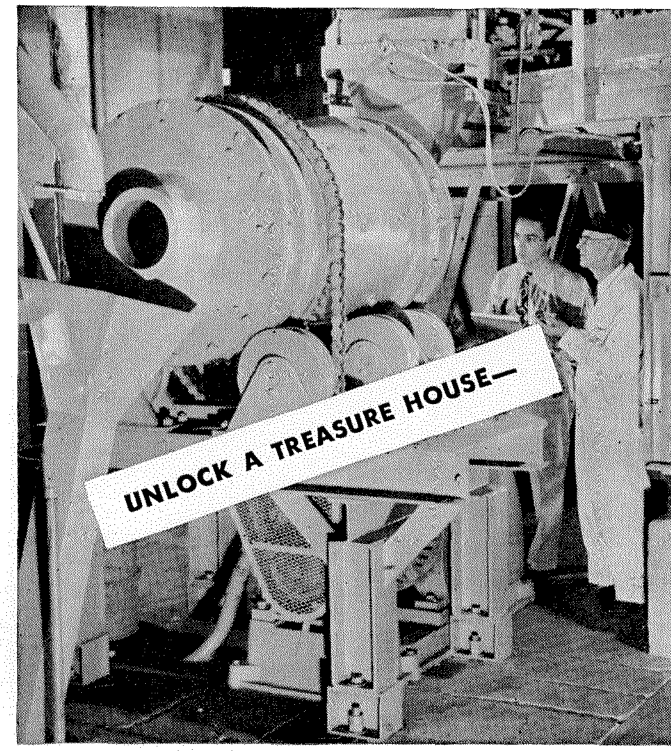
ENGINEERING AND SCIENCE

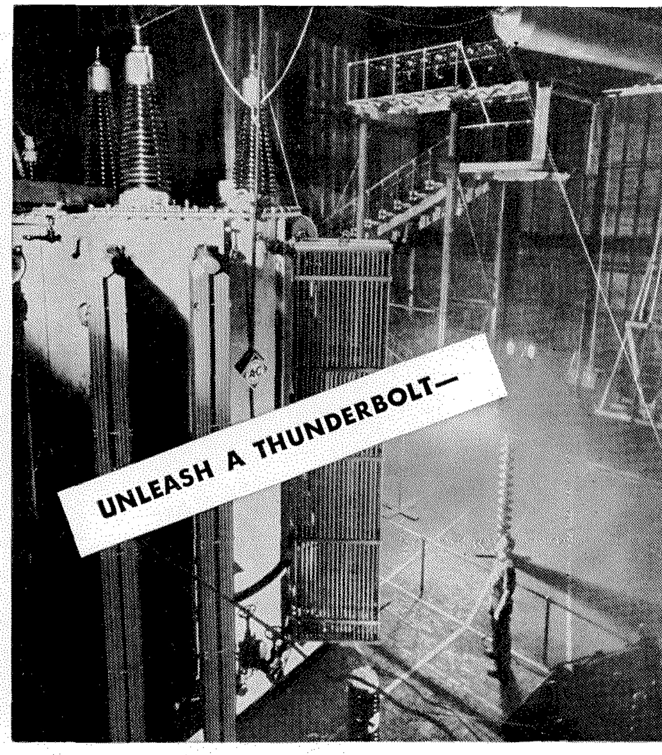
MONTHLY

OCTOBER 1948

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

OPEN: New Fields to Explore!





An Allis-Chalmers scientist seeks new, better ways to reduce low-grade ores . . .

. . . another hurls lightning at giant transformers to test abnormal stresses . . .

. . . another catches "wolf whistles" from the sun for clues to better power transmission!

The whole history of A-C is one of far-flung research and pioneering . . . of revolutionary advancements in almost every field of science and industry!

Whatever your chosen field—electric power, hydraulics, processing, machine design or production—you'll find unequaled opportunities in Allis-Chalmers' broad range of operation!

INVESTIGATE

ALLIS-CHALMERS

ONE OF THE BIG 3 IN ELECTRIC POWER EQUIPMENT—
BIGGEST OF ALL IN RANGE OF INDUSTRIAL PRODUCTS!

Write for Book No. 6085, outlining A-C's Graduate Training Course.

Allis-Chalmers Mfg. Co., Milwaukee 1, Wisconsin

Letters

Dear E & S:

When I wrote you on April 19, 1948, I did not realize I would get to the International Conference on High Voltage Transmission Systems to be held in Paris, in connection with my technical paper which they had accepted for presentation. However, I was selected to attend the conference as an official delegate of the State Department. . . .

There were 1,140 engineers from 40 countries in attendance . . . of whom 15 were from the United States. I presented two papers by Bureau of Reclamation engineers, one of which I co-authored. After the conference, I made a trip to Switzerland and witnessed demonstrations on a new concrete-filled steel tube, and a transmission line tower, and inspected a new underground power plant, and a high head (1,750 meters) hydroplant. I also visited the large hydraulic laboratory at Grenoble, France.

Wendal A. Morgan '33
Denver, Colorado

• • •

Dear E & S: . . .

Having been one of the golf architects and laborers who installed the three-hole course back of Throop Hall in 1923, I thought you might be interested in the golfing status of the golfing Simpsons.

Mrs. Rilla Simpson, several times a winner of the Woodbury (N. J.) Country Club women's championship, was crowned again July 8th. Rilla won the South Jersey Women's Golf Championship in 1946 and was runner-up in 1947 and 1948.

Bert Simpson, a two-handicapper at his home club of Woodbury, recently won the South Jersey Boys Championship. . . . He played No. 1 on the Woodbury Country Club team in the 1948 Philadelphia Golf Association Interclub Matches and more than held his own against some topnotch golfers. Bert is now attending the Peddie School at Hightstown, N. J.

Tom Jr., 15, a five-handicapper at home, recently distinguished himself by being the 1948 runner-up in the South Jersey Amateur Championship at the Woodcrest Country Club at Haddonfield. Tom's 76 led a large field of over 200 whose scores ran high because of the soggy course, but Tommy finally was bettered by a 73—and went on to win his age division in the South Jersey Boys Championship the following week.

Pop also plays golf, as a seven-handicapper at Woodbury. He is not a tournament player, which explains his lack of trophies; but Pop boasts a score of 80 at the Pine Valley Golf Club. In case any old alumnus friend on an Eastern excursion wishes to enjoy a day of divot digging, sand blasting and bush whacking at "The Valley," he is invited to

Continued on page 14

ON THE COVER

Sure sign of fall at Caltech—a noontime volleyball game on the campus. This month's cover shot was taken by Ralph Lovberg '50.

ENGINEERING AND SCIENCE
Monthly
The Truth Shall Make You Free

CONTENTS FOR OCTOBER, 1948

●

ENGINEERING AND SCIENCE MONTHLY
Published at the California Institute of Technology

ENGINEERING AND SCIENCE MONTHLY is published monthly, October through July, by the Alumni Association, California Institute of Technology, Inc., 1201 East California Street, Pasadena 4, California. Annual subscription $3.50, single copies 35 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879.

ENGINEERING AND SCIENCE
Monthly

Vol. XII, No. 1 October, 1948

ARE WE IN FOR A LONG DROUGHT?

A look at the past provides the outlook for the future

by FRANKLIN THOMAS

PROBABLY IN no other area of comparable size in the world is the value of water so high when measured in terms of wealth it creates as in Southern California. During the period of residence here of most of the present population, there has not been much occasion to consider or question the availability of adequate water supplies. However, the 1947-48 season of low rainfall, while acute and damaging, is a period such as has occurred in Southern California at intervals in the past and must be anticipated in the future. In fact, this locality is fortunate that the current shortage of rain has not been experienced several years earlier than now, for a repetition of the severe eleven-year drought which occurred from 1893 to 1904 might be considered overdue.

The accepted rainfall record of Los Angeles extends for 71 years, since 1877, and is the longest available in the metropolitan area. That of Pasadena is continuous for the past 66 years.

The amount of rainfall is greater for inland locations than along the coast and increases with altitude toward the mountains. For instance, the seasonal aver-

Annual Rainfall in Inches for Los Angeles
Rainfall Season, July 1 to June 30

1877-78	21.26	1895-96	8.51	1913-14	23.65	1931-32	16.95
1878-79	11.35	1896-97	16.86	1914-15	17.05	1932-33	11.88
1879-80	20.34	1897-98	7.06	1915-16	19.92	1933-34	14.55
1880-81	13.13	1898-99	5.59	1916-17	15.26	1934-35	21.66
1881-82	10.40	1899-1900	7.91	1917-18	13.58	1935-36	12.07
1882-83	12.11	1900-01	16.29	1918-19	8.58	1936-37	22.41
1883-84	38.18	1901-02	10.68	1919-20	12.52	1937-38	23.43
1884-85	9.21	1942-03	19.32	1920-21	13.65	1938-39	13.07
1885-86	22.31	1903-04	8.72	1921-22	19.66	1939-40	19.21
1886-87	14.05	1904-05	19.52	1922-23	9.59	1940-41	32.76
1887-88	13.87	1905-06	18.65	1923-24	6.67	1941-42	11.18
1888-89	19.28	1906-07	19.30	1924-25	7.94	1942-43	18.17
1889-90	34.84	1907-08	11.72	1925-26	17.56	1943-44	19.22
1890-91	13.36	1908-09	19.18	1926-27	17.76	1944-45	11.59
1891-92	11.85	1909-10	12.63	1927-28	9.77	1945-46	11.65
1892-93	26.28	1910-11	16.18	1928-29	12.66	1946-47	12.66
1893-94	6.73	1911-12	11.60	1929-30	11.52	1947-48	7.22
1894-95	16.11	1912-13	13.42	1930-31	12.53	1948-49	?

Average of 71 years = 15.32 inches

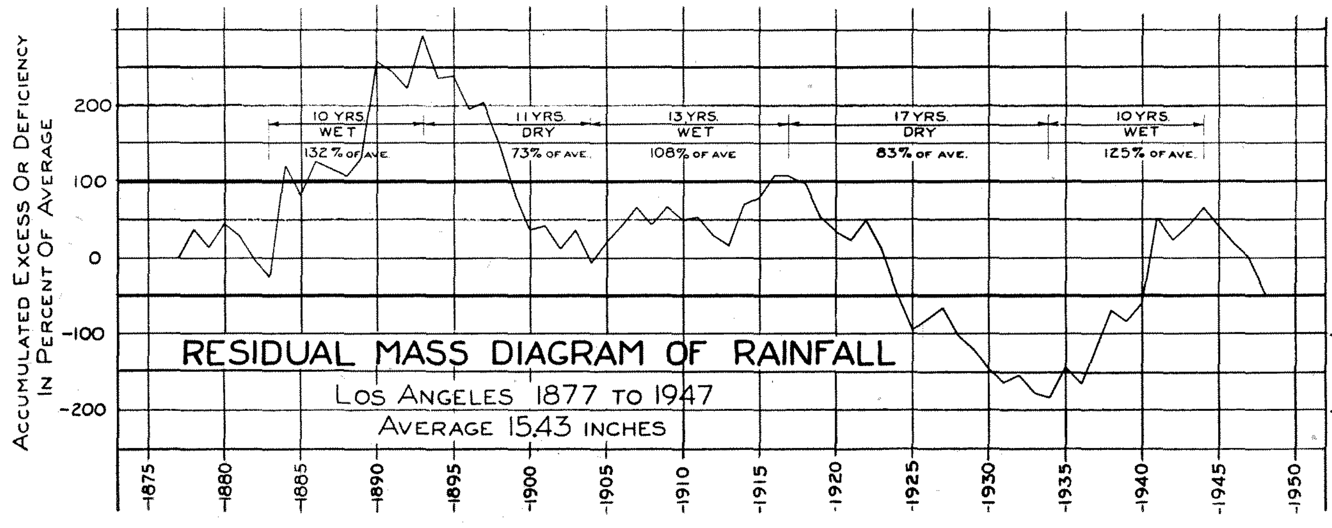


Diagram showing 71 years of rainfall for Los Angeles reveals alternating periods of above and below-average precipitation.

age for Pasadena, 20.63 inches, is slightly more than a third greater than 15.32 inches for Los Angeles. However, there is complete consistency between locations on the Coastal Plain in regard to the pattern of wet and dry periods.

While the fluctuations of rainfall as represented by the record of Los Angeles may not be sufficiently regular in extent and duration to be called cycles, there do seem to occur alternating periods of above-average and below-average precipitation. In the 71 years of rainfall record, there are three periods of above average rainfall alternating with three periods of below-average rainfall.

Identifying these wet and dry sequences is facilitated by constructing a chart called a residual mass diagram which represents an accumulation of seasonal excesses or deficits of rainfall in comparison to the average throughout the whole record. Such a chart appears above. It resembles the fluctuations of a savings bank account in which a surplus is built up by deposits larger than the average of all withdrawals over a period of time—a surplus that may later be depleted by withdrawals in excess of the average. The chart shows that there have been wet and dry periods following each other in succession and extending from ten to seventeen years in duration. The season of 1943-44 seems to have terminated a ten-year series of years providing considerably more rain than the average for Los Angeles, and the current season was the fourth consecutive season of sub-normal precipitation. Either a wet or a dry period may include one or more conflicting seasons with only a temporary interruption of the general trend.

The present marks the second time that four successive years of sub-normal precipitation appear in the record. They brought 70% of average. The other occurrence was from 1927-31 and represented 75% of average. On two other occasions three successive years of sub-normal precipitation occurred: 1897-00 at 45% of average, and 1922-25 at 53% of average. Such series of dry years occur in, and largely create, a below-average sequence. There seems to be less probability of the successive occurrence of above-average wet years. A succession of three wet years appears but twice: 1904-07 at 125% of average, and 1913-16 at 131% of average. On six occasions there are two successive wet years. All of the latter pairs of wet years occurred in wet sequences except one, 1925-27, which constituted a two-year interruption of, and minimized the severity of, a 17-year dry sequence.

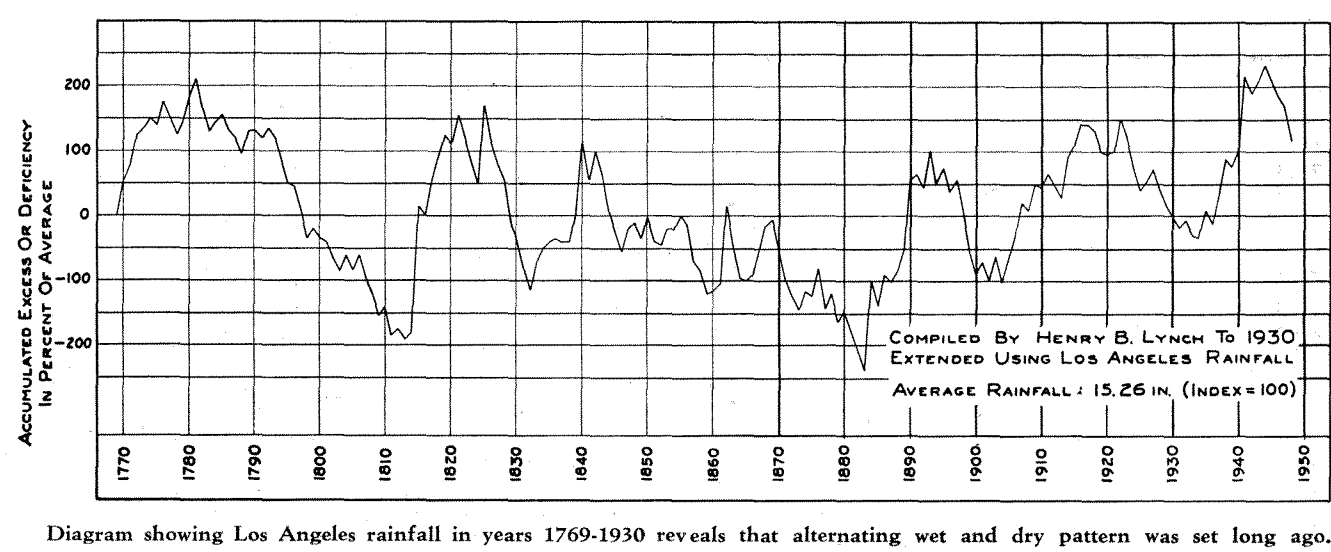


Diagram showing Los Angeles rainfall in years 1769-1930 reveals that alternating wet and dry pattern was set long ago.

On the basis of past indications then, there is good reason to expect that the season of 1948-49 will provide above-average rainfall to be followed by, in the aggregate, from five to ten years of less-than-average precipitation.

Historical rainfall indices

In a populous area where the water supply is so variable and so largely dependent upon that brought from distant sources, it is of great importance to have as much information as possible about conditions prior to the relatively recent date when the collection of official records of rainfall began. The best compilation available of such data is that accumulated through years of research by Mr. Henry B. Lynch, a Consulting Engineer who has made exhaustive search of crop records of the California Missions, reports of the Padres, diaries, journals, miscellaneous writings, court records and newspaper files, and from them assembled facts concerning rainfall, floods and droughts.

Mr. Lynch determined rainfall indices for successive seasons in relation to the record of recent years. The index of a season of average rainfall is taken as 100, then the indices of other years are expressed in per cent of the average.

His table of indices begins with the year of the founding of the San Diego Mission in 1769 and carries them through to 1930. The indices for the Los Angeles area are shown below, together with a residual mass diagram of the Lynch rainfall indices, on page 4.

The historical record shows alternating wet and dry trends similar to those which comprise the record of recent years. There are some aspects of the historical record, however, which are more ominous than the recent indications. California's most severe drought occurred in the period 1821-32; of the eleven years all but one had low rainfall indices ranging from 35 to 75. Following the conflicting season of 1824-25, notable for its great flood, there were seven consecutive and acutely dry years, including that of 1828-29, when the index dropped to the low of 35.

Aside from the drought just described, one extending twenty-eight years, from 1781-1809, is most pronounced, but more for its duration and lack of appreciable interruption than for its intesity. In contrast, during the century when California was being settled,

Rainfall Indices Los Angeles Area 1769 - 1930

1769-70	155	1810-11	155	1850-51	60	1890-91	109
1770-71	125	12	110	52	95	92	79
72	145	13	85	53	125	93	158
73	110	14	110	54	100	94	49
74	115	15	195	55	120	95	123
75	90	16	85	56	85	96	62
76	135	17	155	57	45	97	119
77	75	18	135	58	85	98	50
78	75	19	135	59	65	99	41
79	125	20	85	60	125	1900	64
80	135	1820-21	145	1860-61	90	1900-01	117
1780-81	125	22	65	62	220	02	72
82	55	23	65	63	40	03	137
83	65	24	65	64	50	04	61
84	115	25	220	65	95	05	137
85	110	26	45	66	110	06	134
86	75	27	65	67	135	07	152
87	90	28	75	68	140	08	88
88	75	29	35	69	110	09	140
89	135	30	75	70	55	10	95
90	100			1870-71	50	1910-11	121
1790-91	90	1830-31	55	72	75	12	82
92	115	32	45	73	80	13	81
93	85	33	165	74	129	14	163
94	65	34	120	75	92	15	120
95	65	35	110	76	143	16	131
96	95	36	105	77	38	17	100
97	65	37	95	78	124	18	92
98	55	38	100	79	54	19	66
99	115	39	145	80	118	20	97
1800	85	40	210	1880-81	71	1920-21	103
1800-01	95	1840-41	40	82	69	22	150
02	75	42	145	83	68	23	72
03	80	43	65	84	240	24	53
04	125	44	45	85	61	25	64
05	75	45	65	86	147	26	115
06	125	46	70	87	90	27	119
07	65	47	135	88	118	28	69
08	75	48	110	89	134	29	76
09	65	49	75	90	206	30	82
10	115	50	135				

Average rainfall season, 15.26 inches = 100.

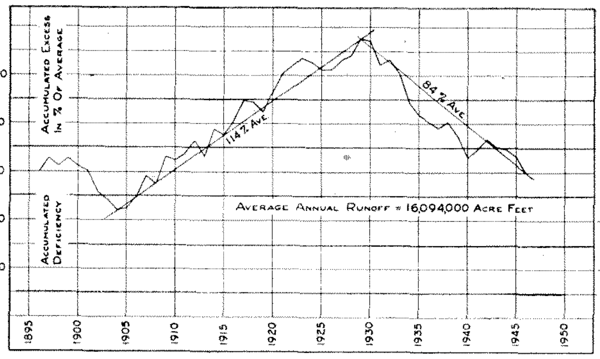


Diagram of Colorado River's flow shows longer wet and dry sequences than those in Los Angeles rainfall record on page 3

there were three seasons characterized by outstanding floods. They were 1824-25, 1861-62, and 1883-84. These floods are believed to have been on the order of that which occurred in March 1938.

Tree ring indications in Southern California

Studies of "Tree Ring Hydrology in Southern California", by Dr. Edmund Schulman, published by the University of Arizona, have identified tree ring records on Mt. San Bernardino back to 1350 A.D. For the period of historical and measured reports of rainfall, the years of poorest growth were 1864 and 1899. But Dr. Schulman notes that "In the last five centuries there were years of substantially greater severity for tree growth in A.D. 1492, 1542, 1580, 1585, 1590, 1613, 1633, 1654, 1670, 1782, and 1845, with many others of comparable deficiency." In contrast, growth in a number of years in previous centuries exceeded the greatest extremes of the last dozen years. Notwithstanding the recognition of evidence of alternating wet and dry periods in the distant past, no cycles of such regularity and dependence as to be usable in long range forecasting have as yet been identified from the study of tree rings.

Colorado River discharge

Those areas in Southern California which have had the foresight to protect their needs through arrangements for Colorado River water can view the current drought with moderate complacency. The question then arises whether shortages of rainfall in this part of the State would coincide with periods of low seasonal run-off in the Colorado River.

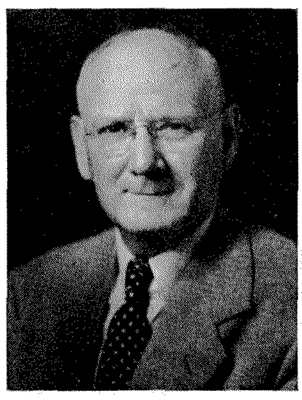
The most significant flow measurement station on the river is at Lee Ferry in Arizona, a few miles downstream from the southern Utah boundary. For this station, the flow record of measurements since 1921 has been adjusted by government engineers for upper river depletions for irrigation and projected backward to 1897.

A residual mass diagram of this record is shown above. The most conspicuous indication is that the sequences are of much longer duration on the Colorado River than are those of the Los Angeles rainfall record. Following the termination of the drought at the turn of the century when the two records were in phase, the flow of the river entered a 25-year trend, until 1929, of runoff above the average of 16,094,000 acre-feet per annum. Subsequently, for 19 years at least, until 1946, the long trend of deficiency persisted. Confirming favorable snowfall reports on the upper water shed of the Colorado during the past winter, the run-off prospects are about 10% above normal, constituting a fortunate contrast to local rainfall experience. It cannot be determined as yet how much longer this current downward trend will continue.

Tree ring indications on the Colorado

Studies of "Tree Ring Hydrology of the Colorado River Basin" have identified tree-ring records back to 1288 A.D. By determining departures both in excess and below-the-average growth, and plotting the diagram for trends, the indications of recent years correspond approximately with the rainfall indices. The longer record, however, shows more extreme conditions than those of the historical period. The severe drought of 1573-1601 was of such length and severity that it is believed to have caused the abandonment of the habitations which existed in considerable number in northern Arizona and southern Utah.

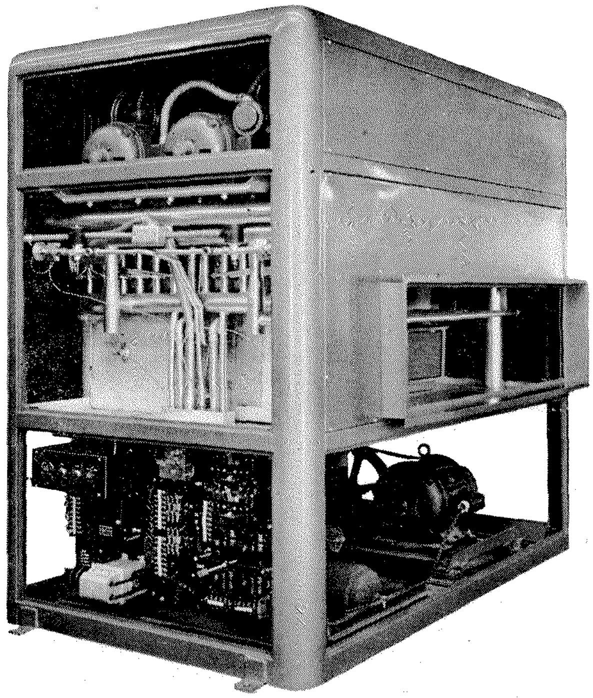
Fortunately, man's ingenuity has made it possible to extract water from underground accumulations with power machinery; such reserves would, in the future, do much to alleviate the deficiencies of surface water as they may occur. So long as local droughts do not coincide with periods of low flow in the Colorado water, needs on the Coastal Plain can be fairly well met. Heavy demands on the underground basins, however, should be relaxed by an extensive use of imported water so as to permit water to accumulate underground as a reserve supply against the contingency that a shortage in the Colorado might occur.



When Franklin Thomas talks about Southern California's rainfall and the habits of the Colorado River, he knows whereof he speaks, for probably no other single person has had more to do with obtaining Colorado River water for the region. In 1947, Professor Thomas was appointed to the Colorado River Board of California by Governor Earl Warren, and in 1948 he was made Chairman of the Board. He has served in a consulting capacity on flood control and sanitation projects for Los Angeles and Orange Counties, and for the City of Los Angeles; and from 1928-1947 he was vice-chairman of the Board of Directors of the Metropolitan Water District. From 1922-1933 he was a member of a special committee on Irrigation Hydraulics of the American Society of Civil Engineers. During the past summer, Professor Thomas' interest in such matters took him to Europe, where he attended the International Congress on Large Dams in Sweden.

These are some of Professor Thomas' activities outside academic circles. At the Institute, which he joined in 1913 as an Associate Professor of Civil Engineering, Professor Thomas has been full professor since 1915; from 1924-1944 he was chairman of the Division of Civil Engineering, Mechanical Engineering, Aeronautics and Meteorology; and since 1944, Dean of Students.

Professor Thomas grew up in Iowa, graduated from its University in 1908, and received his C.E. there in 1913. In 1910 he married Marie Planck, and they are the parents of six children, two of whom, Edward and Robert, were lost in World War II. The Thomases are active in many community affairs in Pasadena and have been influential in its cultural growth; Professor Thomas has been president of the Chamber of Commerce, and has headed up both the Community Chest and the Pasadena Civic Orchestra Association.



Typical air-actuated heat pump — Drayer-Hanson's 5 hp "Airtopia". Panels have been removed to show refrigerant headers, blower motors, electrical panel and motor compressor assembly. The large opening at right, center, is outside air inlet.

THE HEAT PUMP

What it is, what it does, and what it may do someday

by BILL HOLLADAY

SINCE DECEMBER 1852, when Lord Kelvin presented before the Glasgow Philosophical Society a modest little paper, "On the Economy of the Heating or Cooling of Buildings by Means of Currents of Air," the Heat Pump has been a prime target for technical writers. In fact, for most of the 96 years since Kelvin's article, there have been more papers on the subject than there were heat pumps in operation. (A bibliography listing 160 references was published by the Southern Research Institute in 1946.) Recently, however, a number of experimenters and manufacturers have made efforts to equalize the disparity. In California, for instance, there are over 100 heat pumps now in use.

First, what is the heat pump? Briefly, any refrigerating machine is simply a device for moving heat from one point to another. It can be used not only to cool food or people or freeze water; it can also be used for heating things with the very heat which is disposed of when the machine is used "normally." We all know, if we have not forgotten, that a mechanical refrigerating unit does its job by means of a motor-driven compressor, which sucks "refrigerant" vapor out of a vessel called an evaporator, where the resulting pressure reduction causes a violent boiling of the remaining liquid refrigerant. This boiling, or evaporation, is accompanied by absorption of heat, just as boiling water on the stove absorbs heat from a burner.

The compressor then squeezes together a charge of refrigerant from the evaporator, a process accompanied by a rise of temperature and super-heating of the vapor. In order to reuse the vapor, it must be liquefied. This is done by cooling it under pressure, and when something more than the equivalent of the latent heat of evaporation has been given up, the vapor will liquefy and may be fed into the evaporator by means of a pressure-reducing valve. The circuit is shown on the following page.

This cycle has been used for quite a number of years for cooling or water-freezing in a great variety of sizes—commercially from one-tenth to hundreds or thousands of horsepower. The condenser heat on sizes up to about three hp is frequently discharged into the atmosphere; on larger sizes, the unwanted heat is sometimes disposed of by heating a water stream going into a sewer—though not in Pasadena, New York, or an increasing number of other municipalities, where disposal capacities could not keep pace with water use for this purpose. Cooling towers, spray ponds, or evaporative condensers are also used for heat disposal.

With the increasing use of these machines for cooling air in summer, inventors and engineers have turned more and more to the possibilities of using the refrigerating principle for heating as well as cooling. It's an appealing idea, and it looks easy. If we can dispose of heat, we should be able to pick it up again—maybe even the same heat—when we need it.

One source of such heat is the atmosphere—billions of tons of it, always at hand. One needs merely to put an evaporator outside the structure to be heated, cool off some outdoor air, pull the heat thus acquired into our machine, and subsequently raise the temperature of the air in the house. Unfortunately, we are licked by the freezing point of water, which occurs at a point well above average winter temperatures in most inhabited areas. As soon as the surface temperature of our evaporator reaches 32°F. moisture from the air condenses and then begins to freeze, covering the surface with an insulating blanket which prevents the flow of air and the pick-up of heat.

Further, there is a thermodynamic reason why air actuation is limited in application. Carnot showed in 1824 that the maximum possible theoretical coefficient of performance of a reversible heat engine could be expressed by a simple temperature relationship:

$$\text{c. o. p.} = \frac{T_1}{T_1 - T_2,} \text{ where}$$

T_1 = condensing temperature, degrees absolute
T_2 = evaporating temperature, degrees absolute

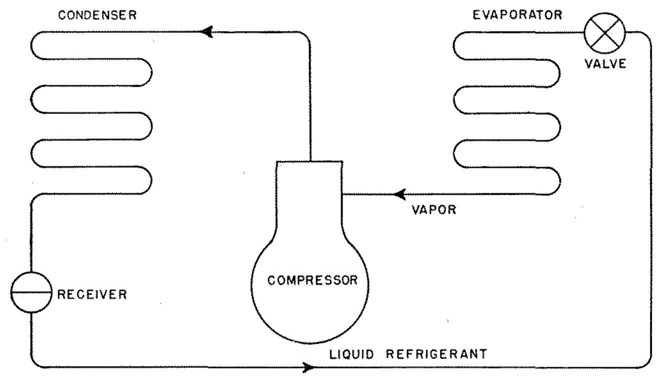
It will be seen that as the evaporating temperature decreases, the efficiency of our system is sharply lowered, and we are faced with a problem of a machine reducing its capacity in the face of an increasing load. The only answer to such a situation is a larger machine, one that has sufficient capacity at a low design temperature to take care of the increased load at that point. Such a solution is costly and cumbersome.

A second source of heat is water, and again we have some practical limitations; cost, temperature, disposal problems. Comparatively few structures are located beside rivers, lakes, or springs where the water supply is limitless and free except for pumping cost. Water temperature, in some areas around 50°F. or below in winter, sharply limits the potential heat. As an example, water can safely be cooled with most equipment to 35°F. If 70-degree water is available, about three gallons per minute will be required for a five hp unit. But if the initial water temperature is 40°F. one must pump over 20 gpm to obtain the same amount of heat.

A third source is the earth. Much research on this idea is going on at present, but no firm statements about practicability should be made. For maintenance reasons it does not seem advisable to bury refrigerant coils, although some successful projects have been operated for periods up to several years in this manner. The best way to remove earth heat now seems to be through the use of a water coil, and the transfer of heat from water to refrigerant through an exchange of conventional design. The bottleneck in heat transfer is from earth to water pipe, and a number of ingenious schemes have been planned or tried for improving conductivity at that point. No matter how we do it, one or both of these limitations face us:

The conductivity of earth varies between wide limits, depending on the structure and moisture content of the soil; hence quantitative engineering design is difficult if not impossible.

To use earth heat, a hole must be dug, and the cost, while not always predictable, will surely be high: maybe from 25 to 50 per cent of the entire project.



Basis for the heat pump is the standard refrigerant cycle.

This is the gloomy side of the picture, of course. There are some areas, usually having hot summers, where the temperature rarely if ever goes below freezing in winter, and where air can be used at a heat source. Other areas may have colder winters, but the dew point is so low that frost formation is not burdensome. Defrosting methods are available and have been used successfully. Supplementary electric heat can be applied in some cases, though the rates for standby service of this kind are not usually attractive.

There are some structures located on streams, or in country where water is close to the surface, and sometimes water can be pumped out of one well and disposed of into another, if the two are not too close together. There are many successful projects employing the heat sources discussed, or combinations of them.

Each of these so-called "sources" of heat should be used as the sink for getting rid of heat in the summer, for it is not yet commercially practical to use a refrigeration machine purely as a heat source, though experimental household water heating units have been built and operated. The first cost of the equipment is sufficiently high that, to justify the investment, we must think in terms of a year-round conditioning unit which can, either automatically or manually, be used for heating or cooling as needed.

The refrigerant flow diagrams for a year-round system don't bear much resemblance to the simple picture shown above. Some plants use the right and left hand heat exchangers alternately as condenser and evaporator, so that the conditioned air stream, always following the same path, may be heated or cooled as required. The transfer valves for this method are usually manually operated, since it is necessary to change the fluid flow through four pipes. Dual-purpose coils are not very efficient heat exchangers, since a good condenser does not necessarily make a good evaporator.

In other systems, single-purpose coils are employed, with air streams shifting from side to side. This involves extra duct work and dampers, and is somewhat cumbersome and expensive.

Still another plan has two condensers and two evaporators, one of each in each air stream. When the conditioned air evaporator is in use for cooling, the outside air condenser is employed. While this arrangement is also expensive, it is quite efficient and it is possible to handle the transfer automatically with but two solenoid valves; the comparative freedom from trouble of the simple valve mechanism may overbalance some additional cost.

In California there are probably 125 to 150 heat pumps operating today—a few of them for periods up to ten years. Most of these are products of Drayer-Hanson, Inc., a Los Angeles manufacturer which has promoted the heat pump idea aggressively.

In operation, coefficients of performance usually run between 3 and 4. As an example, a 5-hp unit, taking about 5 kw, will produce about 55,000 Btus per hour. Since the heat equivalent of 5 kw is 17,000 Btus per hour (the amount of heat which would be obtained if the 5 kw were used to actuate resistance heaters), the apparent coefficient of performance is 3.22. Of the 55,000 Btus per hour listed as the output of the unit, 14,000 is the input to the compressor (the 17,100 motor input less motor losses) and the balance of 41,000 must be picked up from air, water or earth. Therefore, if one wishes to use electricity for heat, it costs only 1/3 to 1/4 as much to do so through a heat pump as through resistance heating.

Some conclusions from field experiences with the heat pump may be summarized here.

The best field for commercial exploitation is a commercial establishment where the winter heating load and the summer cooling load approximately equalize. This obtains in offices, restaurants, stores, where people constitute a large source of heat and where the level of interior lighting is fairly high.

Buildings should be well-insulated, since good insulation reduces external load both in summer and winter, and tends to reduce also the difference between the two. Buildings should be shaded as much as possible, and windows should be shaded, particularly on south and west sides.

Prices are comparatively high, although a good case can be made out for the advantages of year-round temperature control (which can be obtained from other systems, though not so easily).

Operating costs of heating are probably higher than for efficient gas-fired furnaces. (When one includes summer cooling, the comparison naturally looks better.) Present utility rates are around 2 to 2½ cents per kwh for this service, and on a theoretical basis the cost equalizes with gas at about 1 cent per kwh. Utility spokesmen state that the minimum profitable rate is probably about 1.75 cents per kwh. On the other hand, few genuine mechanical improvements in living have been sold because they cost less. Usually they cost more.

The application problems are subtantially those of any air conditioning system, which means that a heat pump installation ought to take good layout engineering and careful erection. More operating failures have been due to poor application and bad air distribution than to manufacturing and design errors. In other words, the pump isn't a piece of package goods like a radio or refrigerator, but an engineering project.

The field of special applications of the heat pump principle is wide, and new possibilities continue to be investigated. Any building requiring heating and cooling may investigate whether the heat pump can be installed to advantage or profit, and in a large ratio of cases, it will be found to compare favorably with other methods of air conditioning.

Bill Holladay has been a part of the refrigerating and air conditioning industry for 21 of his 24 years since graduation — first with the General Electric Company, for which he pioneered the original "Monitor Top" refrigerator in Texas and Oklahoma; then for 14 years as service manager for the George Belsey Company in Los Angeles. He was also Purchasing Agent for the General Air Conditioning Company of Oakland, and Manager of Field Engineering for Drayer-Hanson, Inc., Los Angeles. He is now Vice President of Hieatt Engineering Company, a firm specializing in ultra-low temperatures and other unusual applications of what he would like to call "thermal engineering," if he were sure of being understood.

He is a member of A.I.E.E. and A.S.R.E., an associate of A.S.H.V.E., teaches refrigeration and air conditioning at the University of Southern California on the side, and is an ardent Scouter and photographer. He is married, has three children, and lives in Altadena.

FIRST HIXON SYMPOSIUM ON "CEREBRAL MECHANISMS AND BEHAVIOR"

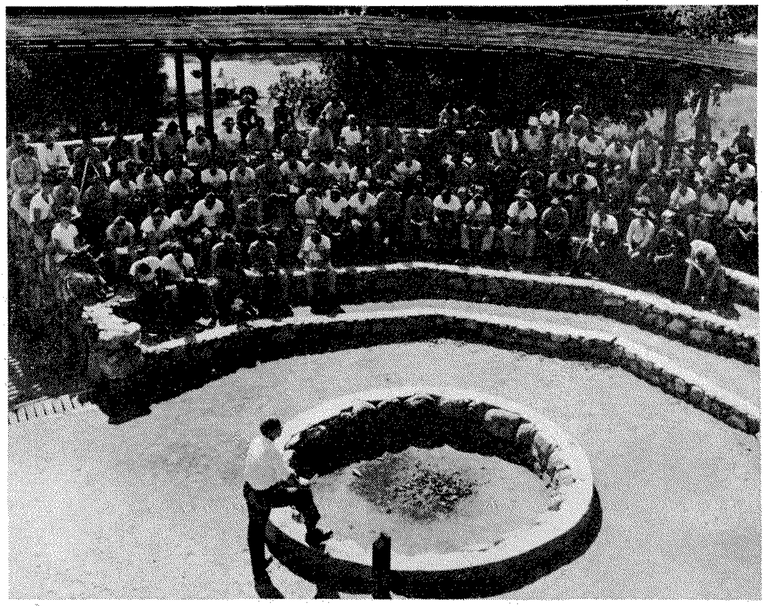
THE OVERLAP of psychology into the field of biology and vice versa, were examined and discussed this month at Caltech when the biology division sponsored the first Hixon Symposium on "Cerebral Mechanisms in Behavior."

To discuss this relatively new field of psychobiology twelve outstanding scientists in the fields of psychology, neuropsychology, psychiatry, zoology and mathematical physics met daily at Caltech from September 20 through 25. Host to the group was Dr. George W. Beadle, Caltech biology division head, and Dr. Lloyd A. Jeffress, visiting professor of psychobiology.

Seven papers, with titles ranging from "Functional Differences between the Occipital and Temporal Lobes" to "Why the Mind is in the Head" were presented and discussed. The final day of the symposium was devoted entirely to discussions on the general subject of psychobiology.

Speakers were Professor Ward C. Halstead, University of Chicago; Professor Heinrich Kluver, University of Chicago; Professor Wolfgang Kohler, Swarthmore College; Professor K. S. Lashley, Harvard University; Dr. R. Lorente de No, Rockefeller Institute for Medical Research; Professor Warren S. McCulloch, University of Illinois; and Dr. John von Neumann, Institute for Advanced Study.

Discussion panel members, in addition to the above and Dr. Jeffress, included Professor R. W. Gerard and Professor Paul Weiss, University of Chicago; Professor H. S. Liddell, Cornell University; Professor Donald B. Lindsley, Northwestern University, and Dr. J. M. Nielsen, Los Angeles psychiatrist.



THE MONTH AT CALTECH

NEW STUDENT CAMP

As THE OCTOBER issue of E&S goes to press, 180 freshmen and 40 new upperclassmen, transfer students from other institutions, are attending New Student Camp, which is being held as usual this year at Camp Radford up in the San Bernardino Mountains.

The three-day Camp opened on Friday, September 24, with the following faculty members on hand to greet the newcomers: Deans Foster Strong, Paul Eaton, Winchester Jones and Franklin Thomas, and Professors Chester Stock, Ernest Swift, Robert F. Sharp, Wallace Sterling, Fred Lindvall, Donald Clark, George Beadle, and Harvey Eagleson.

Between song-fests and get-acquainted sessions, the new students heard from President DuBridge and Alumni President Howard Lewis; from the Director of Athletics and the Coaches for Track, Football and Basketball. Chuck Forester, Senior Class President, told the camp how he made his first "D", and other members of the student body described ASCIT social activities, life in the student houses, the "Y" program, and Throop Club plans for the coming year.

JOHN MILLS, 1880-1948

IN 1945, when John Mills retired after twenty years as Director of Publications for the Bell Telephone Laboratories, he joined the staff of the California Institute of Technology as a Student Counselor. And from that time until his death, on June 14, the Institute, and the many undergraduates who came to him for guidance and vocational advice, made grateful use of his wise understanding of the ways of the scientific worker and the ways of the world; of what the scientist must have to offer, and what is expected of him. Mr. Mills was an engineer and a trainer of engineers. And because he was a man who for many years had given much of his thought to understanding the minds of others, he came to the Caltech campus well equipped for his duties.

When he was Personnel Director for Western Electric Company during the period of its rapid expansion following World War I, Mr. Mills evolved six "man specifications" for the selection of able college-trained technical personnel: intellectual curiosity, ability to study, habituation to study, ability to learn from men, ability to cooperate with them, and ability to lead them. At Caltech, when undergraduates came to him for vocational direction, Mr. Mills shared with them his conviction that the college graduate's value to engineering and science lay, not just in his ability to fill a particular job, but in his possibilities of growth.

John Mills was born in Morgan Park, Illinois, in 1880. He graduated from the University of Chicago in 1901 and received his Master's Degree in Physics from the University of Nebraska in 1904. After several years of teaching, first at Western Reserve, and later at M.I.T. and Colorado College, he joined the engineering department of the American Telephone and Telegraph Company, where he worked on problems connected with trans-continental and transoceanic wireless telephony. Besides making several major contributions to the communications art, Mr. Mills was the author of many books, including **Letters of a Radio Engineer to his Son, Electronics Today and Tomorrow** and **The Engineer in Society,** published in 1946.

To the public, John Mills is probably best known as the creator of the Bell Telephone exhibits at the world's fairs in Chicago, San Diego, Dallas, San Francisco and New York. Mr. Mills believed that the public really enjoyed first-rate scientific novelties; given them, it would be receptive to a sound explanation of the intricacies involved. The success of "Pedro the Voder" and "Oscar," the binaural dummy at the Chicago Fair, bore him out, as did the audition at the New York fair, which gave people a chance to listen to the reproduction of their voices, and the souvenir telephone calls which indulged the temptation to eavesdrop and offered the excitement of chance.

PLANT RESEARCH--AND GUINEA PIGS

FOUNDATIONS ARE being poured for the Institute's new Earhart Plant Research Laboratory and it is expected that the project will be completed in April, 1949.

The new laboratory, located at the corner of Michigan Avenue and San Pasqual Street, is being built at a cost of $407,000, granted to the Institute by the

Earhart Foundation. When completed, it will be the only air-conditioned laboratory of its kind, and will enable Caltech plant physiologists to grow plants under any and all conditions of weather. Cold, hot, dry, wet, light or dark, windy or quiet, no matter what the weather, it will be possible to produce it in this new lab.

The new underground biology annex, built at a cost in excess of $100,000, is nearing completion and is already partially occupied. The annex, with some 7,000 square feet of floor space, is entirely underground and so built that automobiles may be parked on its roof. It adjoins the west wing of the Kerckhoff Biology Laboratory.

First occupants were some 300 guinea pigs given the institute by a grower who called George W. Beadle, division chairman, recently to explain that the bottom had dropped out of the guinea pig market so said animals were available to Caltech for the asking. Dr. Beadle pushed the occupancy date ahead a bit to accommodate the animals.

* * * * * * *

(Editor's note—We now have 400 guinea pigs)

LIFE AT CALTECH

THE AUGUST 23rd issue of LIFE Magazine carried a two-page picture story of Caltech's Guam Harbor research project, being conducted for the U. S. Navy under the direction of Dr. Robert T. Knapp. This work is being done with a 120-foot square model of Guam's Apra Harbor, located in a steel hangar at Azusa. One of the objects of the project is to determine the proper design for Apra Harbor installations so as to keep typhoon damage to a minimum and the port open at all times.

A SCIENTIST AND PHILOSOPHER

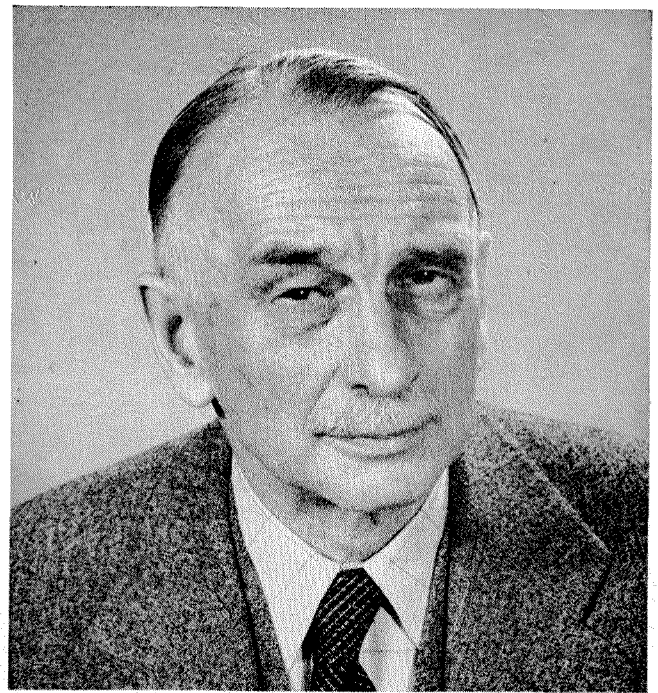
ON SEPT. 5, Dr Richard Chace Tolman, who has been called the world's greatest cosmologist, died at Huntington Memorial Hospital after a three-week battle against the effects of a stroke suffered at his home in Pasadena.

One of the nation's top atomic scientists, Dr. Tolman served as scientific adviser to Maj. Gen. Leslie R. Groves on the Manhattan Project during the war. In 1946 he became scientific adviser to Bernard M. Baruch on the United Nations Atomic Energy Commission.

His theories on the structure of the universe ranked Dr. Tolman alongside Dr. Albert Einstein in the field of cosmology. His versatility made him an expert, not only in cosmology and atomic energy, but in the fields of relativity, thermodynamics, statistical mechanics, chemistry and mathematical physics as well. Beyond his scientific achievements, however, Dr. Tolman will be remembered at Caltech for his helpfulness to students and faculty alike. From 1934 to 1946 he served as Dean of the Graduate School.

Tolman was born in West Newton, Mass., in 1881. After being educated at the Massachusetts Institute of Technology and in Germany, he taught at M.I.T. and the Universities of Michigan, Cincinnati, California and Illinois. During World War I he served as a major and chief of the dispersoid section of the Chemical Warfare Service. From 1919 to 1921 he was director of the War Department's Fixed Nitrogen Research Laboratory.

In 1921 Dr. Tolman came to Caltech as professor of physical chemistry and mathematical physics. He left temporarily in 1940 to serve as vice-chairman of the National Defense Research Committee. He was awarded the Medal for Merit by the United States Government for his war work as adviser to General Groves. The British Government more recently made him an Officer of the Order of the British Empire—the highest honor bestowed upon foreigners.



Dr. Richard Chace Tolman, 1881-1948

In 1946 Dr. Tolman was appointed by General Groves to head the declassification board of the U. S. Atomic Energy Commission. He recommended the release of some atomic energy data and predicted great advantages to industry and medicine, particularly in the field of cancer research, when all the secrets of the Manhattan Project could safely be revealed.

Dr. Tolman later served as adviser to Bernard Baruch on the commission for world control of atomic energy.

He returned to Caltech late in 1946. On campus he was known both as a scientist and a philosopher.

"Science," he said in a now-famous address delivered at Brown University in 1947, "is concerned with judgments of existence, not judgments of value. The judgments of men and of nations of men as to what is good depend partly on the static factors of childhood training and the prevailing custom, but partly also on the dynamic consequences of the new spiritual insights which determine the teachings of ethical leaders, and which each of us may sometimes experience in the closet of his conscience. As the judgment is being reached, science can advise as to the nature of the facts. When the judgment is being advocated, science can point out its consequences. When the judgment is being implemented, science can supply tools for the accomplishment. But in its final essence, ethical judgment is a creative activity of man.

"It is my faith that the ethical insight and scientific intelligence of man are such that the control of evil is possible. I am sure that humanity will continue to encounter great troubles, but I do not think that civilization will destroy itself. To surmount our troubles, we shall need courage, and patience, and clarity of thought, and sincerity in the advocacy of fair and reasonable courses of action. For these virtues we may pray, each in his own fashion."

ALUMNI NEWS

ALUMNI ASSOCIATION OFFICERS

PRESIDENT	SECRETARY
H. B. Lewis '23	D. S. Clark '29
VICE-PRESIDENT	TREASURER
J. W. Lewis '41	H. R. Freeman '25

BOARD OF DIRECTORS

N. A. D'Arcy '28	R F. Mettler '44
E. R. Hoge '18	W. B. Miller '37
R. M. Lehman '31	W. D. Sellers '25

G. K. Whitworth '20

ALUMNI CHAPTER OFFICERS

Chicago Chapter:

PRESIDENT — Edward A. Wheeler Ex'39
1045 Chestnut Ave., Wilmette
North Shore Broadcasting Co., Evanston — UNiversity–6406
VICE-PRESIDENT — Le Van Griffis '37
8421 Indiana Ave., Chi.
Armour Research Foundation — VIctory–3300
8421 Indiana Ave., Chicago
SECRETARY-TREASURER — Robert T. Dillon '25
1710 Central Ave., Wilmette

New York Chapter:

PRESIDENT — Clifford C. Burton '40
25 W. 16th St., New York 11, N. Y. — CA 4-4595
C. F. Braun & Co., 630 5th Ave., New York, N. Y., CI 5-6380
VICE-PRESIDENT — Charles K. Stipp '31
32 N. Woods Rd., Manhasset, N. Y. — Manhasset 3206
Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y., STilwell 4-6708
SECRETARY-TREASURER — Richard T. Brice '37
106 N. Walnut St., East Orange, N. J. — ORange 2-5353
Otis Elevator Co., 260 Eleventh Ave., New York 1, N. Y. — CH 4-8000

San Francisco Chapter:

PRESIDENT — Robert P. Jones '35
1431 Park Blvd., San Mateo — San Mateo 3-7634
Standard of California — SUtter 7700
VICE-PRESIDENT — James J. Halloran '35
936 Filmore Street, Albany 6 — LAnscape 5-0791
Electro-Engineering Works, Oakland — OLympic 3-1588
SECRETARY-TREASURER — L. Dean Fowler '23
933 Bridge Rd., San Leandro
Motor Section, General Electric Company

The San Francisco Chapter meets weekly for lunch at the Fraternity Club, 345 Bush Street, on Thursdays.

CALTECH ALUMNI IN STANFORD RESEARCH

ON AUGUST 9, Dr. J. E. Hobson, Ph.D. '35, Director of the Stanford Research Institute, announced the appointment of Dr. A. M. Zarem, Ph.D. '43, as Chairman of Physics Research and Manager of the Institute's new Los Angeles Division.

Before joining the Stanford staff, Dr. Zarem was chief of the electrical section of the physical research division of the U. S. Naval Ordnance Test Station in Pasadena. During the war, he was a research engineer and group leader on several government contracts in electronics and physics administered by Caltech. And before the war he served as a research and development engineer for Allis-Chalmers Manufacturing Co. in Milwaukee. Dr. Zarem is an authority on ultra-high-speed photography and measurements, and is inventor of the Zarem camera—a precision time-measuring device developed at the Naval Ordnance Test Station in Pasadena.

The new division of the Stanford Research Institute, which opened August 15, is an outgrowth of the increasing demand for additional research facilities in the Los Angeles area. The Institute's initial staff of 15 . . . which includes two more Caltech alumni, Dr. Carsten Steffens, Ph.D. '34, who will be its Assistant Director, and Paul L. Magill '24, Chemical Engineer . . . is at present carrying on numerous problems of interest to the industry of the area, including a study of the smog problem, an economic study to determine the expansibility of the aircraft industry in a national emergency, and an evaluation of detergents for a Los Angeles firm in connection with patent developments.

In welcoming the opening of the Los Angeles Division, President DuBridge pointed out that its work would "bring to the service of industry the methods and techniques of science in solving industrial problems. It will accelerate the application to industry of the great fund of fundamental knowledge in pure and applied science which flows from the educational and research institutions of the country. The educational institutions concerned with the primary task of educating men and women for the nation's tasks can usually not undertake the investigation of specific industrial problems and should properly concern themselves more particuarly with the exploration of new fields and the seeking of basic new knowledge. An agency like the Stanford Research Institute is able to make this new knowledge directly available to industry, and thus serves as a welcome and needed connecting link between educational institutions and industry."

"HOW'S EVERY LITTLE THING?"

HIGHLIGHT OF the 1948 banquet of the Alumni Association held at the Athenaeum on June 11, was the speech delivered by Dr. Ray E. Untereiner, Caltech Professor of Economics.

"How's Every Little Thing?" was the title of the address—and the usual answer Dr. Untereiner gets to that query these days is, "We're in a mess!"

The reason for the mess, he explained, is that we have just gone through the first phase of a revolution; and the first phase of any revolution is likely to be marked by a lot of enthusiasm, a lot of idealism, a lot of destruction, and very little constructive achievement. As a result, those who have valued our traditional American ways, and have been aware of the extent of their destruction, are inclined to take a gloomy view of the state of the nation.

Taking a quick look at our accomplishments to date in the way of wreckage of our traditional institutions, Dr. Untereiner scored the destruction of the safeguards, laid down by the Constitution, for a system of individualism and of government as the servant rather than the master of people.

The first safeguard to go down was the principle of limitations on the power of the central government. "During the past dozen years," said Dr. Untereiner, "the Supreme Court has been busily engaged in striking out the constitutional limitations on federal power. . . . Today it is safe to say that the Supreme Court will give the green light to any federal infringement on individual rights or freedom which Congress and the President see fit to enact, unless it can find in the Constitution a specific prohibition on such infringement. That means that only our civil liberties, such as freedom of speech and religion, are now protected from encroachment by the government."

The second safeguard to be destroyed was the Constitutional provision that even the limited powers of the federal government should never fall into the hands of the same man or group of men. "In our day we have seen the federal powers become constantly more and more concentrated in the Executive branch." Inevitably, "concentration of governmental power in the Chief Executive has resulted in actual exercise by administrative agencies composed of the so-called 'bureaucrats' . . . government by men, and not by law."

The third safeguard — economic individualism or self-dependence, embodied in the institutions of private property, the incentive system, and freedom of contract—has been undermined to the point where the government has assumed many of the risks and responsibilities of private citizens. Farm prices are set, retail prices frozen, wages fixed; federal regulations hamper the right to make agreements.

How do we get out of this mess? "Only if (the people) want a future of individual freedom, and opportunity, and responsibility—under the fairest possible rules—will the government set its course toward that goal. . . . We don't, as a people, lack in intelligence and judgment. We only lack, too frequently, in information. . . . Give us the facts for better judgment, and we shall arrive at wiser decisions."

If we had the facts about wages (over 77% of corporate income in 1947) we might not approve the government's policy of backing the tactics of organized labor. If we had the facts about profits (7% in 1947) we wouldn't think industry was getting more than its share. If we had the facts about taxes we'd realize that "soaking the rich" produces little additional revenue and removes the incentive to investment.

"We have gone through the first phase of a revolution. We have destroyed much. We have yet to build what is to take its place. The great American people will decide what that is to be. The wisdom of their decision will depend on the extent of their knowledge of the facts. . . . Certain it is that if we crusade for individual freedom, under rules that will make it work, we shall have history on our side. Our national experience is a living proof that the free American, making his own decisions and taking his own risks, can build a great civilization."

GUGGENHEIM FELLOW

DR. L. H. TEJADA-FLORES, native of Bolivia and Tech graduate in Electrical Engineering, is returning here this fall to do post-doctorate research work under a John Simon Guggenheim Memorial Foundation Latin American fellowship.

Dr. Flores obtained his doctorate degree in Electrical Engineering at Caltech last June. He obtained his bachelor's degree at the Institute in 1938 and returned to Caltech in 1942 as a Roosevelt Fellow, for graduate work that led to his obtaining his M.S. in 1943.

From 1943 to 1946 he was a teaching assistant in electrical engineering at Caltech while studying for his doctorate degree, and is currently a lecturer on that subject at the University of Southern California.

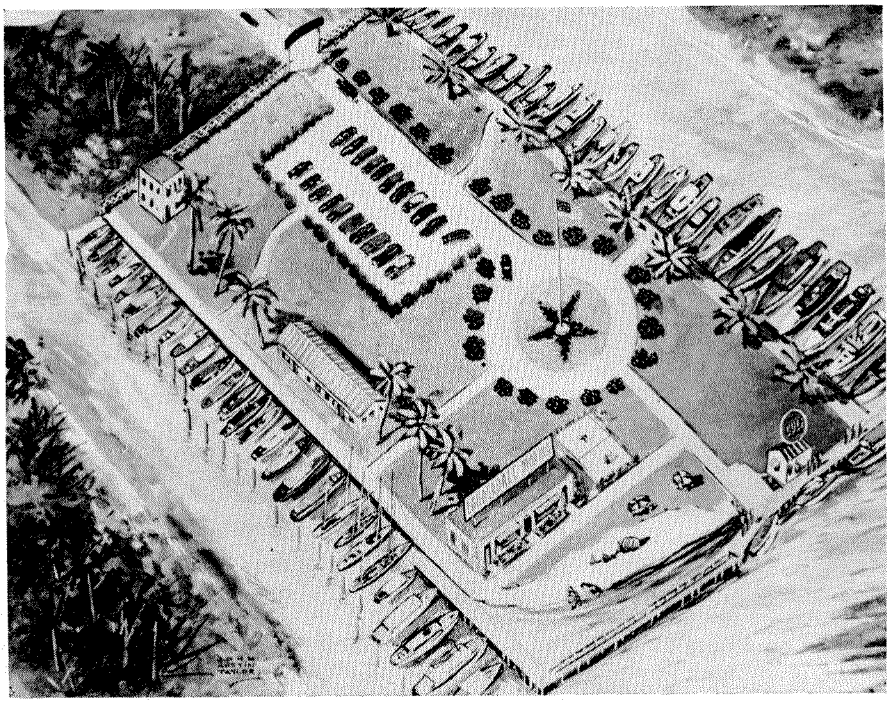
Dr. Flores will do post-doctorate study under the Guggenheim Fellowship in dielectric recovery under Professors Gilbert D. McCann and Royal W. Sorensen of the Caltech Electrical Engineering Department.

FRED DE SILVA, EX 22, DIES

FRED DE SILVA, Ex '22, who for many years had been a teacher of English and guidance counselor at the Hoover High School in San Diego, died on August 21 in Lewis Memorial Hospital in Yosemite National Park as a result of injuries received in an auto accident in the park on August 12. Mr. De Silva's daughter, Mary Lee was also fatally injured.

Mr. De Silva was born in Alameda and was educated at the Institute and at San Diego State Normal School (later San Diego State College); he received his Master's Degree from the University of Southern California. With the exception of a wartime leave of absence when he worked at the Consolidated Vultee Aircraft Corporation, Mr. De Silva had been with the San Diego school system since 1928.

LETTERS -- Continued from page 1



The Cox yacht basin at Fort Lauderdale, Fla.—on a dawn-to-collapse schedule.

send Pop a postal card or to phone Woodbury, N. J. 2-1104 or Paulsboro, N. J. 8-1040. "The Valley" is considered by many to be the world's best, bushiest, toughest and sandiest course. You'll find out!

Thomas P. Simpson '25
Woodbury, N. J.

For other news of Tom see page 15.

Dear E & S:

Engineers are a breed of cats that won't write letters they should write. My husband, Robert Osborne Cox '40 is such a creature, so I am taking it upon myself to speak for him.

I am enclosing a picture (see above) of the yacht basin we are putting into operation here in Fort Lauderdale. We think it is going to prove to be a pretty fine way of life. We live on an 83-foot motor Sailer known as the "Ungava." Needless to say, Bob has re-engineered all our "plumbing," and is all set to do the same for any other boat he can get loose in! Fortunately, there is a tremendous need for an engineering service which coordinates the many electrical and mechanical devices necessary to the happy running of a yacht. My poor husband's blood curdles when he finds the efficiency of one good mechanism after another ruined because of—shall we say—unthinking installation. How many inconveniences are endured on some of our finest yachts, because the installation of a deep-freeze, air-conditioner, or pressure water system is presented to the owners as a monstrously involved and expensive matter, instead of being handled as good engineering! The examples go on into really complex problems, which are most interesting, and suffice it to say, we are doing something about them.

Besides having dockage for about sixty yachts to begin with, including every service one would find in the best hotels, we will have a restaurant, marine supplies of all sorts, a shop for installations and repairs of mechanical and electrical equipment, a club house and recreational facilities. You can see that during the winters life will not be dull, as we will be on a dawn-to-collapse schedule until we get things properly organized.

Even better, summers we have our shop, where Bob will be able to develop models and do all the things engineers always say they are going to do, but never have time for. These periods should be fun and, I hope, productive. . . .

Cathleen Virginia Cox
Fort Lauderdale, Florida

PERSONALS

1925

ROBERT W. FULWIDER and Harold W. Mattingly announce the consolidation of their practices in patent, trademark and copyright law under the firm name of FULWIDER & Mattingly. WARREN L. PATTON '34, an Associate of R. W. Fulwider, will continue with the firm at its Wilshire Boulevard office in Los Angeles.

THOMAS P. SIMPSON is Director of the new Research and Development Laboratories of the Socony-Vacuum Oil Company at Paulsboro, New Jersey. When the Laboratories' new Chemistry and Physics Building held open house on April 30, over 8500 persons visited it.

1926

MANLEY W. EDWARDS was Deputy Emergency Power Director of the Power Conservation Division of the California Public Commission during the recent power shortage in Northern California in February, March and April 1948.

1928

FRANK NOEL is a resident engineer on highway construction between Fall River Mill and Glenburn, California.

1930

COMMANDER BURT RICHARDSON is back in uniform for a month undergoing training in guided missiles at the Naval Air Missile Test Center, Point Magu and at the Naval Electronics Laboratory, San Diego.

1931

COMMANDER PERRY M. BOOTHE has been transferred from the Public Works Department, Puget Sound Naval Shipyard to the Facilities Division, Munitions Board, Pentagon, Washington 25, D. C. He will be dealing with the problem of industrial security.

1934

GEORGE F. WISLICENUS, Ph.D., is the author of "Fluid Mechanics of Turbomachinery," a book published recently by McGraw-Hill Book Company. Mr. Wislicenus is a Compressor Research Engineer.

1937

HUGH F. WARNER is a Manufacturing Engineer with Westinghouse at Sunnyvale, California. He and Mrs. Warner report the birth of a daughter, last February 18. Their son is now three years old.

ROBERT W. WEBB, Ph.D., has transferred from the Los Angeles campus of the University of California to the Santa Barbara campus, where he is Associate Professor of Geology and University Coordinator of Veterans Affairs. His home address is 2830 Verde Vista Drive, Santa Barbara.

1939

LT. COMDR. TYLER R. MATTHEW, who recently returned from the South Pacific, is now assigned as Executive Assistant Navy Supply and Fiscal Officer MCAS, Cherry Point, North Carolina. On their way back to this country from Guam, Lt. Comdr. and Mrs. Matthew visited points in Japan, China and the Philippine Islands. And on the West Coast they had a visit with Mr. Matthew's Mother in Hollywood and with Mrs. Matthew's parents, Mr. and Mrs. J. Ernest Knight of Tacoma, Washington.

FINANCIAL STATEMENT
OF THE ALUMNI ASSOCIATION

California Institute of Technology — July 1, 1947 — June 30, 1948

BALANCE SHEET -- June 30, 1948

ASSETS

Cash in bank		$ 5,151.81
Accounts receivable		1,782.83
Investments:		
C.I.T. Trust	$21,506.38	
U. S. Treasury Bonds	222.00	21,728.38
Furniture and fixtures		221.04
Postage deposits		112.73
TOTAL ASSETS		$28,996.79

LIABILITIES

Accounts payable		$ 2,848.16
Due to Alumni Fund		50.00
Commissions payable:		
R. C. Colling and Associates	$ 29.10	
Other	131.14	160.24
Deferred income to E. & S.		18.50
Life membership reserve:		
Fully pd. life mem.	21,450.00	
Installment payment life members	1,770.69	23,220.69
1948-49 dues paid in advance		3,698.00
TOTAL LIABILITIES		$29,995.59

EQUITY

Eq. Def. July 1, 1947	(73.78)	
Excess of exp. over income, year ended June 30, 1948	(925.02)	
Equity Deficit, June 30, 1948		(998.80)
TOTAL LIABILITIES AND EQUITY		$28,996.79

ALUMNI ASSOCIATION
Statement of Income
Year Ended June 30, 1948

INCOME

Dues	$6,418.25		
Interest on trust fund	817.06		
Gain on trust fund capital transactions	56.38	$7,291.69	
Less reserve for subscriptions to E & S		4,000	$3,291.69
Life memberships realized			100.00
Social committee—			
Income from functions		1,098.60	
Less expenses		1,039.51	59.09
Program committee—			
Income from functions		829.50	
Less expenses		755.12	74.38
Athletic committee—			
Income from functions		108.80	
Less expenses		103.29	5.51
Seminar income		1,772.50	
less expenses		1,564.63	207.87
Directory sales			4.00
Miscellaneous			56.33
TOTAL INCOME			$3,798.87

EXPENSES

Administration:			
Dues and subs.	$ 20.00		
Directors	147.67		
Miscellaneous	17.29		
Postage	446.67		
Printing	71.90		
Services	1,442.01		
Supplies	307.08	$2,452.62	
Chapters		118.65	
Membership:			
Postage	36.60		
Printing	78.71		
Allocation of E & S costs	391.47	506.78	
Placement		250.00	
Undergraduate assistance		107.01	
Fund Committee:			
Dues and subs.	5.00		
Miscellaneous	1.40		
Postage	114.39		
Printing	276.18		
Services	6.55		
Supplies	14.90	418.42	
Directory:			
Postage	42.40		
Printing	809.55		
Services	87.40		
Supplies	3.14	942.49	
TOTAL EXPENSES			$4,795.97
Excess of Income Over expense Before E & S			(997.10)
Net Income From E & S			72.08
Excess Of Income Over Expenses			(925.02)

ENGINEERING & SCIENCE MONTHLY
Year Ended June 30, 1948

INCOME

Subscriptions:		
Alumni	$4,000.00	
Student	32.00	
Other	1,559.60	$ 5,591.60
Advertising		4,396.00
Miscellaneous		1,434.10
TOTAL INCOME		$11,421.70

EXPENSES

Advertising commissions:			
Colling	$239.70		
Agency	530.45	770.15	
Cash discounts		53.88	
Dues and subs.		5.00	
Committee expense		33.18	
Loss from bad accounts		65.00	
Mileage		93.64	
Miscellaneous		26.35	
Paper		1,944.08	
Photo and engraving		749.91	
Postage and mailing		113.57	
Printing		4,991.25	
Services		2,854.10	
Supplies		40.98	
TOTAL EXPENSES			$11,741.09
Excess Of Income Over Expenses			(319.39)
Costs Transferred to Membership Committee:			
Portion of cost of November issue		351.47	
Portion of cost of May issue		40.00	391.47
NET INCOME			$ 72.08

STATEMENT OF AUDIT

On August 26, 1948, I examined the balance sheets of the Alumni Association as of June 30, 1948, and the related statements of income and expense. The bank balance was reconciled and spot checks were made on disbursements. Spot checks were also made on ledger and journal entries. In my opinion, the balance sheets and income and expense statements fairly represent operations for the year ending June 30, 1948, and the position of the Association at that time. The Association is fortunate in having a Treasurer of the ability of Mr. Freeman who will and can devote the time necessary to supervise its books.

(signed) Allen L. Laws
Auditor

1940

JOHN S. BILLHEIMER has joined the solid propellants division of Aerojet Engineering Corporation at Azusa, California as a development engineer.

Before returning to Caltech in 1946, John was in the incendiary program at the Twin Cities Ordnance Plant, the plutonium pilot plant at Chicago, and was Chief of Process Control for the thermal diffusion works at Oak Ridge.

GERALD PENTLAND FOSTER and Mrs. Foster adopted a son, David Scott Foster, on July 21, 1948.

1942

R. C. VAN ORDEN left the Building Department of the City of Los Angeles late last fall where he was employed as an Associate Structural Engineer, to become Chief Engineer for Bennett & Bennett of Pasadena. Mr. VanOrden plans to keep on with his consulting in the Balboa Harbor area.

1943

ROBERT A. MOORE was married in New York last fall to Miss Betty Stewart of Schenectady. Mr. Moore is with the General Electric Company there.

1946

MAJOR JOHN W. BARNES has been assigned as Operations and Supply Officer for the U. S. Army Engineer Test Department at Fort Churchill, Manitoba, Canada. He will spend twelve to eighteen months supervising arctic tests of military equipment.

1947

ALBERT H. J. MUELLER who has been in Schenectady, New York, and Pittsfield, Massachusetts for some time has recently returned to his home in Van Nuys, California and hopes to be back at Caltech doing graduate work this fall.

LT. EUGENE S. ROSE is stationed at the Wind Tunnel Branch, Aircraft Laboratory, Engineering Division, Air Material Command in Dayton, Ohio.

COLONEL JACK A. GIBBS, M.S., '47, and MAJOR HARRY L. GEPHART, M.S., '46 are stationed there also.

JEPTHA A. WADE, JR. of San Jose, California, was married late last fall to Miss Mary Lee Seaver. Mr. Wade is an Assistant Engineer with the California Water Service Company.

Index to Advertisers

The Main Line

OCTOBER, 1948

If you can't think of any plausible excuse for not having planned your fall vacation yet, here are four stalwart reasons for tossing your troubles into the old kit bag right away:

I. BEAUTY

Indian Summer is the most delightful time of year along our lines all over the West. In the Sierra, leaves are turning scarlet. On the coast, the ocean's still warm for swimming. In valleys, the frost may be on the pumpkin at night, but there's laziness in the sunlit air all day.

II. ECONOMY

It isn't peak *winter* vacation season yet in places like Arizona's resort country and Palm Springs. The climate in the fall is mild and balmy. The summer heat is over. Come before the rush. Many resorts and guest ranches there offer reduced rates for the next couple of months. Also, it is past *summer* season, which means you stand a good chance to get a special rate at summer resorts all over the West, too. Fall's the time for economy... but time is fleeting.

III. COMFORT

You have more elbow room to relax in now. There's just as much or more of nature to enjoy, but not so many vacationers getting away from each other together.

IV. RESERVATIONS

With the summer vacation crush over, not only are resort and hotel accommodations more available, but space is easier to get on our finest fastest trains.

Whichever way your fancy takes you, there's an S.P. Route, with fine trains to take you there. So steal a few days (or weeks) and make this Centennial Year Indian Summer a truly memorable one. (And don't forget the Portola Celebration in San Francisco almost all this month.)

"Burning Daylight"

One of our British correspondents recently sent us a clipping from the London News Chronicle, whose roving reporter, Ian MacKay, had just made the *Daylight* trip from San Francisco to Los Angeles.

It's pleasant to receive kudos from abroad once in a while, so we'd like to extract a few lines from Mr. MacKay's column:

"The Daylight . . . which they should call *Burning Daylight* after that lively local lad Jack London . . . is one of the world's wonder trains. It offers you every convenience except billiards and a swimming pool."

Upside Down Geography

Although he was most casual with the location of some California cities, Mr. MacKay presented some added whimsy:

". . . if all the biggest and largest things are in Chicago, nearly all the capital cities of the world are in California.

"First you come to Paso Robles, which proudly proclaims itself to be the 'almond capital of the world'. Then as you pass through the rich Santa Clara Valley . . . which they call the 'world's salad bowl' . . . you come to Watsonville . . . shades of Sherlock . . . which disputes with several other villages for the title 'prune capital of the world'.

"A mile or two beyond Watsonville we reached Salinas (it's actually 17 miles . . . but the *Daylight* is deceptively comfortable . . . RGB) the 'lettuce capital of the world', and not far away we came to Castroville, the 'artichoke capital of the world'. Somewhere south of Salinas there is a 'cucumber' and a 'cauliflower' capital of the world.

"After all this it was rather an anti-climax when the train pulled up at Glendale for Hollywood, the 'movie capital' and it was a great relief to me when I reached Los Angeles and ran into an old friend from Bolton, 'the tripe and onions capital of the world'."

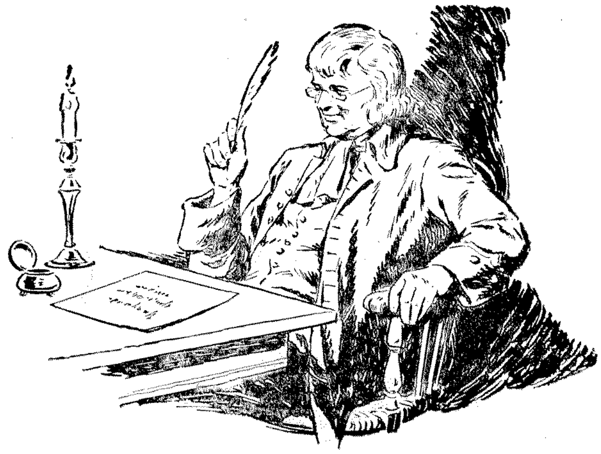
All our "world capitals" seem to have confused Mr. MacKay on his California geography a bit. Last time we looked, Paso Robles was still between San Miguel and Templeton, *not* on the San Francisco Peninsula, Salinas Valley was the "salad bowl", and Watsonville was growing more apples than prunes.

But we modestly concede that he knows a good train when he sees one.

—R. G. Beaumont

S•P The friendly Southern Pacific

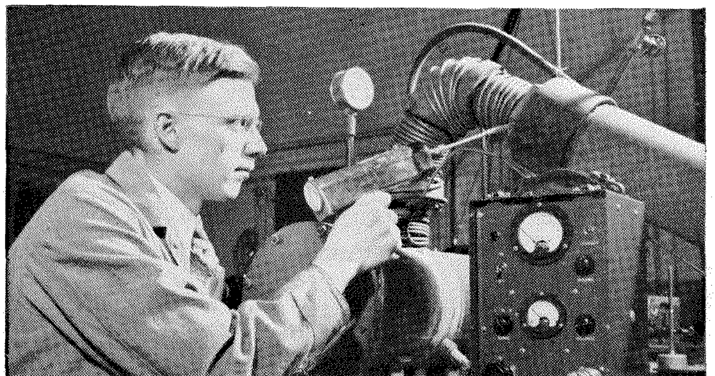
guaranteed.



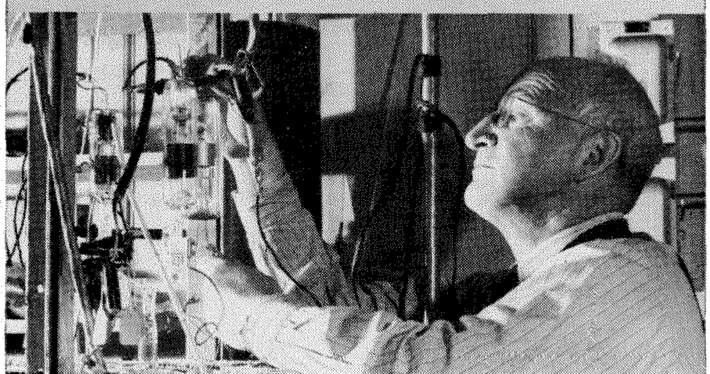
"I chose my wife, as she did her wedding gown, not for a fine glossy surface, but such qualities as would wear well . . ."

—THE VICAR OF WAKEFIELD

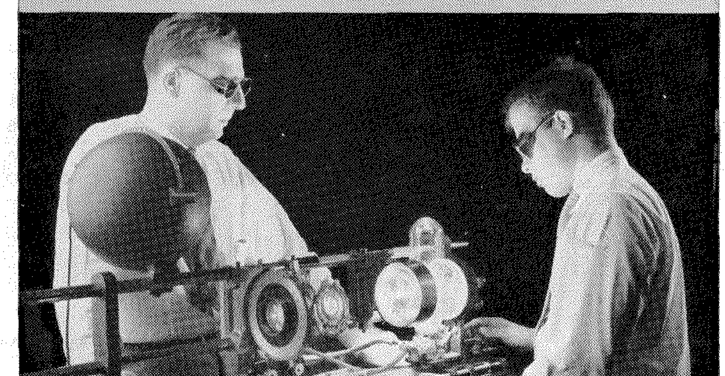
. . . *for "such qualities as would wear well"*



This electronic "sniffer" makes sure that every G-E refrigerator part is leak-proof.



High vacuums in G-E electronic tubes assure longer life and more efficient operation.



It takes 480 tests to determine whether a lamp meets General Electric standards.

THE dressmaker who pleased the vicar's wife, even as she herself pleased the vicar, did so, we submit, by a time-tested procedure: painstaking attention to the details that add up to excellence; assiduous care with the parts upon which is founded the quality of the whole.

The exacting requirements of customers like the vicar and his wife are those which General Electric products are built to meet. We feel that we could turn our wares beneath the vicar's appraising eye with equanimity.

Before the customer has a chance to examine a General Electric refrigerator, for example, specially developed electronic "sniffers" have made sure there is not the slightest leak in its refrigerating unit . . .

G-E radio tubes must pass tests that duplicate the impacts of naval broadsides and the vibrations of plane engines . . .

The General Electric lamps you see for sale have passed as many as 480 quality tests and inspections.

Every General Electric product is designed for high standards of performance . . . is tested to see that it will meet those standards . . . is built to serve you faithfully.

You can put your confidence in

GENERAL ELECTRIC