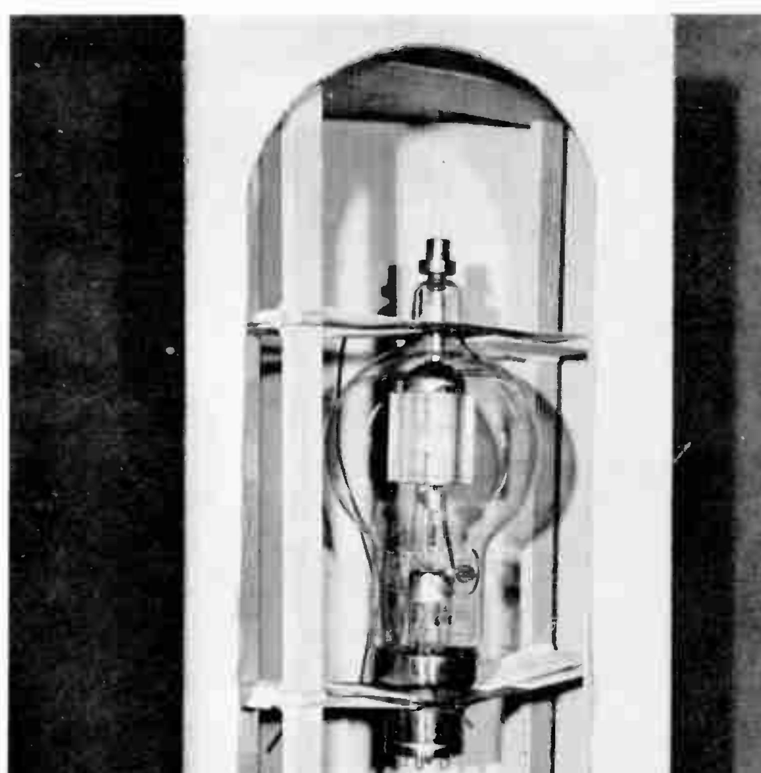


**One reason girdles were hard to get**

system involves an investigation of the deceleration forces acting on the tube when dropped from specified heights in the critical directions.

Since the practical system is of the "spring" type the maximum deceleration force, which accrues from stopping the tube after the package has contacted a rigid surface, will be proportional to the height from which the package has been dropped and inversely proportional to the distance through which the spring system acts in stopping the tube. This relationship is illustrated in Fig. 1.

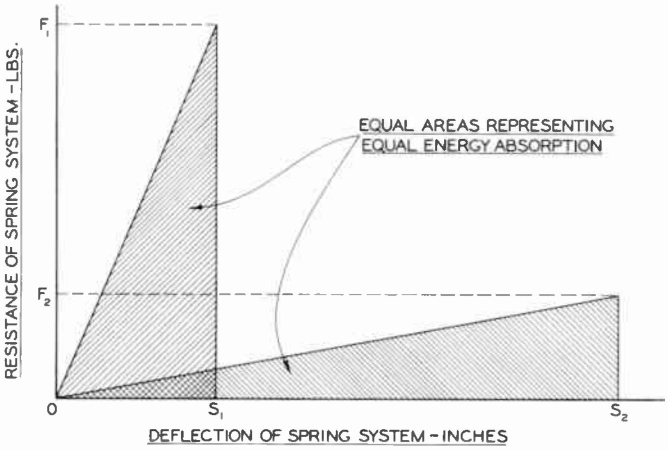



FIG. I

Actually for the complex suspension system shown in Fig. 2 the relation between "F" and "S" is not absolutely linear, but tests indicate that this relationship is sufficiently linear to approximate the maximum deceleration which the tube receives by employing the following equations.

$$mgh = \frac{1}{2} FS$$

$$\not{m}gh = \frac{1}{2} \not{m}aS$$

$$a = \frac{2gh}{S}, \left(\frac{in.}{sec.^2}\right)$$

$$\text{or, } a = \frac{2h}{S}, (\text{"g"})$$

Where:

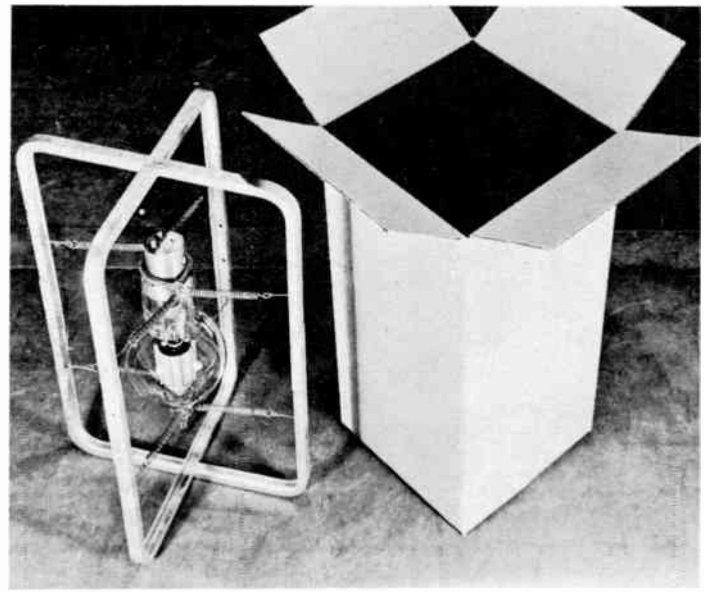
h = Height of drop—inches

g = Acceleration due to gravity—386.4 inches per sec$^2$ or 32.2 ft. per sec$^2$

m = Sprung mass—lbs. sec$^2$ per inch

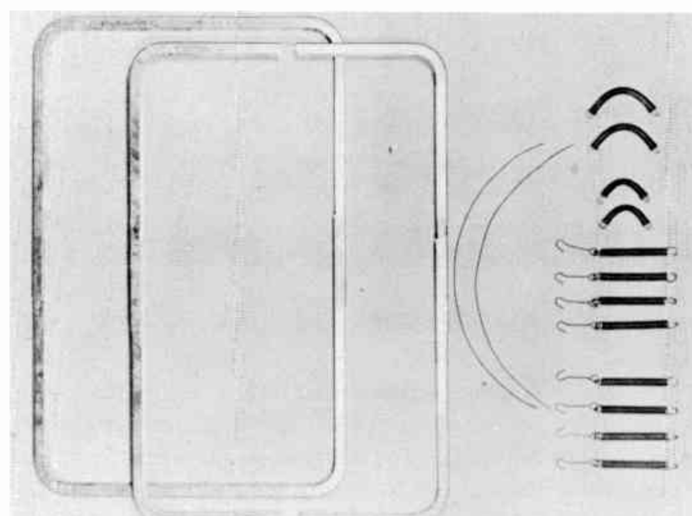
F = Maximum deceleration force of spring system—lbs.

S = Total deflection of spring system in absorbing energy—inches.



## THE SPECIFICATIONS

**The X-frame shown above is an interlocking type made of No. 22 U. S. gauge galvanized sheet steel. The supporting springs are of stainless steel, No. 17 W & M gauge (.054"). The body length of springs is 2 25/32" with 29¾ active coils. The spring rate is approximately 10 pounds per inch. The loops attached to the springs which hold the tube are of steel wire, No. 13 W & M gauge (.091"). The stainless steel hooks holding the springs to the frame measure 1¾" in length and are No. 16 W & M gauge (.063"). The rubber tubing used on the loops for the neck and base of the tube are 3/16" I.D. and 5/16" O.D. The neck length is 2¼" and the base length is 3⅜". The tie wires are of soft iron, No. 20 W & M gauge (.035").**



When the height of fall and the maximum allowable deceleration for a given tube is known, the size of package can be determined immediately from the foregoing criteria by solving for "S" and adding twice this value to the major dimensions of the tube. Again, given a package size, tube size, and maximum allowable deceleration, solving the expres-

*(Continued on next page)*

# The Eimac Spring Package—(continued)

sion for "h" will indicate the maximum possible drop.

After establishing the package size by either of these conditions, the next step is to determine the spring characteristics which will use the freedom of the tube within the carton efficiently. The tube must use all of the space in the carton as it is stopped after a specified fall in any of the critical directions, but must not bump the ends or sides of the carton. The material immediately following deals with the analysis of an eight spring system.

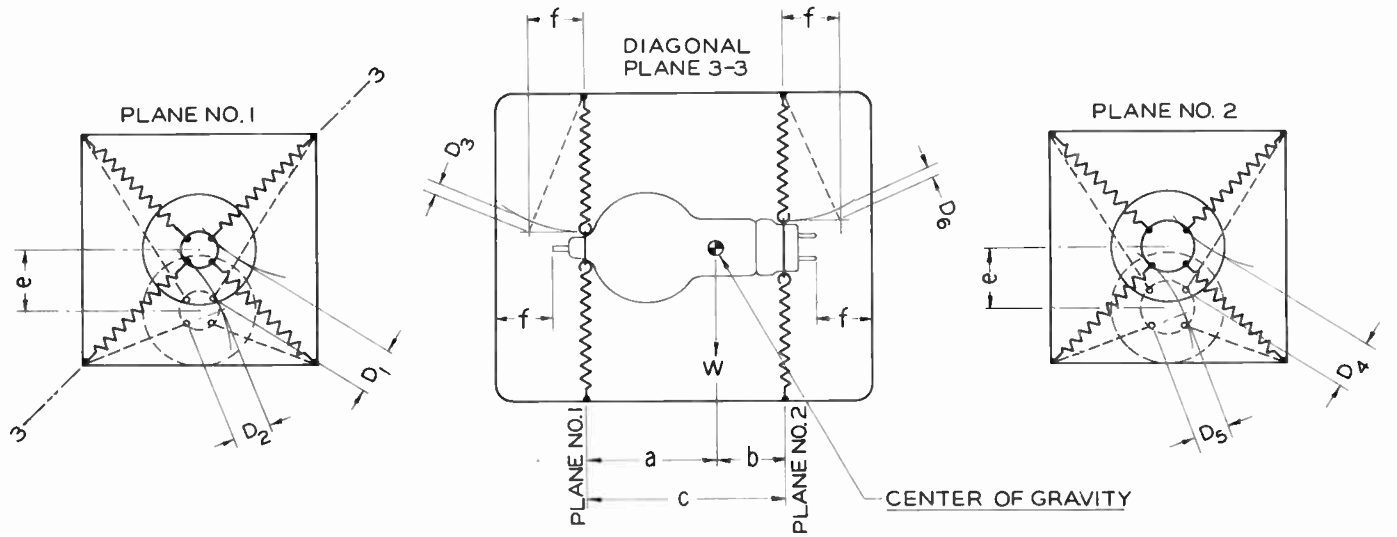



FIG. 2

Notations:

$W$ = Weight of tube—lbs.

$W_1$ = Weight of mass of tube concentrated at plane No. 1 in equivalent system $(W \times \frac{b}{c})$ plus weight of saddle, links and half estimated weight of springs—lbs.

$W_2$ = Weight of mass of tube concentrated at plane No. 2 in equivalent system $(W \times \frac{a}{c})$ plus weight of saddle, links and half estimated weight of springs—lbs.

$K_1$ = Spring rate of springs in plane No. 1—lbs. per inch.

$K_2$ = Spring rate of springs in plane No. 2—lbs. per inch.

Determined Graphically or Analytically from Geometry of System:

- $D_1$ = Extension of springs for lateral tube deflection in plane No. 1—inches (see fig. 2)
- $D_2$ = Relaxation of springs for lateral tube deflection in plane No. 1—inches (see fig. 2)
- $D_3$ = Extension of springs for axial tube deflection in plane No. 1—inches (see fig. 2)
- $D_4$ = Extension of springs for lateral tube deflection in plane No. 2—inches (see fig. 2)
- $D_5$ = Relaxation of springs for lateral tube deflection in plane No. 2—inches (see fig. 2)
- $D_6$ = Extension of springs for axial tube deflection in plane No. 2—inches (see fig. 2)

$P_1$ = Assembled spring tension in plane No. 1—lbs.

$P_2$ = Assembled spring tension in plane No. 2—lbs.

$e$ = Maximum lateral deflection of tube—inches (see fig. 2)

$f$ = Maximum axial deflection of tube—inches (see fig. 2)

*$h$ = Height of drop of package—inches

*(Height of drop "h" actually consists of fall of package plus tube deflection "e" or "f". In most cases "e" and "f" are negligible compared with package drop.)

FOR A LATERAL DEFLECTION OF "e" AT PLANE NO. 1: — SEE FIG. 2

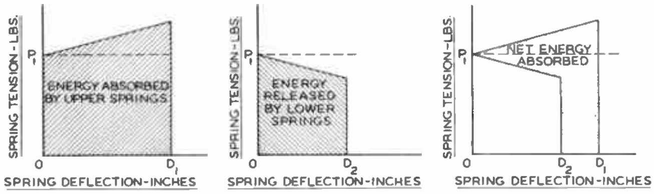



FIG. 3

FROM FIG. 3:

$$W_1 h = 2\left[\frac{1}{2} K_1 D_1^2 + P_1 D_1 - \left(P_1 D_2 - \frac{1}{2} K_1 D_2^2\right)\right]$$

$$W_1 h = K_1\left(D_1^2 + D_2^2\right) + 2P_1\left(D_1 - D_2\right)$$

SIMILARLY FOR PLANE NO. 2: — SEE FIG. 2

$$W_2 h = K_2\left(D_4^2 + D_5^2\right) + 2P_2\left(D_4 - D_5\right)$$

FOR AN AXIAL DEFLECTION OF "f" AT PLANE NO. 1: — SEE FIG. 2

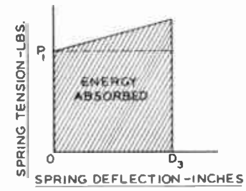



FIG. 4

FROM FIG. 4:

$$W_1 h = 4\left(\frac{1}{2} K_1 D_3^2 + P_1 D_3\right)$$

$$W_1 h = 2K_1 D_3^2 + 4P_1 D_3$$

SIMILARLY FOR PLANE NO. 2:

$$W_2 h = 2K_2 D_6^2 + 4P_2 D_6$$

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SPRING CHARACTERISTIC SOLUTIONS

CASE I: WHEN THE SYSTEMS AT PLANES NO. 1 AND NO. 2 ARE TREATED INDEPENDENTLY AND ARE SOLVED IN EACH CASE FOR THE CORRECT SPRING — $K_1 \neq K_2$ AND $P_1 \neq P_2$

$$W_1 h = K_1\left(D_1^2 + D_2^2\right) + 2P_1\left(D_1 - D_2\right) = 2K_1 D_3^2 + 4P_1 D_3$$

$$W_2 h = K_2\left(D_4^2 + D_5^2\right) + 2P_2\left(D_4 - D_5\right) = 2K_2 D_6^2 + 4P_2 D_6$$

FROM WHICH:

$$K_1 = \frac{W_1 h}{2D_3\left[D_3 + \left(\dfrac{D_1^2 + D_2^2 - 2D_3^2}{2D_3 - D_1 + D_2}\right)\right]} \text{ LBS PER IN} \qquad P_1 = \frac{W_1 h}{4D_3\left[D_3\left(\dfrac{2D_3 - D_1 + D_2}{D_1^2 + D_2^2 - 2D_3^2}\right) + 1\right]} \text{ LBS.}$$

$$K_2 = \frac{W_2 h}{2D_6\left[D_6 + \left(\dfrac{D_4^2 + D_5^2 - 2D_6^2}{2D_6 - D_4 + D_5}\right)\right]} \text{ LBS PER IN.} \qquad P_2 = \frac{W_2 h}{4D_6\left[D_6\left(\dfrac{2D_6 - D_4 + D_5}{D_4^2 + D_5^2 - 2D_6^2}\right) + 1\right]} \text{ LBS.}$$

CASE II: WHEN THE SAME SPRING IS USED IN BOTH PLANES — $K_1 = K_2 = K$ AND $P_1 \neq P_2$

$$W_1 h = K\left(D_1^2 + D_2^2\right) + 2P_1\left(D_1 - D_2\right)$$

$$W_2 h = K\left(D_4^2 + D_5^2\right) + 2P_2\left(D_4 - D_5\right)$$

$$h\left(W_1 + W_2\right) = 2K D_3^2 + 4P_1 D_3 + 2K D_6^2 + 4P_2 D_6$$

FROM WHICH:

$$K = \frac{h\left(\dfrac{W_1 + W_2}{2} - \dfrac{W_1 D_3}{D_1 - D_2} - \dfrac{W_2 D_6}{D_4 - D_5}\right)}{D_3^2 + D_6^2 - \dfrac{D_3\left(D_1^2 + D_2^2\right)}{D_1 - D_2} - \dfrac{D_6\left(D_4^2 + D_5^2\right)}{D_4 - D_5}} \text{ LBS PER IN}$$

$$P_1 = \frac{W_1 h - K\left(D_1^2 + D_2^2\right)}{2\left(D_1 - D_2\right)} \text{ LBS.}$$

$$P_2 = \frac{W_2 h - K\left(D_4^2 + D_5^2\right)}{2\left(D_4 - D_5\right)} \text{ LBS}$$

# The Eimac Spring Package—(continued)

The choice between the two systems illustrated depends mainly upon the distribution of mass between the two planes. If the center of gravity of the sprung weight is nearly midway between the two planes, in which case $W_1$ and $W_2$ will be nearly equal, the solution illustrated in Case II is satisfactory. In this case all eight springs are similar and the different values of $P_1$ and $P_2$ are accomplished by using suitable links connecting the saddles to the springs.

In many instances the masses at the two planes will be of considerable difference in magnitude. When this condition occurs the solution illustrated in Case II will give ridiculous values for K, $P_1$ and $P_2$. Therefore it becomes necessary to use two entirely different types of springs calculated on the basis illustrated in Case I.

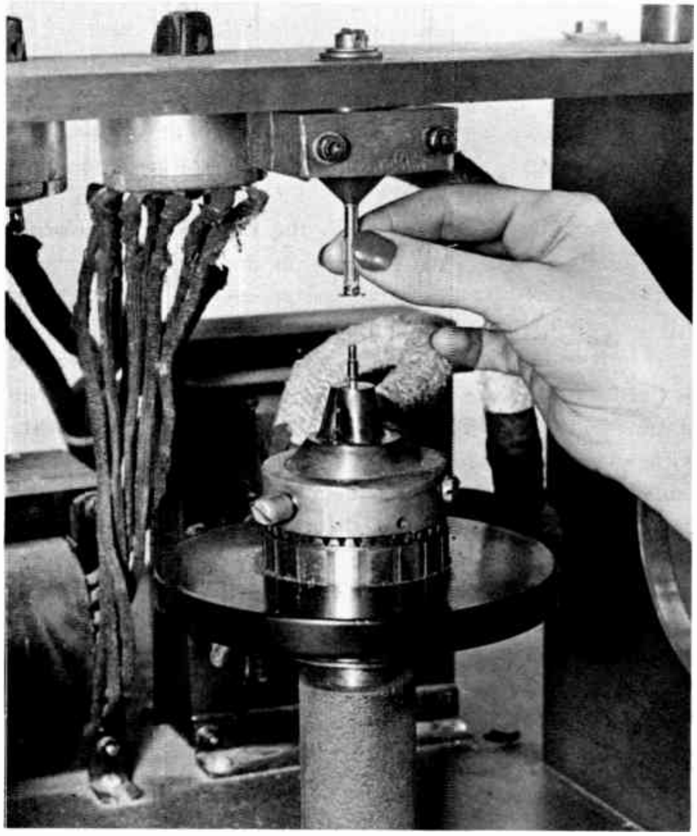
Springs are selected by the conventional methods of calculation or from tables. Particular attention is paid to the following contingencies:

1. Stress at the fully deflected lengths.
2. Initial tension to produce sufficient values of $P_1$ and $P_2$.
3. Sufficient assembled extension to prevent coils from closing at maximum relaxation.
4. Weight of springs. Springs should be as light as possible, and if their weight differs greatly from the estimated value previously included in $W_1$ and $W_2$, the values of K and P should be corrected accordingly.

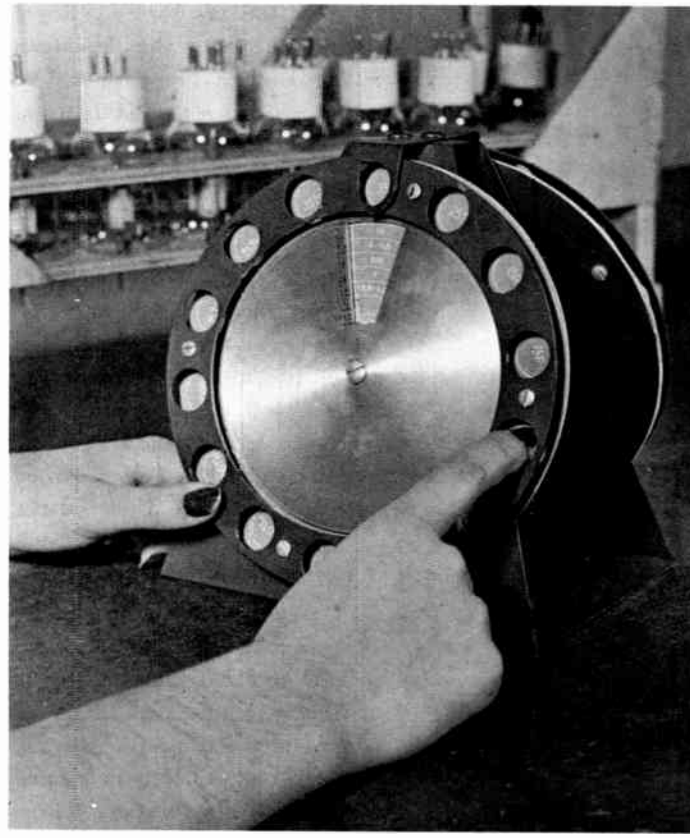
Before initial drop testing a package, a static check on the energy absorption is made. This test is accomplished by placing the assembled package on a platform scale and measuring the load versus deflection characteristics of the system in the required directions. The resistance in lbs. is then plotted against the deflection through distances of "e" and "f". The areas under the resulting curves represent energy absorbed and serve as a check on the accuracy of the preceding spring calculations.

When the packaging requirements are less critical a four spring system, two springs at each plane, is sometimes used. In cases of extremely critical requirements a sixteen spring system, eight in each plane, becomes necessary. In both instances the same fundamental method of analysis is used.

# ALONG THE PRODUCTION LINE



Simple but accurate is this welding jig, used in welding Eimac 15-E type grids to their beaded tungsten leads. The wheel (below) operates the chuck that holds the lead. The grid is held above in a sleeve.



Specifications for more than a dozen vacuum tube types are conveniently listed on this finger-tip dial used in the Eimac Inspection Department. The data are posted on an easily replaceable blueprinted scale.

NEWS ITEM—SCIENCE FINDS BATS USE KIND OF RADAR IN NIGHT FLYING.


*"REPORT TO EMPEROR HONORABRE SECRET WEAPON PRENTY HIGH CRASS! BAT CROSSED WITH HOMING PIGEON MAKING TWO-WAY RADAR VERY CONFUSION TO ENEMY!"*

# FIELD NOTES

RANDOM OBSERVATIONS FROM EIMAC'S FIELD ENGINEERS

Royal J. Higgins
600 South Michigan Ave.,
Chicago 5, Illinois
Harrison 5948

From the midwest Royal Higgins reports the Michigan State Police are now using radiotype between East Lansing and Detroit. When Sol Berk of Concord Radio Corp. (formerly Lafayette) of Chicago found that Eimac can deliver tubes on L-265 he said, "Isn't that hell? If that condition had only existed six months ago!" Up Detroit way the Detroit Edison Company is expanding its use of two-way radio and doing away with a great number of the toll circuits which had previously been used to control the equipment. Radio control will be used in the UHF region. Royal has just returned from a week at the San Bruno plant where he absorbed the latest 'goings on.'

M. B. Patterson
Allen Bldg.
Dallas 1, Texas
Central 5764

Pat Patterson says Howard R. Dreggors, chief engineer for Braniff Airlines, Dallas, informed him that his company is now beginning the installation of 20 grounds stations in Mexico. The first one, which is in Mexico City, is now in operation. These stations are to serve Braniff in its extended passenger service over most of Mexico.

On the Pacific Coast Herb Becker finds the reaction to Eimac's being able to ship tubes on L-265 is very favorable, and says this move should give some relief to jobbers around the country. Yes sir, that's it, prompt delivery on practically any Eimac tube on L-265.

Herb Becker
San Bruno, Calif.
Phone S. B. 4000

The police communication officers in California are very active in their organizational efforts. Last May the police boys from Southern California met with the Northern California group in Fresno, and because of the success of that meeting another is planned for the near future. Police communication in California is quite a bit different than found in most other states. In the first place there is about every kind of terrain with which to contend. Some counties actually have mountains, hills and desert within their boundaries. To those who haven't been out this way, California is a state 1,000 miles long . . . which is a lot of state.

From what is in evidence on this Coast, electronic heating seems to be doing a good production job for many plants. The Merit Diathermy Company of L. A. and Northwest Syndicates of Tacoma, both manufacturers of high frequency heating equipment, appear to be quite busy. (Of course, Eimac tubes!)

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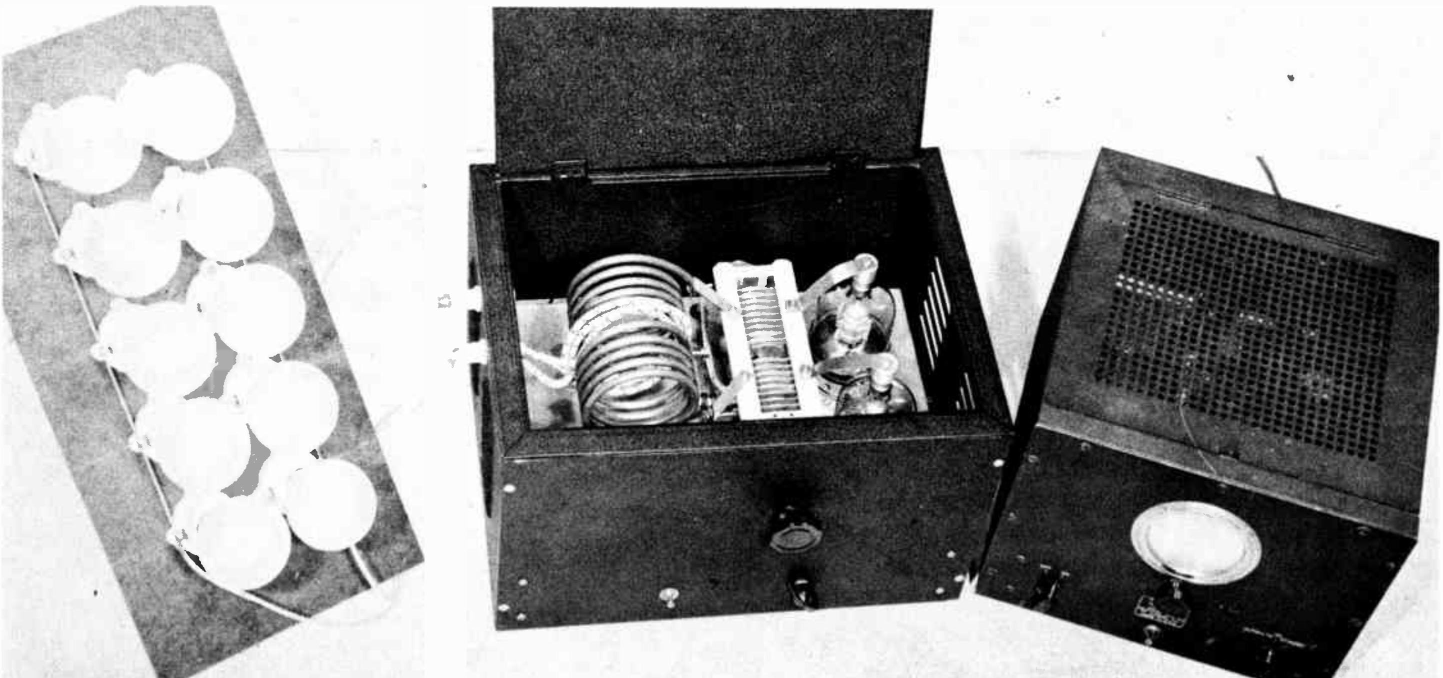
With the advent of the Industrial Edition of The Eimac News, a column of trade gossip from Eimac's field engineers and representatives seemed appropriate. There was not enough time to receive contributions from two field men: Adolph Schwartz, 262 Grayson Place, Teaneck, N. J. (phone Teaneck 6-7557) and Verner O. Jensen, 2605 Second Ave., Seattle 1, Wash. (phone Elliott 6871).



**This 750-watt transmitter was built in the Eimac Laboratory to illustrate the low driving-power requirements of the new Eimac 4-125A tetrode. The two 4-125A's operate at 75% plate efficiency at 14 Mc. when driven by the 6L6 doubler output stage in the Meissner Signal Shifter (at right). Full technical data on the 4-125A will be presented in an early issue of the Eimac News, Industrial Edition.**

# Vacuum Tube Ratings

Transmitting tube ratings seem to be subject to wide variations in interpretation. Herewith is a description of the why and wherefore of Eimac tube ratings

The subject of vacuum tube ratings has received what would seem to be an adequate amount of publicity in recent years. One would assume, from the volume of printed material available on the subject, that anyone who has even a nodding acquaintance with a vacuum tube would by this time be thoroughly conversant with tube ratings and their interpretation.

Yet, tubes continue to be operated under conditions which exceed the maximum ratings in certain respects, the user nevertheless stoutly maintaining that the maximum ratings are in his estimation not being exceeded. Such a state of affairs shows that the explanatory material to date apparently has not been adequate for the needs of all tube users.

## RATINGS IN GENERAL

The data presented on tube data sheets are usually divided into three categories, (1) Electrical and Mechanical Characteristics, (2) Maximum Ratings, and (3) Typical Operating Conditions. Electrical and mechanical characteristics are self-explanatory. The typical operating conditions are intended to guide the user in application of the tube under certain "typical" conditions. Several typical operating conditions for each class of service are usually given, with plate voltage as the independent variable. The conditions are chosen so that maximum performance is obtained for each value of plate voltage.

The conditions indicated as "typical" are not the only ones under which the tube can be used, however, and for this reason maximum ratings are given, so that if the user desires to choose his own conditions he will know the maximum capabilities of the tube in regard to certain restricting factors.

Maximum ratings are set solely on a basis of expected tube life. Each rating has been carefully determined by the tube manufacturer as the maximum value which will still permit a reasonable life expectancy for the tube.

Ordinarily the manufacturer sets each limit on an individual basis without regard to any other limit except where such limits are by their nature interdependent within the tube itself. Where the limits are interdependent in this way simultaneous operation at the maximum ratings involved is assumed in setting the limits, which may then be used as individual maximums.

The obvious objective in setting individual maximums is to allow the tube user the greatest amount of freedom in his choice of operating conditions—he need only observe each of the maximum ratings and take suitable measures to be certain that none of them is exceeded. Unfortunately, however, the practice of setting individual maximums has probably been the major cause of confusion in interpreting vacuum tube ratings.

It would seem to be obvious that it is quite possible in many cases to exceed a maximum plate dissipation rating, for instance, without approaching either maximum plate voltage or plate current. But, curiously enough, situations often arise where the tube user assumes that because he has not exceeded either a maximum plate voltage or plate current rating he cannot possibly be operating the tube above its rated capabilities, even though the plate dissipation happens to be several times the maximum rating.

There is little that can be done about such a situation, however, other than to continue to give the greatest possible publicity to tube rating systems and to set forth clearly the reasons for each maximum rating.

## MAXIMUM PLATE DISSIPATION

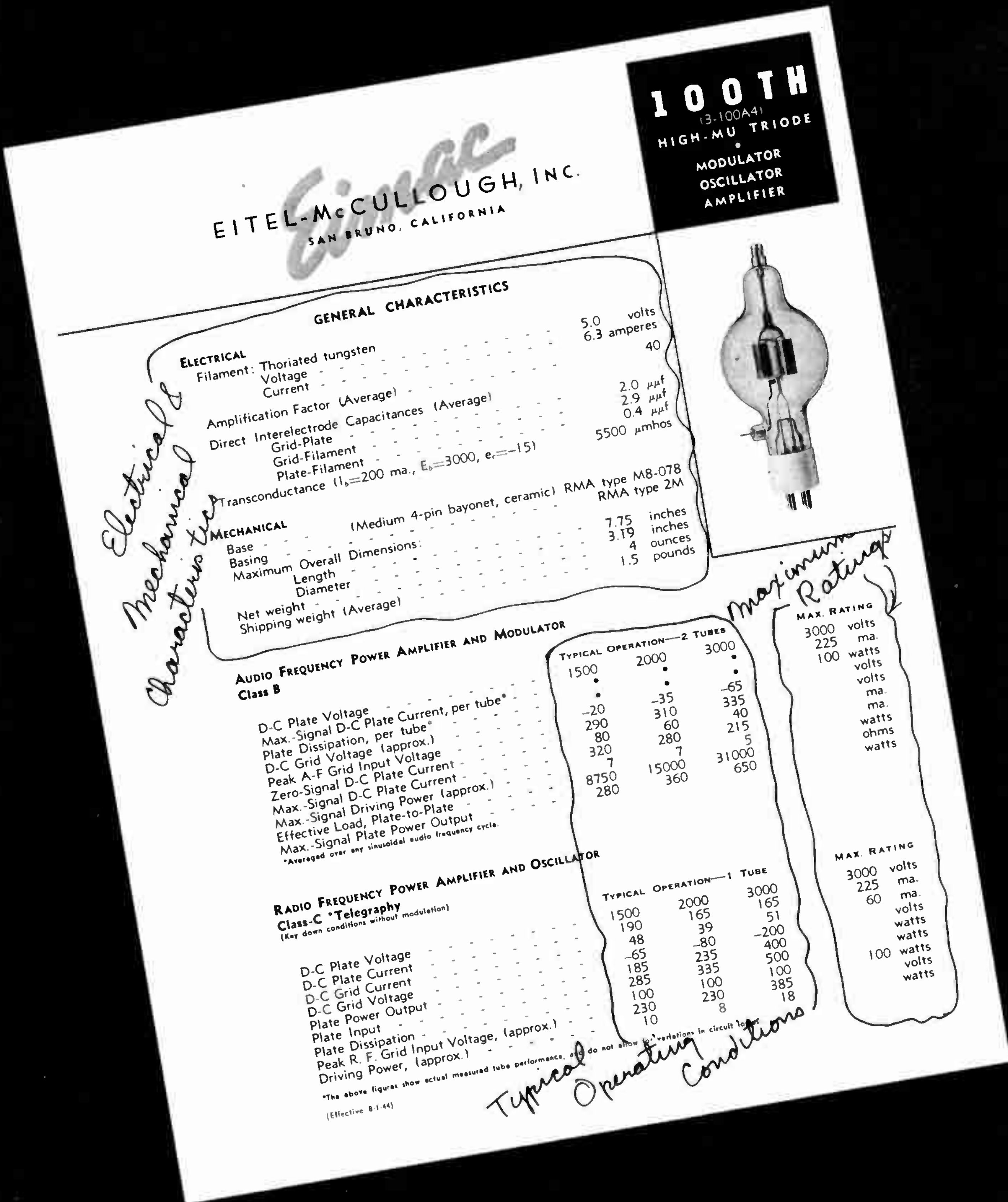
The plate dissipation of all radiation-cooled Eimac tubes is limited by plate temperature and its effects on parts of the tube other than the plate. The plates of all radiation-cooled Eimac tubes will withstand several times their maximum rated plate dissipation, but the heat generated by such operation has a considerable effect on other parts of the tube. The radiant heat from the plate causes the grid, filament and envelope to become heated, while heat conducted away from the plate by the plate lead contributes to the heating of the plate seal.

*" . . . plate dissipation . . . is limited by plate temperature and its effects on parts of the tube other than the plate"*

These effects are not ordinarily instantaneous, however, and for this reason all radiation-cooled Eimac tubes may be momentarily subjected to plate dissipation in excess of the maximum rating. The maximum plate dissipation rating is intended to set a point where continuous operation may be carried out without damage to any part of the tube, even though the other portions may at the same time be operating at their maximum ratings.

***Regardless of other conditions, the maximum plate dissipation rating should not be exceeded in continuous operation.*** **Plate dissipation in excess of the maximum rating is per-**

*(Continued on page thirteen)*



EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac

**100TH**
(3-100A4)
HIGH-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER

**GENERAL CHARACTERISTICS**

**ELECTRICAL**

| | |
|---|---|
| Filament: Thoriated tungsten | |
| Voltage | 5.0 volts |
| Current | 6.3 amperes |
| Amplification Factor (Average) | 40 |
| Direct Interelectrode Capacitances (Average) | |
| Grid-Plate | 2.0 μμf |
| Grid-Filament | 2.9 μμf |
| Plate-Filament | 0.4 μμf |
| Transconductance ($I_b$=200 ma., $E_b$=3000, $e_c$=−15) | 5500 μmhos |

**MECHANICAL**

| | |
|---|---|
| Base | (Medium 4-pin bayonet, ceramic) RMA type M8-078 |
| Basing | RMA type 2M |
| Maximum Overall Dimensions: | |
| Length | 7.75 inches |
| Diameter | 3.19 inches |
| Net weight | 4 ounces |
| Shipping weight (Average) | 1.5 pounds |

**AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR**
**Class B**

| | Typical Operation—2 Tubes | | | Max. Rating |
|---|---|---|---|---|
| D-C Plate Voltage | 1500 | 2000 | 3000 | 3000 volts |
| Max.-Signal D-C Plate Current, per tube* | • | • | • | 225 ma. |
| Plate Dissipation, per tube* | • | • | • | 100 watts |
| D-C Grid Voltage (approx.) | −20 | −35 | −65 | volts |
| Peak A-F Grid Input Voltage | 290 | 310 | 335 | volts |
| Zero-Signal D-C Plate Current | 80 | 60 | 40 | ma. |
| Max.-Signal D-C Plate Current | 320 | 280 | 215 | ma. |
| Max.-Signal Driving Power (approx.) | 7 | 7 | 5 | watts |
| Effective Load, Plate-to-Plate | 8750 | 15000 | 31000 | ohms |
| Max.-Signal Plate Power Output | 280 | 360 | 650 | watts |

*Averaged over any sinusoidal audio frequency cycle.

**RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR**
**Class-C °Telegraphy**
(Key down conditions without modulation)

| | Typical Operation—1 Tube | | | Max. Rating |
|---|---|---|---|---|
| D-C Plate Voltage | 1500 | 2000 | 3000 | 3000 volts |
| D-C Plate Current | 190 | 165 | 165 | 225 ma. |
| D-C Grid Current | 48 | 39 | 51 | 60 ma. |
| D-C Grid Voltage | −65 | −80 | −200 | volts |
| Plate Power Output | 185 | 235 | 400 | watts |
| Plate Input | 285 | 335 | 500 | watts |
| Plate Dissipation | 100 | 100 | 100 | 100 watts |
| Peak R. F. Grid Input Voltage, (approx.) | 230 | 230 | 385 | volts |
| Driving Power, (approx.) | 10 | 8 | 18 | watts |

*The above figures show actual measured tube performance, and do not allow for variations in circuit loss.

(Effective 8-1-44)



**Front page of a typical Eimac data sheet, annotated to the accompanying discussion on vacuum tube ratings**

missible for short periods of time with all Eimac radiation-cooled types.

### MAXIMUM PLATE VOLTAGE

Since Eimac tubes have no internal insulators, the only purpose of the maximum plate voltage limitation is to set a point above which the glass envelope will become damaged from dielectric losses or to set indirectly a limit to the r-f charging current flowing in the plate and filament leads. The charging current is a function of the r.f. plate voltage, which is in turn a function of the d.c. plate voltage; this makes it possible to set an adequate limit on r.f. plate current without requiring the difficult task of determining the current directly. Most Eimac maximum plate voltage ratings fall in the r-f-plate-current-limit category. However, an example of the glass-stress type of limit may be seen in the UH-50 data. This tube has the same electrode structure as the 75TL. Due to the fact that its grid and plate leads are adjacent at the top of the envelope, however, the UH-50 has a maximum plate voltage rating of 1250 volts, whereas its counterpart, the 75TL, which has widely separated electrode terminations, has a maximum plate rating of 3000 volts.

*Regardless of other conditions, the maximum plate voltage rating should not be exceeded.*

### MAXIMUM PLATE CURRENT

The maximum d-c plate current limit on Eimac tubes is based on the available filament emission. The maximum figure is intended to set a value which may be easily realized throughout the life of the tube. There has been no conclusive indication to date that excessive current has any direct effect on the life of the filament, although there is a certain amount of evidence to support such a belief. However, if operating conditions are chosen which require that the maximum plate current limitation be exceeded at the start of tube life, it may become increasingly difficult to maintain the excessive plate current as the tube ages.

*Regardless of other conditions, the maximum plate current rating should not be exceeded.*

### MAXIMUM GRID RATINGS

Maximum grid current ratings, when coupled with maximum bias voltage or maximum r-f grid voltage ratings could conceivably limit grid dissipation. In many tubes, however, there is little justification for an independent grid bias or r-f grid voltage rating from a practical standpoint. Actually, of course, excessive r-f or bias voltage could cause excessive seal heating or breakdown of glass insulation. On most Eimac tubes these limitations are more academic than actual, since the magnitudes of voltage required to damage the tube are far in excess of those needed in practice, and their use results in no advantage to the tube user.

In the practical sense, the only grid limitation for most Eimac tubes is grid dissipation. Excessive grid dissipation can result in either primary (thermionic) emission from the grid or in deformation or melting of the grid through overheating. Most Eimac tubes now have non-emissive grids, so that deformation or melting is usually the only result of excessive grid dissipation.

In the past, maximum grid dissipation has been more or less implied, rather than stated, on the Eimac tube data sheet by indicating a maximum grid current value. It was assumed that the tube user would not be likely to use more grid bias than necessary, since this would result in an increase in driving power without other compensating advantages, and that with a maximum grid current rating grid dissipation was thereby limited by practical considerations rather than by a definite statement. When the limit of grid dissipation was exceeded the user was usually made aware of the fact through a falling off of grid current as primary grid emission started to take place. The grid-emission phenomena is characteristic of tubes which do not employ special non-emissive grids, and its meaning is generally understood by the great majority of tube users.

The introduction of the non-emissive grid has led to difficulties with the maximum-grid-current rating, since there is generally little sign of grid emission in these tubes up to the point where the grid is permanently deformed by overheating. Obviously a new system of maximum grid ratings is required.

While it would be possible to set a limit on grid dissipation by giving maximum figures for both grid current and bias or peak r-f voltage, this has not been considered to be advisable since it places unnecessary and artificial restrictions on the application of the tubes. The new method of rating will consist only of a maximum on grid dissipation, and, in a few cases where glass-stem insulation is involved, a limit on r-f grid voltage. This grid-rating system will be used on all future printings of Eimac tube data sheets.

The influence of plate dissipation on grid temperature has been taken into consideration in setting up the grid dissipation maximums. The maximum grid dissipation figure given for each tube may be used simultaneously with maximum rated plate dissipation.

### GRID DISSIPATION MEASUREMENT

The obvious objection to grid-dissipation ratings is the necessity of determining the actual value of grid dissipation. Since grid dissipation is always equal to the total grid driving power less the power lost in the bias source, it is a simple matter to determine grid dissipation if the driving power is known. Driving power is equal to the driver output less the loss in the coupling circuits between the driver and the amplifier grid circuit (the coupling circuits include the driver plate tank, the coupling transmission line, and the amplifier grid tank, if one is used). Ordinarily, the losses in the coupling circuits will amount to about 30 per cent of the driver output. If this method is used:

$$P \cong N\,(P_{o\ driver}) - E_c I_c$$

Where $P$ = Grid Dissipation
$N$ = Coupling Efficiency (Ordinarily $N = 0.7$)
$P_{o\ driver}$ = Driver output power
$E_c$ = D-C Bias Voltage
$I_c$ = D-C Grid Current

Another method of determining grid dissipation is to

*(Continued on next page)*

subtract the bias loss from the driving power calculated by Thomas' formula[1]:

$$P_d \cong E_{gm}\ I_c$$

Where $E_{gm}$ = Peak R-F grid voltage

Grid dissipation is then approximately equal to:

$$I_c(E_{gm} - E_c) \cong P_g, \text{ or alternatively}$$

$$P_g = e_{gm}\ I_c, \text{ [2]}$$

Where $e_{gm}$ = Peak Positive Grid Voltage

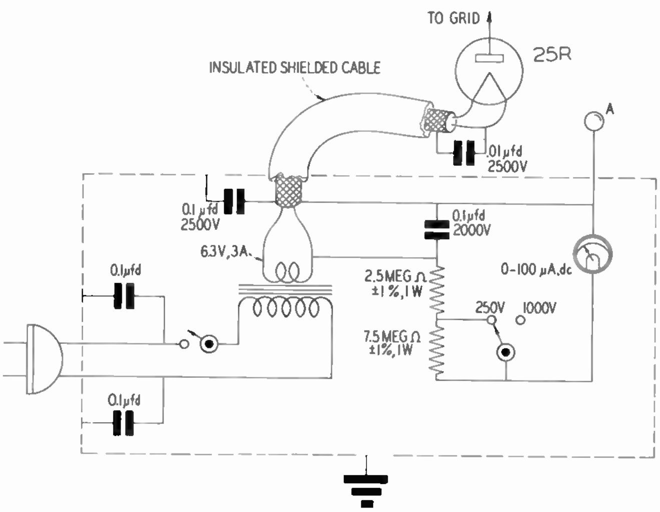



**Figure 1. Peak vacuum tube voltmeter for making $E_{gm}$ or $e_{gm}$ measurements.**

**"Polimerator" r. f. heating unit manufactured by Merit Short Wave Diathermy Co. The Polimerator employs two Eimac 304TL's in the high frequency oscillator unit.**

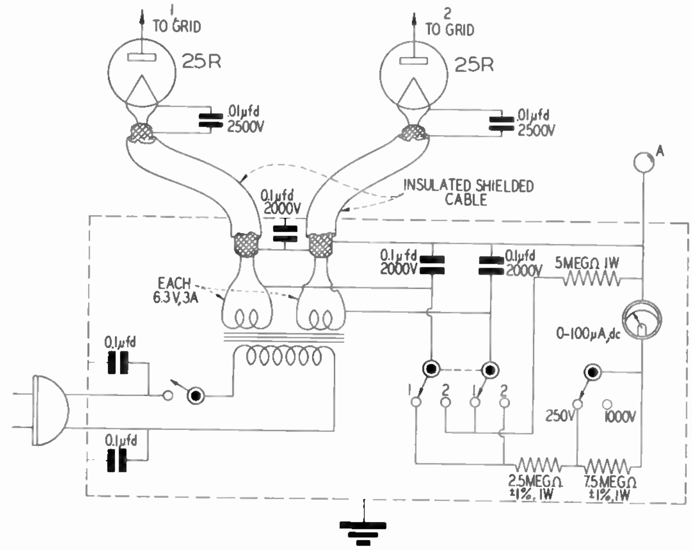



**Figure 2. Dual peak vacuum tube voltmeter for $E_{gm}$ or $e_{gm}$ measurements on push-pull stages.**

In order to use these expressions for $P_g$ it is necessary to determine either $E_{gm}$ or $e_{gm}$. A suitable peak voltmeter for this purpose is shown in figure 1. When terminal (A) is connected to the negative end of the C-bias supply the meter reads $E_{gm}$. With (A) connected to ground, the meter indicates $e_{gm}$. The first method of connection is most useful in measuring total grid driving power. When used to determine grid dissipation or driving power on a push-pull stage by measuring the voltage on each grid separately it may be advisable to shunt the "free" side of the grid tank circuit with a small capacitor having a capacitance equal to that introduced by the v.t.v.m. A dual peak v.t.v.m. suitable for $E_{gm}$ or $e_{gm}$ measurements on each side of a push-pull stage is shown in figure 2. When determining driving power per grid or grid dissipation per grid on a push-pull stage the value for $I_c$ should be taken as one-half the total D-C grid current, of course.

The following is a tabulation of the maximum allowable grid dissipation for a group of Eimac tubes:

| Type | Max Pg (Watts) | Type | Max Pg (Watts) |
|---|---|---|---|
| *25T | 7 | 250TL | 35 |
| 3C24 | 8 | 304TH | 60 |
| **35T | 15 | 304TL | 50 |
| 35TG | 15 | 450TH | 80 |
| UH50 | 13 | 450TL | 65 |
| 75TH | 16 | 750TL | 100 |
| 75TL | 13 | 1000T | 80 |
| 152TH | 30 | 1500T | 125 |
| 152TL | 25 | 2000T | 150 |
| 250TH | 40 | | |

*Max. $E_{gm}$ = 500 v.

**Max. $E_{gm}$ = 500 v.

*Regardless of other conditions, the maximum grid dissipation rating should not be exceeded.*

1. Thomas, "Determination of Grid Driving Power in Radio Frequency Amplifiers," **Proc. I.R.E.**, Vol. 17, p. 1134, (1933).
2. Everitt, "**Communication Engineering**" p. 562; McGraw-Hill.

# Nutrition at Eimac

## It All Started Here Simply Because A Lot of People Were Hungry

The Eimac nutrition program may not be the first of its kind in the country, but it can well lay claim to being one of the finest, as the War Foods Administration has publicly testified.

The essence of the program is the serving of attractive, delicious, complete and well-balanced hot meals for 25 cents, and free snacks at each rest period for plant and office workers. These two solid features reach maximum effectiveness through long-range planning and skillful administration.

The regular meal, served through the dinner hour on each shift, consists of a green salad, a choice of two entrees such as roast beef, roast pork, grilled liver, Swiss steak, fish, or on the weekly meatless day, a meat substitute. Once in a while abalone appears on the menu, or roast turkey.

Potatoes appear in a variety of presentations, fresh fruit and vegetables in abundance, a choice of enriched breads, butter, light desserts, and coffee, tea or milk (or all three).

For the light luncher, or the girl concerned with her weight, the salad counter offers a varied selection which together with soup, bread, dessert and beverage will provide an ample luncheon—also for two bits. Milk is free with or without any meal.

The aim is a meal that satisfies but does not stuff, for the average individual in the average job at Eimac, where the difference between plant and office work is not so marked as it is in heavier industries.

On something of the same principle, the same free snacks are served during the 10-minute rest periods (two hours after the start of each shift and two hours after the dinner period) to plant and office workers alike. These snacks consist of milk, tea, fruit juice or coffee—the latter a compromise with an American custom that outweighs pure nutrition. On cold days hot soup is provided. Doughnuts, small cakes, cookies, supplement the beverages at intervals.

The real value of the Eimac program, however, is not to be measured alone by the price or quality of the food. Like any other management service to employees, its worth lies in its motives.

It was no paternalistic gesture that started the cafeteria, set the price, sent the rest period snack trucks into the plant and office. It wasn't a cure-all for an industrial illness, a manpower nostrum.

It was simply the recognition of a human need as naked as an unguarded mechanical hazard. Here was a large group of people who had neither time nor facilities for adequate attention to their own nutritional requirements. Here were hungry people trying to work.

There was no place anywhere near either of Eimac's two

*(Continued on next page)*

**Leone Woods is the presiding genius at the Eimac San Bruno cafeteria. A graduate nutritionist and dietician, she is expert in large-scale feeding**

**Between meals snacks keep fatigue down**

**A kitchen compact and efficient as a ship's galley, spotlessly clean**

## Nutrition at Eimac—(continued)

plants (San Bruno, California, and Salt Lake City, Utah) where a good meal was to be had, particularly on the night shifts.

Relatively few of the employees had adequate means for preparing box lunches at home, and a cold lunch is not sufficient for a precision worker subject to eye and nerve strain aggravated by war conditions.

The result: men and women subsisting on soft drinks, sandwiches, pastries hastily procured from a neighborhood grocery store. In many instances people simply went without food through a shift, save for coffee or a coke.

Here then was the first item of necessity.

Eimac made its first venture into this problem when the company included a cafeteria in the main building plan at the new Salt Lake City plant which opened in August, 1942. This cafeteria was started as a leased concession, however, an operation which did not prove to be wholly satisfactory.

When in the spring of 1943 it finally became possible to erect a cafeteria building in the San Bruno plant, it was decided to coordinate both programs and to make them entirely company-managed.

The San Bruno cafeteria opened July 8, 1943. A single-coin price of 25 cents for the full meal was established for both cafeterias simultaneously. By agreement with the Signal Corps and with the various federal agencies concerned, this price was to cover the cost of raw food alone. No charge was to be made to the employees for labor, overhead, food preparation and service, the cost of the building and equipment, or for the free snacks or for the free vitamin tablets offered with each meal.

Considerable discussion preceded the establishment of the 25-cent price. At one time it had been planned to serve a free meal, but since this would tend to deprive the customer of his inherent right to register complaint about the food or the service, and since an unavoidable tendency to waste food seemed certain to result, this plan was discarded.

*(Continued on next page)*

# Nutrition at Eimac—(continued)

The 25-cent price was adopted because a single coin exchange involved less lost time at the cash register, and because it appeared possible that such an amount might cover raw food cost, as the Army suggested.

A summary of the first six months of operation of the new cafeteria showed a difference between cash register returns and actual food cost of just one-half a cent!

The price was high enough to provide freedom for grumbling (to date there hasn't been any), high enough to hold down waste, yet low enough to provide serious competition with public restaurants, box lunches or the soft drink-sandwich combination.

So two bits it was and two bits it still is—a fair price and a convenient one. No effort is made to control the number of meals served to any one person.

Breakfast is served between 6:30 and 8:00 A.M., covering those who are coming off the graveyard shift and those going on the day shifts (plant and office).

Because it is a supplementary service, the price of breakfast is scaled at total cost (food and overhead). However, since it rides on the very efficiently administered cafeteria program, the breakfast cost is relatively slight, and one can get a highly satisfactory meal for 25 cents, while for 50 cents one could stoke up for a mountain climbing expedition.

The management's concern over the employee's nutritional well-being does not stop with serving good food at food cost, nor with free snacks, free milk, free vitamins.

Of considerable importance to nutritional benefit is enjoyment of food. Enjoyment is accomplished by several simple means—a quiet, attractive, informal environment, music, community dining tables for sociability, complete democracy in a single standard of food, price and service for every customer regardless of job or position.

No less important from the enjoyment standpoint is the selection and preparation of *attractive* food combinations, the selection and training of a cheerful, courteous staff.

Special diets are provided to individual employees on the request and the advice of the plant medical department. Individual employees are advised by the nutritionist-manager in problems of home food preparation, diets and substitutes. Posters, pamphlets, articles in the plant news magazine supplement these services.

Because of the incidence of eye strain, foods high in vitamin A content are emphasized—you'll find carrots in nearly every meal.

Vitamin preservation is a conscious, directed effort in all food purchasing, storage and preparation. Food values get equal attention with food flavors.

A frequent question from visitors is something like this: "Have you noticed any increase in the efficiency of your workers since you opened the cafeteria?"

The answer is that the management does not know and does not particularly care. There is no possible way of measuring such an effect, and to attempt to calculate the human benefits of the program in terms of production units would defeat the prime purpose of the program.

**Good food, well prepared, is the secret**

Medical department records show a distinct flattening in the accident frequency rate following the opening of the cafeteria, but this could just as well be ascribed to better training of supervisors, the acquisition of skill by the workers, or to any other convenient factor.

**(See graph on page 19)**

Absenteeism and turnover cannot be measured against such a program, though there can be little doubt that adequate feeding has a very decided effect on these two industrial headaches. Eimac, by virtue of consistent application of the same principles that led to the establishment of the cafeteria problem, has always enjoyed a phenomenally low absenteeism and turnover rate.

The effect of a good nutrition program has to be considered from a broader point of view. What, for example, is the effect of good nutrition—or bad—on any group of people under any conditions? Common sense provides the answer, adequately supported by medical findings.

Industry at large could well afford to consider the adage that "you are what you eat," in pondering employee health and welfare programs.

*(Continued on next page)*

# EIMAC CAFETERIA IS A COMFORTABLE SORT OF PLACE

**Music and a restful atmosphere make good meals even more enjoyable**

## Nutrition at Eimac—(continued)

Industry has readily available the information, the technical ability at least to begin to overcome some of the faulty food habits which at least 50 per cent of the wage earners in this country have followed from birth.

A poor diet is not a special attribute of the hourly-rate worker. It is quite as prevalent among office workers, particularly women. Even college-trained people are prone to eat according to habit patterns rather than in light of modern nutritional knowledge.

Malnutrition, of one grade or another, is far more widespread than is ordinarily imagined. A very large percentage of the physical rejections under Selective Service, numbering 45 per cent of the total called up, can be laid at the door of bad diet.

Malnutrition of any grade leads to disease, defeatism and apathy. Frequent colds, lack of strength and energy, tiredness, irritability, depression—all these are symptoms of faulty nutrition which no packaged pills can entirely correct.

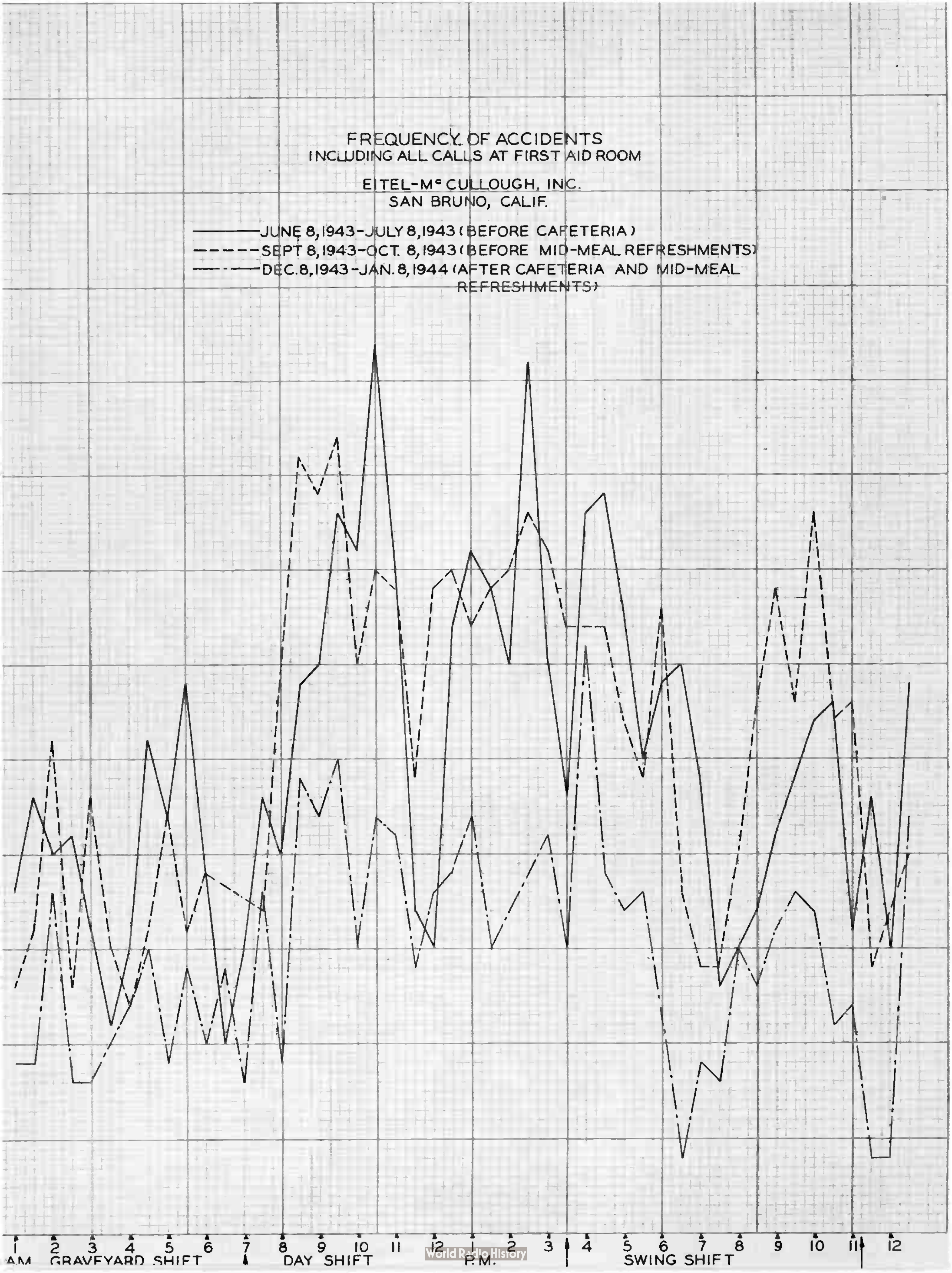
Malnutrition paves the way for serious infections and diseases such as tuberculosis, pellagra, scurvy, polyneuritis.

A sick man is a problem under any conditions. A man, half-sick from poor food, easily gets out of step with the world, becomes a crank, irritable, hyper-sensitive. He loses ambition. He is a safety hazard for himself and his associates. He is a poor employee, a poor citizen in any society.

All this is common knowledge. Less common, unfortunately, seems to be the ability to apply this knowledge to the general theme of industrial welfare, to the obvious truism that the welfare of the employee is the welfare of the employer.

Therein lies the answer to the question of whether a cafeteria improves efficiency. If the cafeteria improves the health of the employee *to any degree whatever,* it cannot but greatly improve the entire industry concerned.

This improvement, of course, is measured directly by the quality of the nutrition program, by the cafeteria and what it provides and how it provides it. Poor food, sloppily prepared and indifferently presented, or served up at competitive prices, will cost the company far more in morale damage than it will gain in food profit, and the initial purpose of improved health will be hopelessly lost. An industrial feeding program established for any purpose less than optimum employee health would be a poor investment in the future.



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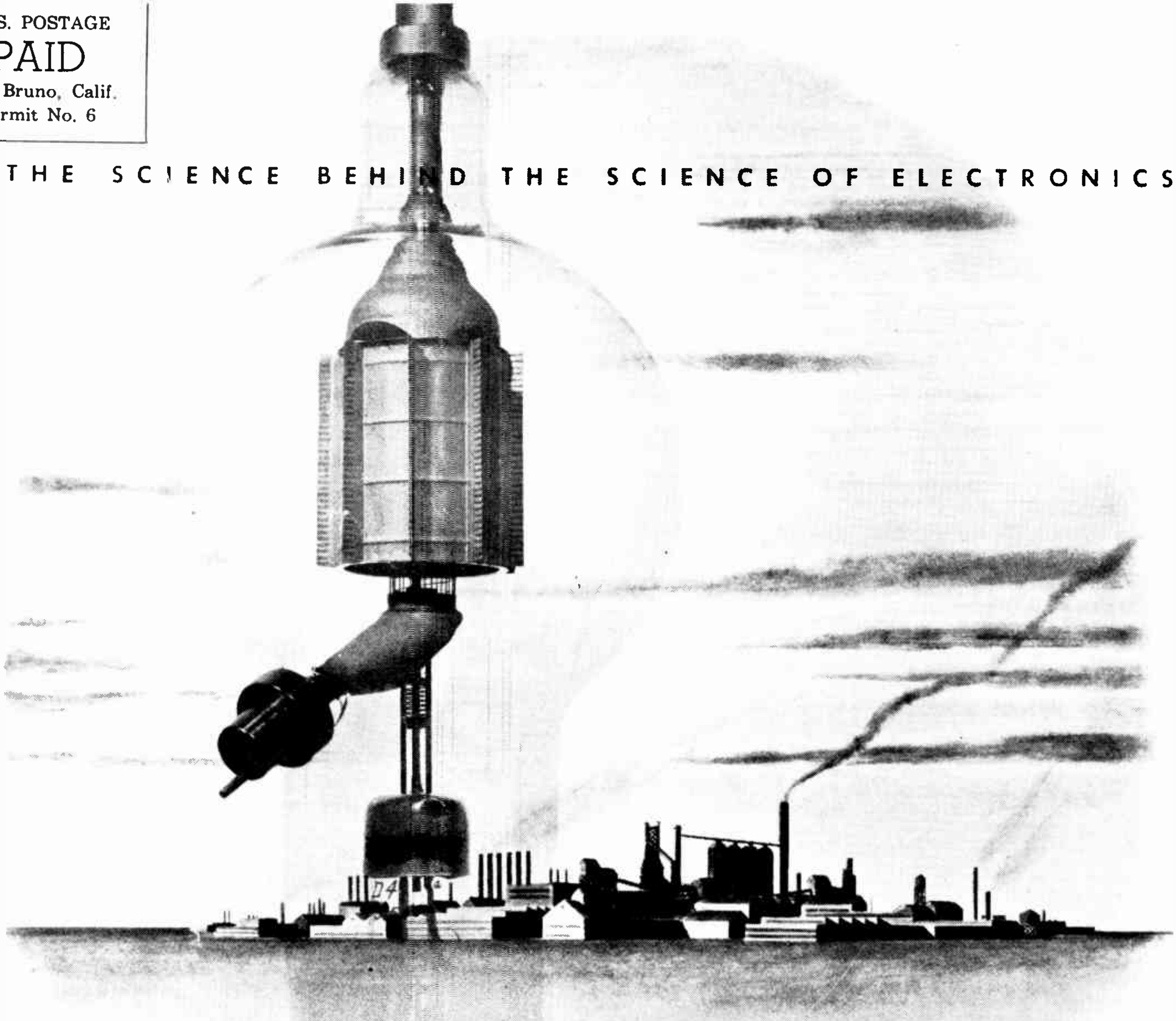

# DAWN of a New Power for Industry...

Of man's achievements in opening new sources of power, perhaps the greatest—certainly the most spectacular—is in electronics. The science of electronics is opening new avenues of productiveness and efficiency to industry. Here man probes almost to the source of energy itself to harness and release new forces. Through the medium of the Electron Vacuum tube, you can put this new power to work. "Eimac" have been exclusively engaged in the development, perfection and production of Electron Vacuum tubes for more than a decade. During this time they have become first choice of leading electronic equipment manufacturers the world over. When selecting equipment for your application, look first for the name Eimac on the tubes.

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TUBES

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