

# The Condensing of Milk

How It Is Carried Out and Its Economic and Vital Importance to the Country

By Robert G. Skerrett

**G**OVERNMENT authorities have recently stated that the American people consume annually an average of 44 gallons of milk per capita. But how many of us know anything about that large industry which is devoted to treating milk so that it will keep for months or years, stand transportation to distant points, and be fit for food in any climate? The condensing of milk is a business of splendid proportions in this country.

From a modest beginning in 1856, when milk was first condensed successfully on a commercial scale, factories have gradually increased in number and amplified in their facilities until they represent today engineering developments of the highest order. Step by step the technicist has improved apparatus and processes so that the product can be turned out now of uniform quality and measuring up to standards deemed practically impossible of attainment in quantity a comparatively short span back. The significance of this is of profound interest, for as the years go on we are becoming less self-sufficient in the matter of native food supplies, and it is growing more and more vital to us that we limit waste and provide ways by which our perishable comestibles can be preserved for delayed use.

Milk, as we have been told time and again latterly, is a so-called "complete food," peculiarly suited to the nourishing of the young, invalids, and persons of advanced age. But it is equally true that every one of us would be the better off physically if we saw to it that milk entered more generously into our daily dietary. It is especially qualified to furnish nutritive factors perhaps lacking in other edibles which frequently predominate in the average fare—in short, milk can do much to insure the balanced ration essential to bodily well-being.

While nationally viewed, each of us may seem to have at his disposal annually an allowance of 44 gallons of milk, there are many thousands of our fellow citizens that are not so favored. This is noticeably the case in the Southern States, where the natives eat

much less of animal foods, such as milk and lean meats, than do others of us who are the beneficiaries of different agricultural conditions. For this reason as has been brought to light of late, pellagra, a disease of malnutrition, is one of the foremost causes of death in the South; and recent figures disclose that fully 125,000 persons are afflicted with it in the course of a twelve-month. The U. S. Public Health Service has not hesitated to say that "Milk is the most important single food in balancing the diet and in preventing or curing pellagra." While the dwellers in that widespread region cannot get fresh milk or enough of it, still, happily, canned milk can be supplied them in plenty. But enough upon the physiological and therapeutic virtues of this topic, for the purpose of this article is to point out the economic aspect of the condensed milk industry and what it stands for in the realm of true conservation.

Thirty years ago the total production of condensed milk here was substantially 37,927,000 pounds, valued at \$3,587,000. In 1900, the condenseries turned out 186,922,000 pounds worth at that time \$11,889,000. Nine years later the production reached 494,797,000 pounds, quoted at \$33,563,000. In 1919, the 240 plants engaged in the business put up 2,030,958,000 pounds of condensed milk of different kinds, which had a market value of approximately \$200,000,000. During the decade from 1909 to 1919 the volume of the production increased 410 per cent! This expansion can be properly attributed to the popular recognition of the character of the commodity obtained through the employment of scientific and typically up-to-date processes. And that we may understand the methods used, let us sketch the procedure in vogue at one of the most modern of condenseries.

After passing the rigid inspection at the receiving room, the raw milk is weighed and then discharged into a large storage vat or enamel-lined tank equipped with power-operated paddles which keep the milk in motion

so that the cream cannot separate from the mass and rise to the surface. The storage tank is generally supplemented by a number of containers—all of them cooled by water jackets—and in these the milk is continually agitated or stirred by rotating sweeps.

Next, the raw milk is fed into what are termed hot wells, deep, open, iron vessels where the fluid is heated sufficiently to kill all contained harmful bacteria, etc. The hot wells are only partly filled, but, when the temperature has been raised to the point desired, the milk expands rapidly and rises in a foamy mass to the top of the containers. When this stage is reached the steam is turned off. About 2,000 pounds of milk are handled at a single heating. Now comes the condensing.

This concentration is effected in large copper vacuum pans or kettles, each of which is capable of treating 100,000 pounds of fluid milk daily. The purpose of the vacuum pans is to promote the rapid evaporation of much of the water content and to achieve this without recourse to a temperature that will cook the milk the while. If the milk were subjected to a temperature of 214 degrees—its boiling point—it would acquire a flavor which is objectionable to many people, therefore vaporizing must take place well below this. A vacuum of about 28 inches occasions ebullition somewhere around 100 degrees Fahrenheit. Interposed between a powerful vacuum pump and the dome of the vacuum pan is a water-jacketed condenser, and as the steam is drawn off by the suction the condenser deals with it. Gradually, the milk thickens as the steam coils in the pan promote evaporation; and when successive tests show that the density has reached the prescribed point the process is halted, and the condensed milk is drained off. It takes about two hours to effect the concentration.

Leaving the vacuum pans, the milk is put through a special apparatus called a homogenizer. This

(Continued on page 16)

## Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

### The High Cost of Flying

To the Editor of the SCIENTIFIC AMERICAN:

Here's something you probably didn't know. I quote from a San Francisco paper, which explains why Japan has barred all platinum exports by telling the applications of this metal. "Its essentiality to war activities is seen in the fact that platinum is the only metal that will stand the intense friction of the contact points in airplane engines. All bearings are coated with it."

It would appear that the flivver of the skies is a long way off. Or perhaps Mr. Ford will evolve some process for substituting gold and silver for platinum in airplane bearings, and thereby bring these craft within the reach of all.

San Francisco.

C. E. RANDALL.

### Wages vs. Prices

To the Editor of the SCIENTIFIC AMERICAN:

Apropos to the series of articles you have had on the labor question, I suggest the following for your consideration:

That the Federal Government appoint a permanent board having the confidence of the laboring classes, whose function shall be to fix the relative scale of wages and the working conditions covering the labor employed in the various industries of the country. The rate of wages shall be based upon the labor, skill, and danger involved in the occupation. Once the rate is determined it should become the law of the land, equally binding upon employer and employee with adequate penalties to insure its enforcement.

This body, at its first meeting, naturally, will not evolve a perfect schedule, but through its power of investigation, and by studying the drift of labor, it will eventually determine a schedule which will be approximately just. At its worst, and in the very beginning, the results obtained will be far better than

the results obtained under the present system where the wages paid are determined by the relative power of the employers and the employees of an industry, and the position of that industry, with little regard to the actual comparative value of the work performed.

The principle underlying the above suggestion is, that each man should be able to buy back from the common fund of wealth produced that part which he has contributed to it and therefore its determination rightfully belongs to society and not to any individual or group of individuals.

The results of the above would be:

1. To reduce the present antagonism between capital and labor.
2. To prevent strikes, for, as the determination of the rate of wages will not lie with the employers, it is hardly conceivable that any body of men will strike against society.
3. To put every industry and every investor, irrespective of location, on the same competitive basis with regard to its labor.
4. To prevent excessive rise in price based upon claims that wages have been advanced, or labor was inefficient, as has been the case last year.
5. To obviate the necessity of delegates with their abuse of power, also the existence of dishonest labor leaders and employers.
6. To do away with child labor and women labor under certain undesirable conditions.
7. To maintain the rate of wages at a time as at present, where it is absolutely necessary that the purchasing power of the country be maintained in order to preserve old values and restore confidence.
8. To prevent depression, for, with wages standardized, commercial loans will show if merchandise is going into consumption or accumulating on the market.

New York.

JEROME LEVY.

### The Cost of Multiple-Arch Dams

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of February 5, 1921, page 108, appears an article by J. F. Springer, describing some of my work. As the designer of this type of dam, and the builder of 14 as well as designer of about 20 more under contract and prospect, it is to my interest that the descriptions of this work be accurate. Of course, many expressions and statements of a non-technical writer

who writes of technical things must be overlooked, for they are apt to have statements made to them by the ill-informed that they are not in a position to refute or to correct. It would seem to bear out the statement of doubt as to the economics of this type of dam when we read in his article that the cost of the Lake Hodges Dam, "exclusive of accessories," is \$4,000,000. It is an error that I should be permitted to correct through your paper, for as a fact the actual overall cost of this dam to the company was, "inclusive of all accessories," \$302,212, which is a far cry from *four millions*.

The San Dieguito Dam cost but 78 per cent of the lowest bid for a plain earth fill. The Murray Dam, which is fairly well described, cost \$124,454 overall, and as it is 900 feet long and 117 feet high, it is surely a record for economy of cost.

The remarkable scientific features of these dams will be very interesting reading to the scientific world, not only the economics, but the features of their design.

JOHN S. EASTWOOD.

Oakland, Cal.

### Mr. Love's Cycle-Car

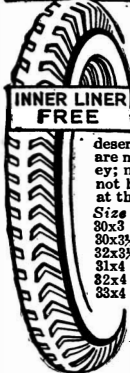
To the Editor of the SCIENTIFIC AMERICAN:

Your article on the "Vest-pocket Automobile" in the issue of April 30th includes some remarks based on a communication I made you some time ago with reference to an illustration appearing at that time. This illustration purported to be "a home-made flivver," and if you refer to my original communication you will find that I was of the opinion that it was really a "Tamplin" cycle-car with "roller-blinds, chip-carving and other home-made improvements." In proof of which opinion I sent you a photograph of the "Tamplin" I purchased last spring, which photograph you reproduce now with accompanying letter-press which might make the reader infer that it was a "V. P. A." reconstructed by me from something else. I must apologize if my bad American has been responsible for the misunderstanding and I should be glad if you can publish this letter as your circulation in Great Britain is doubtless large enough to make your article as it stands against the best interests of the makers of the vehicle in question with whom I have no other relation than as a very satisfied customer.

Lee, England.

ANGUS LOVE.

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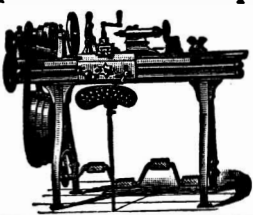
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rollers and saddles do not move until fric-  
tional resistance of considerable magni-  
tude has been overcome. This means that  
the towers must bend to permit this hori-  
zontal displacement. The large dimen-  
sions which masonry towers require to  
sustain the enormous reaction of a long  
span bridge makes them unfit for bending.  
The necessary lateral width causes diffi-  
culty in securing sufficient clearances at  
the point where the roadway passes  
through the tower. The cables will be  
rigidly attached to the tops of the steel  
towers, this with a view to avoiding the  
uncertainty of response of the rollers.  
Hence the steel towers are so designed  
that they can safely deflect in the plane  
of the cables as much as may be required  
to permit a balancing of the horizontal  
forces. The proper proportioning to bring  
this about, when the towers are fixed at  
their base results in slender and graceful  
lines. The strength to withstand the  
bending stresses in addition to the direct  
stresses is provided by the addition of the  
proper amount of material.

The towers are 12 feet wide at the top  
parallel to the cables, widening to 40  
feet at the base. Transversely the width  
is seven feet. The anchorage masonry is  
designed as a monolith. Each will re-  
quire 90,700 cubic yards of masonry, and  
will rest on gravel strata, and on inclined  
caissons extending down to rock or other  
satisfactory material. The horizontal pull  
of the cables combined with the weight of  
the anchorage produces a resultant in-  
clined to the verticle about one foot in six  
feet. To avoid any possible doubt as to re-  
sistance to sliding of the anchorage it is  
intended to sink 20 small caissons to hard  
foundation with the same inclination as the  
resultant of the forces.

A program of widened streets to meet  
the requirements of the new bridge also  
has been suggested by the engineers,  
based on a comprehensive traffic survey.  
The board reports that the bridge can be  
built by July 4, 1926, the Sesquicentennial  
of the Declaration of Independence. Plans  
are now well along in Philadelphia for  
celebrating this with a world's fair.

Rock suitable for foundations was found  
at 86.7 feet on the Philadelphia side and  
91.6 feet on the Camden side below mean  
high water at the site opposite Franklin  
Square, two blocks north of Market Street,  
Philadelphia, recommended by the engi-  
neers for the bridge. At other sites con-  
sidered, the rock level was near the prac-  
ticable limit of pneumatic foundation  
work, exceeding on one side of the river  
or the other 110 feet, below which depth  
the engineers find that men can work  
only in half-hour shifts.

## The Condensing of Milk

(Continued from page 11)

is a sturdy six-cylinder affair that  
pumps the milk under a pressure of 3,500  
pounds through a series of minute pas-  
sageways, and this serves to atomize the  
globules of butter fat, i.e., cream, so ef-  
fectually that they do not again combine  
but remain evenly distributed throughout  
the fluid. Until this machine was de-  
veloped it was found that in a can of  
evaporated milk the lighter solids would  
rise to the top while the heavier ones  
settled to the bottom, and the purchaser  
often mistook this condition as a sign  
that something was wrong.

The preserved milk we have been de-  
scribing is that commonly known as  
evaporated milk, and is unsweetened. As  
it is expelled from the homogenizer it is  
forced first through the coils of a water  
cooler and then on through the pipes of  
a brine cooler where its temperature  
drops to 45 degrees Fahrenheit. Coming  
from the latter refrigerating equipment  
it pours into enamel-lined tanks whence it  
is fed to the filling machines that charge  
the cans familiar to all of us. The cans  
when filled and sealed are carried to the  
sterilizing room where they are exposed to  
the heat of live steam for from thirty min-  
utes to an hour at a temperature ranging  
from 226 to 240 degrees Fahrenheit.

The sterilizer is, in effect, a boiler in  
which is mounted a revolving wheel-like  
structure capable of holding 6,720 cans at  
a time. When this framework is loaded,  
the big iron cylinder is sealed, hot water  
is admitted until the sterilizer is nearly  
filled, and then steam is applied to bring  
the temperature up and to maintain it  
there for the desired period. With hot  
water and steam used so widely in a fac-  
tory of the sort in question, it is not sur-  
prising that an expenditure of three gal-  
lons is required for every pound of milk  
condensed. Therefore, the water supply  
must be abundant and of unquestionable  
purity. When the sterilized cans of evap-  
orated milk have cooled, they are then  
ready to be labeled mechanically, packed  
in boxes, and loaded aboard cars for ship-  
ment. It is entirely practicable to receive  
the raw milk in the morning and to dis-  
patch the finished condensed milk in the  
afternoon.

"Preserved milk," i.e., sweetened con-  
densed milk, is not run through the homo-  
genizer nor is it sterilized after canning.  
About 16 pounds of sugar is added to  
every 100 pounds of raw milk while the  
latter is in the hot wells or after the bulk  
of a charge has been drawn into a vac-  
uum pan. The sugar content plays the  
part of a preservative and thus obviates  
the need of the protective treatment of  
sterilizing, and the sugar also prevents  
the separation in storage of the light and  
the heavy solids in the condensed com-  
modity. But the use of sugar involves  
some very nice problems during the prepa-  
ration of preserved milk, and the utmost  
care must be exercised to guard against  
"sandiness" due to the crystallization of  
some of the sugar. This grittiness does  
not really impair the product, but the  
public insists upon smoothness.

The avoidance of sandiness depends  
upon various things, i.e., the manner in  
which the sugar is commingled with the  
"batch" of milk, the temperatures em-  
ployed in the hot wells and the vacuum  
pans, and also the cooling processes relied  
upon in refrigerating the hot condensed  
milk when it is tapped from the vacuum  
pans. If the percentage of cane sugar  
fall below the requisite measure the re-  
sult is a gelatinous milk or one that may  
spoil sooner or later; on the other hand,  
however, an excess of sugar, no matter  
how skillfully the condensing milk is han-  
dled, will, in all likelihood, induce sandi-  
ness. Needless to remark each manufac-  
turer has his own ways of insuring a sat-  
isfactory outcome; and the raw milk ob-  
tained at the different seasons of the year  
imposes modifications in practice. One  
pound of the final product represents ap-  
proximately two and a half pounds of  
fresh milk, and the water content aver-  
ages about 30 per cent. Normally, milk  
has a water content of 87 per cent.

When the sweetened condensed milk  
has been run through the coolers, it is  
then led to glass-lined tanks from whence  
it is drawn off and supplied to the filling  
machines. The filling apparatus are de-  
signed so that their several cylinders will  
hold just enough milk to charge a corre-  
sponding number of cans; and in the  
course of a working day one of these ma-  
chines will take care of 100,000 fifteen-  
ounce tins. Manifestly, in the prepara-  
tion of both preserved and evaporated  
milk, the original bulk is reduced about  
one-half, and, similarly, the extraction of  
a large percentage of the water dimin-  
ishes the weight greatly in proportion to  
the unit of remaining foodstuff. There-  
fore, results are realized that affect tre-  
mendously the space occupied and the  
weight to be dealt with during subsequent  
transportation and storage. In other  
words, when our condenseries turn out  
in a year a matter of substantially 2,031-  
000,000 pounds of concentrated milk—al-  
lowing for the sugar content in the sweet-  
ened class—the marketable commodity in  
the cans represents a saving in freight of  
quite 1,200,000 tons! At the same time  
they have conserved more than 4,504,000-  
000 pounds of an extremely perishable

foodstuff and placed it within the reach  
of rich and poor everywhere.

Finally, it should be remarked that a  
steadily increasing percentage of the an-  
nual production of concentrated milk is  
what is known to the trade as "plain con-  
densed milk," which is sold in bulk with-  
out being sterilized or preserved with  
sugar. Its keeping qualities, however, are  
greatly improved by the evaporation pro-  
cess to which it is subjected in the vacuum  
pans; and this milk, commonly shipped  
in 40-quart cans, is extensively used by  
confectioners and ice cream manufac-  
turers. The condenseries, therefore, are  
contributing to the insistent and growing  
exactions of America's demand for  
sweets.

## The Heavens for July, 1921

(Continued from page 12)

month, but is too near it to be seen. He  
passes through inferior conjunction on the  
7th, and later comes into sight as a morn-  
ing star, running out quickly to elongation  
on the 28th, when he rises at 3:30 A. M.  
He should be easy to see during the last  
week of the month.

Venus is a morning star, and reaches  
her greatest elongation on the 1st, 45°  
44' from the sun. She rises at 2 A. M.,  
and is exceedingly conspicuous all this  
month.

Mars is just past conjunction with the  
sun, and, though theoretically a morning  
star, is practically invisible.

Jupiter and Saturn are both evening  
stars in Leo, only five degrees apart. On  
the 10th the former sets at 9:50 P. M.,  
and the latter at 10:10. Jupiter is mov-  
ing eastward faster than Saturn, and  
steadily drawing nearer to him; but the  
conjunction of the two will not occur un-  
til they are lost in the sun's rays. We  
still see the dark side of Saturn's rings,  
but they are turned more and more nearly  
edgewise toward us, and after August 3rd  
the bright side will come into view once  
more.

Uranus is in Aquarius, and comes to  
the meridian about 3 A. M. in the middle  
of the month. Neptune is in Cancer, and  
unobservable, setting less than two hours  
after the sun.

The moon is new at 10 A. M. on the  
5th, in her first quarter at 11 P. M. on  
the 11th, full at 7 P. M. on the 19th, and  
in her last quarter at 9 P. M. on the 27th.  
She is nearest the earth on the 6th and  
farthest away on the 21st. During the  
month she is in conjunction with Venus  
on the 1st, when an occultation is visible  
in Europe, with Mars and Mercury on the  
5th, Neptune on the 7th, Jupiter and  
Saturn on the 9th, Uranus on the 23rd,  
and Venus again on the 31st.

## Comets

Winnecke's comet, of which we spoke  
last month, passed perihelion on June  
13th, and was nearest the earth on the  
preceding day at a distance of about 14  
million miles. By July 1st it will be al-  
most twenty million miles from us, and  
rapidly receding. According to an accu-  
rate ephemeris, computed at the Univer-  
sity of California, its apparent position  
will be on July 1st 0h. 32 m. R.A., Dec. 19°  
55' south; while on the 20th it will be in  
1h. 21m. and 34° 27' south. Unless some  
exceptional brightening takes place, it  
will be invisible to the naked eye all  
through the apparition, and will be only  
of the ninth or tenth magnitude in July.

Reid's comet, discovered at the Cape  
in March, is now rapidly receding and  
growing very faint.

A comet was discovered by Dubrage, in  
Russia, on April 29th. According to ele-  
ments computed at Petrograd, it passed  
perihelion on May 7th, at a distance  
of 107 million miles from the sun.  
It is moving in a direct orbit, with an in-  
clination of 22°. A plot of the orbit indi-  
cates that it should remain visible in the  
evening sky for some months, receding  
from the earth and sun and growing  
fainter. No ephemeris for the present  
month is at hand.

Mt. Wilson Observatory, June 11, 1921.