

# Daylight Saving

BY PRESTON S. MILLAR

General Manager, Electrical Testing Laboratories, New York

*"Daylight Saving" is found to reduce the total output of certain central stations and of one gas company by about 3 per cent during the seven summer months. Reduction in output for lighting alone is found to average 8 per cent. Applying these fragmentary data to the country as a whole there is estimated an annual saving by the public of \$19,250,000 in expenditure for artificial light and a reduction of about 495,000 tons per annum in consumption of coal.*

*The principal advantages of "Daylight Saving" are promotion of outdoor recreation, saving in expenditure for artificial light and saving of fuel. Disadvantages are experienced principally by farmers, dairymen, truck gardeners and miners. Economic losses probably far outweigh the gains.*

*Custom in allocating hours for work, sleep and play has been evolved through experience. It is undesirable to alter it by arbitrary legislation. Since advancement of clocks, while serving the interests of one part of the population, has proved so disadvantageous to another part as to compel return to correct time, it seems obvious that those who benefit by advanced time in summer should adjust their habits as desired without disturbing the practise of the remainder of the population.*

IN accepting the invitation of the Lighting and Illumination Committee to present a paper on "Daylight Saving," the author stipulated that in order to consider the subject comprehensively, a considerable part of the paper would have to be devoted to matters remote from electrical engineering. The economic and sociological aspects of daylight saving surpass in importance the effect upon use of artificial light. Any treatment which should ignore these important features would lack perspective and would be likely still further to increase confusion on a subject which is greatly in need of clarification. Accordingly this paper includes a brief survey of daylight saving in its several aspects.

Postponing for the latter part of the paper discussion of the advantages and disadvantages of daylight saving, consideration is first given to the effect upon output of electric plants and upon use of artificial light.

## PART I

### REDUCED USE OF ELECTRICITY

Effort has been made to secure from central stations and from private plants information which will indicate the effect of daylight saving upon output.

No organized data concerning private plants have been located.<sup>1</sup> The general view of those best informed seems to be that the saving is not of great moment.<sup>2</sup>

Statistics have kindly been supplied by several large central station companies. This opportunity is taken to express the author's appreciation of the cooperation accorded in this connection. These companies operate in the northeastern part of the United States in the region bounded on the south by the Potomac and Ohio Rivers (roughly 38 deg. N.) and on the west by the Mississippi River. Differences in latitude within this region are considerable and doubtless have an appreciable effect upon the use of artificial light. Differences in longitude may of

course result in something like one hour greater or less use of artificial light, depending upon location east or west of the meridian with reference to which local time is fixed. However, the variable conditions under which these stations operate and the fluctuations in weather conditions are such as to make impracticable a detailed analysis with reference to latitude and longitude.

The central station statistics have been compiled partly from comparison of output in the years prior to 1918 with the two more recent years, allowance being made for growth of business, and partly from study of daily load curves and daily kilowatt-hours just before and just after change of clocks at the beginning and at the end of the daylight saving periods of 1918 and 1919. Such daily load curves have been reduced to percentages of total daily send-out and have been combined to obtain the composite curves shown respectively in Figs. 1, 2, 3 and 4. The autumn curves differ from the spring curves characteristically due in part to earlier darkness. Beyond this the several composite load curves bear no inter-relation being formed from the data made available for each period of time change, and including in each case different groups of central stations. It is not significant for our purpose, for example, that the ratio of day to evening peak in Fig. 3 is greater than that in Fig. 1. It is significant, however, that in spite of the independence of the four curves they exhibit certain features in common. There is a slight increase in consumption in the early morning under advanced time; a conspicuous valley in the evening; a later and diminished evening peak; and in most cases a slightly increased output in the late evening. The daily load factor is not affected in cases where industrial power absorbs the maximum output. For lighting, as shown later, the output is reduced to about the same extent as the lighting maximum and therefore the daily load factor for such loads is not materially influenced.

In Table I there is a summary of the central station statistics which enter into the construction of the composite load curves in Figs. 1 to 4 inclusive. These

*To be presented at the 8th Midwinter Convention of the A. I. E. E., New York, February 18, 1920.*

1. For references see end of paper.

show for the time of advancing or retarding clocks in both 1918 and 1919, the number of central stations contributing statistics and the average changes in daily send-out for the entire plants. Certain other information not attributable to particular dates is included as "miscellaneous."

TABLE I  
Change in Weekday Output of Central Stations under Daylight Saving

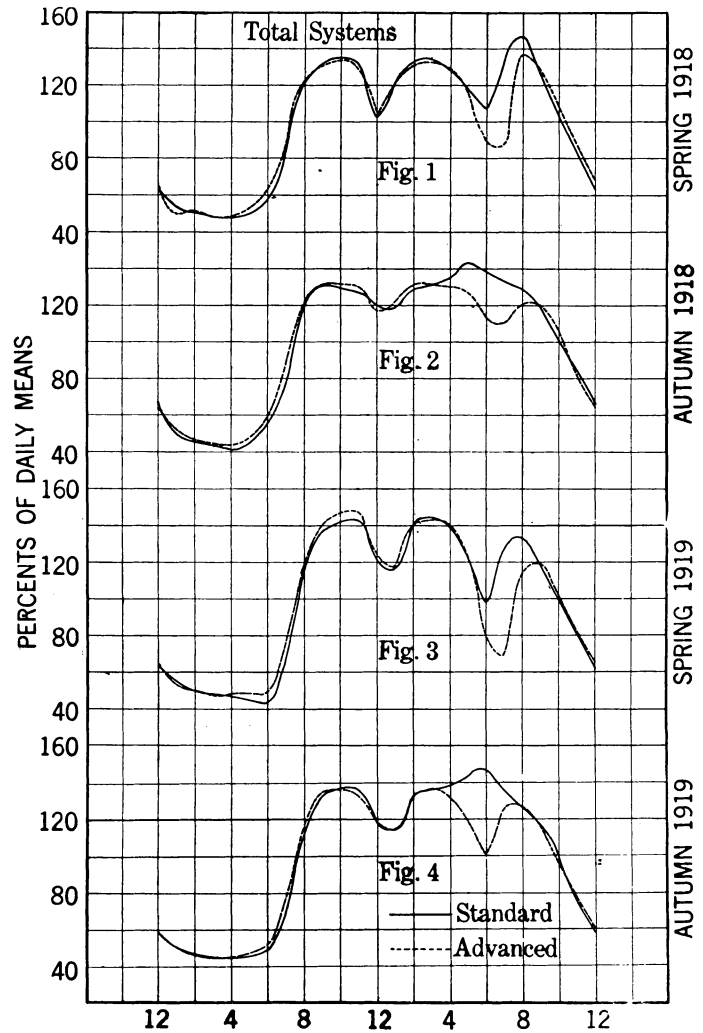
Period	Number of companies	Differences	
		Range	Average
Spring, 1918.....	16	+ 0.3 to - 9.0	- 3.0
Autumn, 1918.....	4	+ 4.4 to - 5.7	- 2.0
Spring, 1919.....	6	+ 3.4 to - 8.0	- 2.5
Autumn, 1919.....	7	+ 0.7 to - 6.3	- 3.1
Miscellaneous.....	4	- 0.8 to - 5.5	- 2.4

Variations due to other causes are greater than the average reduction due to daylight saving, some data actually showing increases of output for certain days under daylight saving. The differences are derived principally from comparison of equivalent weekdays ranging in number from one to five before and after change of clocks. No allowance has been made for the natural decrease in use in the first week of advanced time in April as compared with the last week of standard time in March, nor for the corresponding actual increase in use under normal time in the first week of November as compared with that of the last week of October. The effect of ignoring this variable in both cases is slightly to exaggerate the indicated reduction in use of electricity due to daylight saving.

The average data for the several periods yield reasonably concordant indications as to the extent of the effect upon daily send-out at the beginning and end of advanced summer time. The average reduction in daily kilowatt-hours is shown to be of the order of 3 per cent. There is reason to believe that in the interval between these periods the reduction is not markedly different. Accepting 3 per cent therefore as representative of the extent to which in our general latitude during the seven summer months the kilowatt-hour output of central station plants is decreased, it is possible to form a rough estimate of the amount of coal saved by central stations and of the amount of money saved by the public through the less use of electric light.

In ordinary circumstances good judgment would probably dictate that one refrain from hazarding estimates of these kinds due to the inadequacy of information and to the wide range of conditions throughout the country, many of which depart materially from the conditions of operation of the companies included in this survey. Much unreliable information has been published, however, purporting to indicate

the extent of saving in fuel and money growing out of advanced summer time, and it would appear desirable therefore to offer a reasonable estimate based upon the data here made available. In undertaking to do so it is to be emphasized that the data in this paper are quite meager. Of the many central stations in the country only a very few are represented. In consequence these estimates are to be regarded as only rough approximations which are probably well indicated by the available information but which may depart considerably from real accuracy when



made the basis of assumptions for other localities or for the country as a whole.

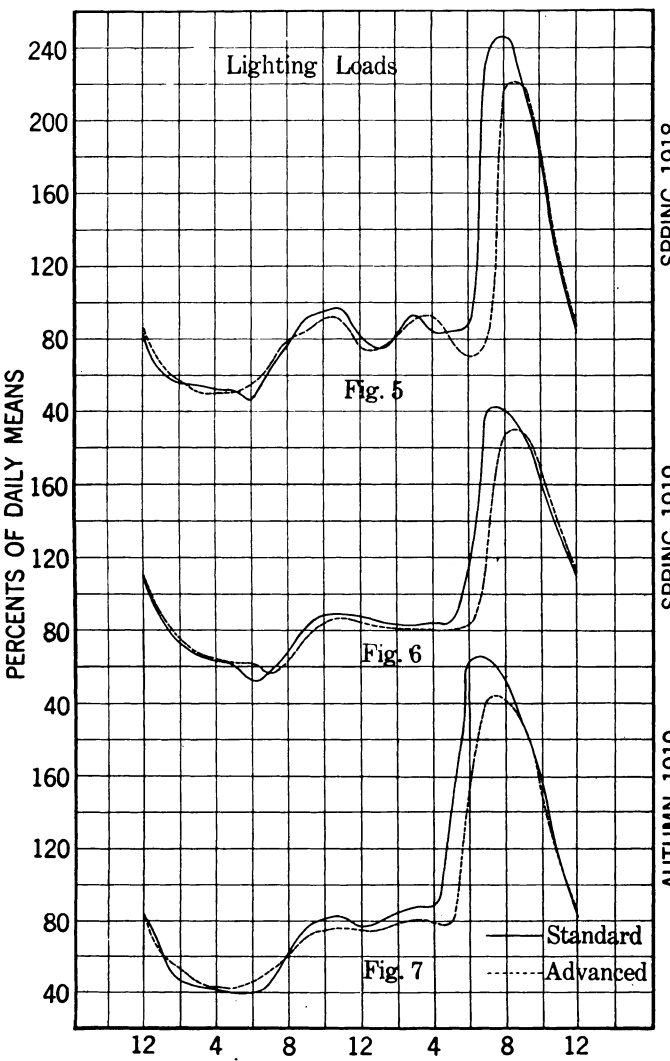
ESTIMATE OF REDUCTION IN EXPENDITURE FOR ELECTRIC LIGHT.

One estimate of saving to the public in cost of electric light is made by estimating the total output of central stations, under normal time, considering 3 per cent to have been saved, and assuming a rate of six cents per kilowatt-hour as applicable to such savings. Another estimate is made by pro-rating over the entire country estimates of total annual savings in particular cities.

Estimated total annual output of steam central stations for light and power if normal time had prevailed in 1918 or 1919 <sup>3</sup> .....	14,375,000,000	kw-hr.
Ditto for seven summer months.....	8,000,000,000	"
3 per cent of above.....	240,000,000	"
At six cents.....	\$14,400,000	
	Range	Mean
Published estimates per capita <sup>4</sup> . 21 cents to 24 cents.		22 cents
Private estimates per capita <sup>5</sup> . 14 cents to 21 cents.		19 cents
Assigned.....		21 cents

Estimated total annual savings at 21 cents of 60,000,000 people in communities served by steam and water plants.....	\$12,600,000
Assigned annual value of reduced expenditure for electric light supplied by central stations.....	\$14,000,000

How much of this is to be considered actual saving to the public is an unanswered question. The long



continued downward trend of rates for electricity was halted by increased costs growing out of the World War. The effect upon central stations of daylight saving has been in a small way to reduce revenues from electric lighting without affording opportunity for compensating reductions in cost. This has con-

tributed to a very slight extent to halting the downward course of rates and to bringing about increases in rates here and there, where these have been found necessary. Furthermore minimum rates for service in force in many localities limit the reduction to smaller amounts than those entering into the foregoing estimate. In view of these conditions it is a question what part of the \$14,000,000 estimated to be the aggregate reduction in payment by the public for electric light should be considered to be an actual saving to the public.

*Saving in Coal.* Taking the above estimate of kilowatt-hours as the annual reduction in output of central stations due to daylight saving, and estimating a coal saving rate of say 2½ pounds per kilowatt-hour, we arrive at an estimate of 300,000 short tons of coal saved per annum.

*Reduction in Residential Use of Electricity.* All of the foregoing has been based upon statistics as to the total daily send-out of central station plants. It is in residential lighting that the effect of daylight saving is most conspicuous. Through the courtesy of certain central station companies it has been possible to obtain information as to the daily kilowatt-hours and daily load curves of certain substations or feeders which are devoted largely to the supply of residential districts, and certain Sunday records which are of a somewhat similar character. These have been consolidated and are presented in Figs. 5, 6, and 7. The valley in the late afternoon occasioned by daylight saving is again seen, the shifting of the peak and the decrease of the maximum are evident and there is exhibited a tendency for people to use light to a later hour according to the clock than under normal time, thus indicating a tendency to sit up later. In passing it may be noted that certain telephone statistics in the spring of 1918 tended to confirm this conclusion.

Statistics accompanying daily load curves for residential service are summarized in Table II.

TABLE II  
Change in Output of Central Stations for Lighting under Daylight Saving

Period	Number of companies	Differences	
		Range	Average
Spring, 1918.....	4	- 2.0 to - 19.0	- 9.0
Spring, 1919.....	5	- 5.3 to - 9.1	- 7.0
Autumn, 1919.....	3	- 5.0 to - 12.6	- 8.5
Miscellaneous.....	2	- 7.0 to - 7.0	- 7.0

The principal interest in this connection has to do with reduction in the use of artificial light under daylight saving. The indication here is that by and large this amounts to approximately eight per cent in residences.\*

\*R. S. Hale, *Electrical World*, January, 1920 estimates for Boston residence customers paying \$100 per annum a saving of 8.3 per cent and for residence customers paying \$20 per annum a reduction of 6.8 per cent during the 7 summer months.

An interesting further study of the reduced residential use of electricity due to daylight saving is afforded through statistics kindly supplied by one central station company to show average kilowatt-hours per residence during each month of the years 1916 to 1919 inclusive. (1919 up to October; estimated for November and December). These are analyzed by a method growing out of a suggestion by Mr. W. F. Wells. The monthly kilowatt-hour averages for 1916 and 1917, prior to the daylight saving period, have been combined and reduced to percentages of the mean monthly value. A like course has been followed in analyzing the 1918-1919 statistics. To the latter, however, a uniform factor has been applied reducing the monthly values to equality for the average of the five winter months with the average of those of 1916-1917. Thus the two curves coincide approximately for the winter months and departures during the seven summer months may reasonably be considered to have been

of residences in 1916-1917. The relative consumption during the daylight saving period is indicated by the light broken line. The reduced use during this period is represented by the cross-hatched area. This indicates for the city represented in this analysis a reduced use in residences of six per cent.

#### REDUCED USE OF GAS

As the preparation of this paper approached completion, it was suggested that a useful purpose would be served by including some information to show the reduction in use of artificial gas due to daylight saving. Hurried requests to a gas company for information met with cordial and prompt response, as a result of which the author was kindly given access to the records of gas send-out. The company operates in the same general region described for electric companies.

In the gas business ordinary variations of output from day to day greatly exceed in magnitude any effect to be anticipated from daylight saving. These fluctuations are so marked and so difficult of explanation as to deter those in responsible positions in the industry from hazarding an estimate of the effect of daylight saving—a view which the records show to be based upon sound engineering judgment. The author, however, after studying the records of this gas company with considerable care, has arrived at an estimate which he feels justified in putting forward as his opinion for which the officials of the company are in no way responsible.

*Reduced Use of Artificial Gas.* Resorting to graphic analysis it has been possible to extort from apparently inconsistent data of send-out at the time of change of clocks an indication as to the effect of daylight saving. In the case of this one company there is indicated a reduction of about three per cent in the total gas output per day due to daylight saving. It is interesting to note that this entirely independent estimate is closely in accord with the average assigned for reduction in use of electricity. The author assumes that the three per cent indicated as the reduction at the beginning and end of the daylight saving period, as in the case of electricity, is fairly representative of the effect during the intervening months. It is equivalent to about  $1\frac{1}{2}$  per cent for the year as a whole.

*Coal Saved Through Reduced Use of Gas.* It has been estimated that in a year preceding the introduction of daylight saving the net consumption of coal in the manufacture of gas aggregated 10,500,000 short tons.<sup>6</sup> If an increase to 13,000,000 be assumed for a daylight saving year, and if one-half that amount be attributed to the seven summer months, there is a total of 6,500,000 tons, 3 per cent of which gives 195,000 tons as a rough estimate of coal saved. An additional reduction was of course effected in the use of oil.

*Reduced Expenditure for Gas.* A U. S. Government report for 1915<sup>7</sup> estimated the annual manufacture

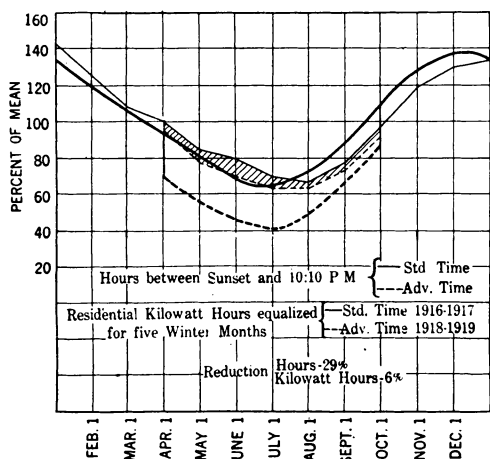


FIG. 8.—EFFECT OF ADVANCING CLOCK BY ONE HOUR  
(LATITUDE 40° N.)

due to daylight saving. For comparison the elapsed time between the hour of sunset (latitude 40 degrees north) and 10:10 p.m. has been taken. This is chosen with a view to making the range of artificial lighting hours employed in this analysis co-extensive with the range in monthly kilowatt-hours. Incidentally, for the beginning and end of the daylight saving period these hours of artificial lighting are found to center fairly well upon the evening peak as indicated in Figs. 5 to 7. In Fig. 8 the hours of artificial lighting thus chosen are indicated by the heavy continuous curve for the several months of the year. The reduction in such hours occasioned by the advancement of the clock in summer time is indicated by the broken heavy line. Both are expressed in per cent of the yearly mean of such hours of artificial lighting. This shows that advancement of the clock during the seven summer months means a reduction by 29 per cent in the evening lighting hours. The light continuous line indicates relative monthly kilowatt-hour consumption

of artificial gas to be 284 billions cubic feet. Assuming that for a daylight saving year this was increased to 350 billions, one-half of which was produced during the seven summer months, and using the estimate reached in this paper of three per cent reduction, there is indicated a saving which at \$1.00 per thousand cubic feet equals \$5,250,000.

SUMMARY OF EFFECT UPON USE OF ARTIFICIAL LIGHT

In asking indulgence for the inadequacy of data entering into these estimates the author begs to submit that he is not directly associated with either of the industries affected but must request from them statistics which are necessary for this purpose. In thus imposing upon the good nature of others it was in order to exercise some restraint, requesting information which might be readily available instead of asking for particular details the procuring of which might involve much effort and cost. The material which has been so courteously offered is believed to be reliable and representative. If by reason of its inexhaustive nature or because of poor judgment of the author in its analysis the estimates are in need of revision that fact will doubtless be made known in discussion of the paper.

Summing up this first part of the paper the following table is presented:

Approximate Estimates of Savings During Seven Months Due to Reduced Use of Artificial Light

	Reduction in total output	Saving in coal	Saving in expenditure for artificial light
Electricity (Central Stations).	3 per cent	300,000 tons	\$14,000,000
Artificial gas	3 per cent	195,000 tons	5,250,000
Totals.....		495,000 tons	\$19,250,000

PART 2

HISTORIC NOTE

Benjamin Franklin is considered to be the father of daylight saving.\* In 1784 Franklin<sup>7A</sup> stated that by rising with the sun, Parisians might save one hundred million francs annually through the reduced use of candles. He suggested that the public be compelled to practise economy in this matter. A tax of a louis per window shuttered in the morning after sunrise was to be a first step.

Every morning as soon as the sun rises let all the bells in every church be set ringing and if that is not sufficient, let cannon be fired in every street to wake the sluggards effectually and make them open their eyes to see their true interest.

Again Franklin says in his Autobiography—

In walking through the Strand and Fleet Street one morning at seven o'clock I observed there was not one shop open though it has been daylight and the sun up above three hours; the inhabitants of London choosing voluntarily to live much by candle

light and sleep by sun light and yet often complain a little absurdly of the duty on candles and the high price of tallow.

In modern times William Willett was sponsor in England for a proposal to advance the clock in summer time in order to utilize daylight to better advantage. The subject in England was agitated from 1908 to 1914 without avail.<sup>9</sup> On May 1st, 1916, Germany as a war measure adopted the plan by advancing clocks one hour for the summer period; England, France and several other countries took like action within the next few months.

On this continent the experiment of advancing the clock had been tried in several localities with varying success.<sup>8</sup> It was adopted in Cleveland in the spring of 1914 by changing from central to eastern time. As Cleveland lies properly just within the western boundary of the eastern zone, this was not a very radical change. It proved successful and has been continued throughout the entire twelve months of succeeding years. In the spring of 1919, when standard time was advanced by federal law, Cleveland advanced its time another hour. This gave rise to much complaint, however, and clocks were retarded on May 11th, 1919, thereby bringing Cleveland to normal eastern time, this last adjustment being still in effect. In Detroit, which lies just within the eastern boundary of the central zone, the clocks were advanced on May 15th, 1915, bringing the City into conformity with normal eastern time both in summer and winter.

In the United States at large agitation for clock advancement in summer time became more pronounced. The National Daylight Saving Association was formed to promote the plan, and the project was furthered by reports of committees of, among others, the Boston Chamber of Commerce and the Chamber of Commerce of the United States. Finally a bill passed by both Houses of Congress was approved March, 1918, fixing standard time to govern the movement of common carriers engaged in interstate commerce and other activities under federal jurisdiction, and providing for the advancement of such standard time by one hour during the period between the last Sunday in March and the last Sunday in October. The States of New York and Pennsylvania adopted parallel legislation to govern state activities. The Federal Act remained in force for two years but that provision which called for advanced time during the summer months was repealed in August, 1919. The repeal became effective at the end of the daylight saving period in 1919.

\*Perhaps the first recorded instance of daylight saving is that brought about by Joshua. The Biblical account relates several miracles by which the bloody conquest of Canaan was accomplished. In the rescue of Gibeon which was besieged by the associated kings of the Amorites, Joshua, even though aided by a hailstorm which slew more of the enemy than did his army, was unable to "mop up" before dark. So he spoke to the Lord and caused the sun and moon to stand still about a whole day and there was no day like that before it or after it.

In European countries such as England, France and Germany, after extended trial, the daylight saving plan will probably be followed during the coming summer as in the recent past. In Canada, after a trial during 1918, proposed renewal of the daylight saving bill was defeated in the Dominion Parliament in 1919. It is understood also that in Australia after a trial daylight saving has been abandoned.

Since the repeal of the Federal Daylight Saving Act in this country the subject has been agitated locally in several cities. For example, in Cincinnati advanced time has been adopted to be effective during the entire year, thus conforming to the action of Cleveland and Detroit. In New York, Hartford, Philadelphia, Pittsburgh, and other cities, provision has been made for advanced time in municipal activities during either five or seven summer months. In Chicago after

disposal a great mass of opinion but very little definite information. From these the following statement of advantages and disadvantages has been prepared.

*Outdoor Recreation.* To those engaged in sedentary pursuits and who are in a position to devote spare time to outdoor recreation, daylight saving undoubtedly has been a boon. Public playgrounds and parks of our cities have borne witness to the stimulation which daylight saving has given to outdoor sport. Tennis and golf (Fig. 9) have become more popular, conferring benefit upon many who probably without the additional hour in the afternoon would not have found it practicable on weekdays to avail themselves of these forms of exercise. Opportunities for pleasure automobiling on weekdays have been multiplied. Amateur baseball, and in general unorganized forms of sports, have been promoted. Business men who



FIG. 9

Photo by Underwood and Underwood

consideration it has been decided to adhere to normal federal time.

After a year's experience in England a Parliamentary committee conducted an investigation of "Summer Time" (clocks advanced by one hour) and reported in favor of its continuance.<sup>9</sup> In the United States there has been no organized investigation of its operation.

#### ADVANTAGES AND DISADVANTAGES OF DAYLIGHT SAVING

The advantages which in advance of adoption the measure was said to offer were principally: increased opportunities for outdoor recreation, reduced consumption of fuel, saving in expenditure for artificial light and promotion of gardening. The disadvantages which were anticipated included confusion in railway schedules, confusion as between astronomical and legal time, and possible interference with children's sleep. The author has reviewed the literature of the subject and has instituted inquiries with a view to collecting information on these and other advantages and disadvantages. In consequence there is at his

maintain their own homes have found an added opportunity on weekdays to carry out in daylight the numerous maintenance operations which fall to their lot. In general, the effect of daylight saving has probably been to promote outdoor living with greater enjoyment of daylight by all members of families. Those who could and did avail themselves of the added opportunity have undoubtedly derived physical benefit which has reacted mentally and increased their value to the sedentary occupations in which they are engaged during business hours. Moreover there was probably a wholesome tendency as time passed for more and more people to avail themselves of such added opportunities.

*Coal Saving.* In Part 1 of this paper it is estimated that the reduction per annum in consumption of coal for lighting is of the order of 495,000 tons. This includes electricity for lighting supplied by central stations and artificial gas.

*Saving in Expenditure for Artificial Light.* The saving in expenditure for electricity and artificial gas is estimated in Part 1 to be of the order of \$19,250,000.



*Gardening.* The amateur gardening movement was more or less coincident with the large increase in the cost of living which began in 1915. Novelty, recreation and economic advantage all played their part. To this after we entered the war there was added patriotic aspiration.<sup>10</sup> The added hour between the close of business and dark probably assisted amateur gardeners (Fig. 10).<sup>11</sup> It is difficult to determine with what part of the increase in such garden produce it should be credited.

Private gardening was carried on to an increasing extent in suburbs and small towns and in the country before the advent of daylight saving. There is no indication that the daylight saving measure either added to or detracted from private gardening.

tinuance of daylight saving<sup>14</sup>, appears to have based its action upon the belief that increased opportunity for outdoor recreation has probably added materially to health and vigor.<sup>15</sup> There is a general view among hygienists that facilities for recreation during daylight are advantageous to those who can and do avail themselves of them.<sup>16</sup> Although there is lack of definite information showing benefit to health, yet it is probable that real improvement has accrued to certain classes of urban and suburban dwellers.

There seems to be practically a consensus that advancement of the clocks in summer brings bedtime for small children well into daylight and interferes with their sleep. Thus children either sit up later or after retiring remain awake later by the clock

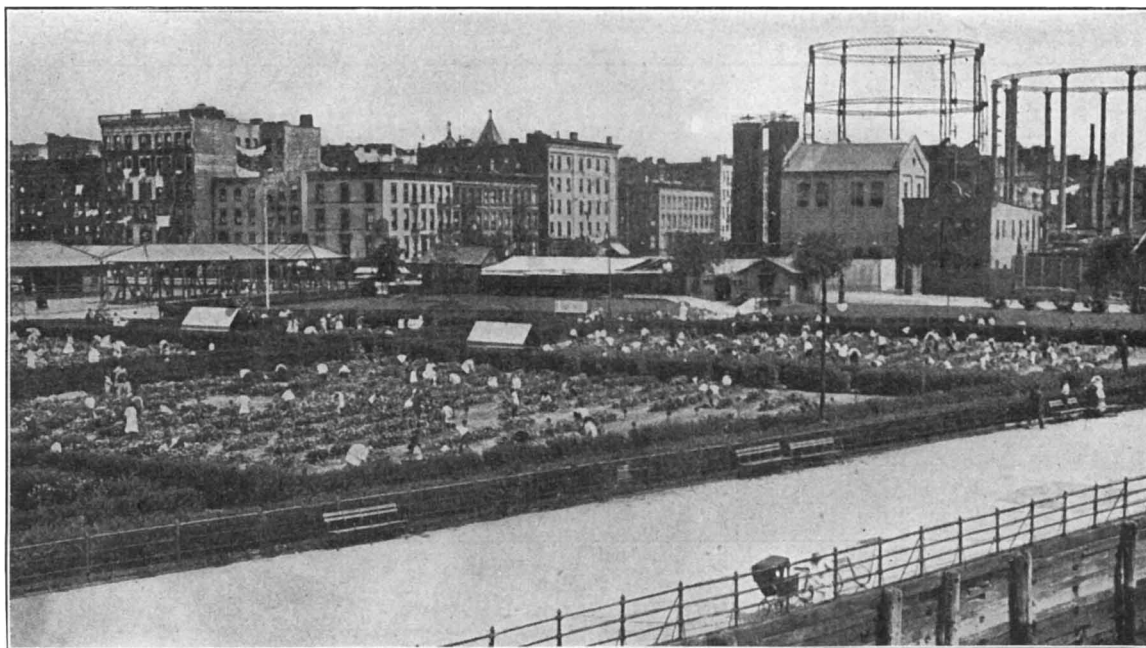


FIG. 10

From "The War Garden Victorious"—Lippincott

Gardening by those who produce a surplus for sale has been impeded by the Daylight Saving Act. Truck gardeners in general have opposed the measure. Vegetable and market-growers' associations in several parts of the country have demanded its repeal. The general reasons given are that advanced time compels gardeners to begin their activity too early for agricultural purposes, but necessarily early in order to maintain contact with the market. These people have to go to bed in daylight or sacrifice sleep.

Upon the whole the evidence appears to be that the disadvantages to professional gardeners of daylight saving have outweighed the advantages to amateur gardeners.

*Health.* There appears to have been no organized study of the effect of daylight saving upon health.<sup>12</sup> The Federal Public Health Service<sup>13</sup> has no definite information on the subject. The American Medical Association while calling in June, 1919 for a con-

than formerly. Just how much weight is to be given to this disadvantage is for hygienists to determine.

Those who live in city tenements as a rule have neither time nor money for the forms of outdoor recreation which are promoted by daylight saving. With the day's work finished their desire is more for rest than for recreation. Their homes lack many comforts and are often ill ventilated and congested. In summer it is a problem with these people to get sufficient restful sleep. The arrival of bedtime finds bedrooms uncomfortably hot and stifling. Recourse is bad to sleeping on fire-escapes, and in extremely hot weather to sleeping in parks, and for those who can do so, on beaches.(Fig. 11). To these people daylight saving is disadvantageous during the summer months. They must choose between retiring to their uncomfortable rooms one hour earlier or losing sleep. On the other hand they must arise one hour earlier in the morning at a time when the most refreshing sleep is

to be had. It is said to be the judgment of nurses and visitors who are constantly going in and out of tenement homes that this is an appreciable factor.

A conclusion as to the effect upon health should be reached after weighing on the one hand additional outdoor recreation on the part of those who can avail themselves of the added opportunities, and on the other hand interference with the sleep of children, with the sleep of all who must retire before dark in order to rise early, and with the sleep of all in this climate in hot weather.

*Farmers.* The most serious complaints concerning disadvantages of daylight saving have come from farmers. To this class is to be attributed most of the influence which led to the repeal of daylight saving. One cannot peruse the agricultural journals and the reports of Congressional hearings on daylight saving without being impressed with the practical unanimity and earnestness of the farmers' opposition.<sup>17</sup> The



FIG. 11

Photo by Brown Brothers

crux of the difficulty is that much of the farmers' work must be regulated by the sun, compelling him to work under normal time, while certain activities as a practical matter have to be adjusted to conform to advanced summer time. The conflict between the two is intolerable. In order to connect with milk trains the schedules of which cannot well be altered because they must serve those who abide by advanced time, it is necessary for the farmer's day to begin one hour earlier than usual. In order that children may attend to chores and get off in time for school, there is the same requirement for earlier rising. This earlier rising in itself is objectionable. The early morning work completed, it is necessary to wait for certain cultivating and harvesting purposes until the dew is evaporated. In considerable part this hiatus means waste. Generally speaking, the farmers who produce surplus food products employ labor. Hired labor is unwilling to work one hour later than do those not engaged in agricultural work. Quitting at the usual clock time, there is a loss of the hired man's

time. The farmer himself on occasions when he desires to go to the neighboring town for business, recreational or social purposes must quit one hour earlier, sun time. The curtailment of farming activity thus occasioned is at the time of day which is best for planting and harvesting purposes.

Farmers refer to the measure as "Daylight Wasting."<sup>18</sup> It is obviously difficult to arrive at a definite statement of resultant loss, but some estimates will prove suggestive. It is estimated that the efficiency of farm help is reduced 15 per cent.<sup>19</sup> The loss to farmers involved in daylight saving is estimated to run 18 per cent as the average of a number of farms.<sup>20</sup> Daylight saving is estimated to have added 15 to 20 per cent to the cost of production on farms.<sup>20</sup> United States Senator Capper of Kansas estimates that daylight saving occasions waste aggregating \$1,000,000,000 a year.<sup>21</sup> While it is impossible to make any definite statements, yet it is evident that the disadvantages to farmers are large. As a result, agricultural organizations and journals are very generally opposed to daylight saving.<sup>17</sup>

*Dairying.* In dairy farming the objections to daylight saving are quite as strong as in agricultural work. To accommodate advanced time cows must be brought in for milking in the morning one hour earlier than usual, and sometimes before daylight. Again they must be brought in in the hottest part of the afternoon. Aside from the inconvenience and hardship which this works upon the dairy farmer, it is stated that there is a very noticeable decrease in the milk yield, one estimate placing the quantity as high as two quarts per cow per day.<sup>22</sup> Under conditions with which the author is personally acquainted on a large dairy farm, a somewhat smaller but quite noticeable reduction has been experienced. It is understood that there are about 300,000 cows in New York State alone. It will readily be seen that the loss in milk will aggregate several millions of dollars.

*Miners.* Next to farmers, miners have probably protested against daylight saving more than any other class of people. This is especially true of those in the Middle West. It is necessary for their wives to rise before daylight to prepare breakfast and pail luncheon, and for the miners to leave home unduly early (sun time) in the morning. At the other end of the day this means retiring while it is still light in the heat of the evening.<sup>23</sup>

*American Federation of Labor.* Delegates to a convention of the American Federation of Labor expressed themselves as in favor of the daylight saving project when the plan was proposed during the war. Officers of the Federation have continued to favor the plan. At the convention of the Federation in June, 1919, however, the delegates voted in disapproval of daylight saving.

*Financial Relations with Europe.* One point claimed for advanced summer time was that it would bring



exchanges in this country into better contact with those of Europe, due to overlapping of hours of active trading. The author is advised that no advantage has been realized, however, because arbitrage transactions by cable have been out of the question since the outbreak of the Great War.

*Accidents.* Another claim advanced for daylight saving was that there would be fewer accidents in industrial districts under advanced time. No information is available to show that such has been the case. Inquiry has brought advice that it would not appear that there has been any appreciable benefit which could be traced to the advent of daylight saving.<sup>24</sup>

*Summary of Advantages and Disadvantages.* Examined in the light of such information as is available, daylight saving is seen to have promoted outdoor recreation on the part of those who were in a position to avail themselves of the opportunity afforded. It has saved fuel although the amount of saving is less than has been claimed. It has reduced expenditure by the public for artificial light but to an amount less than has been stated.

There is nothing to show that the net effect upon the health of the people as a whole has been either beneficial or harmful. Its effect upon financial relations with Europe has not been felt. No effect upon accident rates has been observed.

Its effect upon gardening and garden produce has probably been more harmful than beneficial. It has interfered with the sleep of small children, and has probably caused discomfort to urban poor. Farmers have been inconvenienced, and the efficiency of farm labor has been decreased. Estimates indicate that agricultural losses of a large order have been occasioned. Dairying has been interfered with, and milk yield of cows has been diminished slightly. Miners have been inconvenienced.

#### AUTHOR'S DEDUCTIONS AND OPINIONS\*

During the agitation leading up to adoption of the Daylight Saving Act in the spring of 1918, the writer paid but little attention to the subject. He first became interested as a result of being called upon to make a presentation on the subject before the war meeting of the National Electric Light Association in 1918. Being but little affected one way or the other by advancement of the clock he undertook an examination of the subject fairly free from prejudice, and has followed the development of the discussion and has talked with various classes of people and has observed the workings of advanced summer time with increasing interest ever since.

#### *Why do we Distribute the Hours of the Day as at*

\*The author's thanks are extended to those who have given him the benefit of suggestions and criticisms and to whom he is greatly indebted in connection with the preparation of this paper.

*Present?* A natural question growing out of the proposal to advance summer time was early recognized; namely, why have we adopted existing hours for work, play and sleep? There has been no legislation necessitating the adoption of particular hours. There was not even federal legislation fixing standard time until the passage of the Calder Daylight Saving Act in 1918. Yet in our own time and in earlier times it has been the practise to postpone retiring considerably beyond the end of daylight and to remain in bed considerably beyond sunrise in the summer time. Even in the days of tallow candles, as evidenced by the strictures of Franklin excerpted in the Historical Note of this paper, it was customary to postpone retiring, thus incurring considerable expense for artificial light of a most inferior quality.

In searching for an explanation of this fact, the author arrived at the conclusion that our practise in distributing the 24 hours is the result of a compromise between considerations of light and temperature. It would appear that time of retiring and rising and choice of hours for work and for recreation may be varied considerably in the spring and in the autumn without incurring any disadvantage growing out of temperature extremes. In winter and in summer, however, temperature extremes impose limitations upon living conditions which cannot be ignored. In winter time the problem is to keep warm. In earlier habitations and in dwellings of the poor today, this problem is especially difficult. There is no place where it is quite so easy to keep warm as in bed. When the heating problem is difficult therefore, the natural thing to do is to spend in bed the hours of lowest temperature. In summer the problem of securing restful sleep is one of keeping cool. Considering the way in which indoor temperatures lag behind outdoor temperatures in summer, the choice of hours for most comfortable sleep, if guided alone by the temperature consideration, would be even later than in the winter. Customs tend to become fixed, however, and again a compromise between temperature conditions and light conditions appears to have been reached in the choice of hours for sleep.

Fig. 12 gives for three representative months of the year under New York conditions, fluctuations in outdoor light and temperature. If one were to choose the eight-hour period of the 24 in which outdoor temperature upon the whole is lowest, he would probably select the period 1 a.m. to 9 p.m. The actual period for sleep taken in the diagram as 10:30 p.m. to 6:30 a.m. seems to be a compromise between a choice of the lowest temperature period and a choice of the period of darkness for sleep purposes. It appears to the author that the allocation of time to sleep, work and play has been dictated in part by a choice of the most suitable hours for sleep as well as by choice of the most suitable hours for work. Therefore the arbitrary advancement of clocks by

one hour in the summer time upsets the deliberate custom of a whole people, which custom has been arrived at through experience in which the only consideration has been the greatest comfort and advantage of the greatest number of people. Left to choice in summer time the majority of people would probably prefer to go to bed later and rise later in the morning rather than to go to bed and rise at an earlier hour. Evidence of this is to be seen on every hand in the practise of people on Sundays. Whether it is due to indolence or an unconscious striving for maximum comfort is a question the answer to which will not controvert the proposition that the great

The benefits to the so-called "laboring class" are stated not by members of that class, but by employers or office workers. The real benefits accruing to a large class of urban dwellers are deprecated by agricultural opponents of the plan, as illustrated by the slogan "Daylight saving means an hour saved for play in the city; it means an hour lost for work in the country." And the very real disadvantages which the measure occasions farmers are disposed of by our metropolitan press in a manner illustrated by the statement that "The farmer seems to have been convinced by some sleight of hand argument."<sup>25</sup> It is significant to array classes according to their

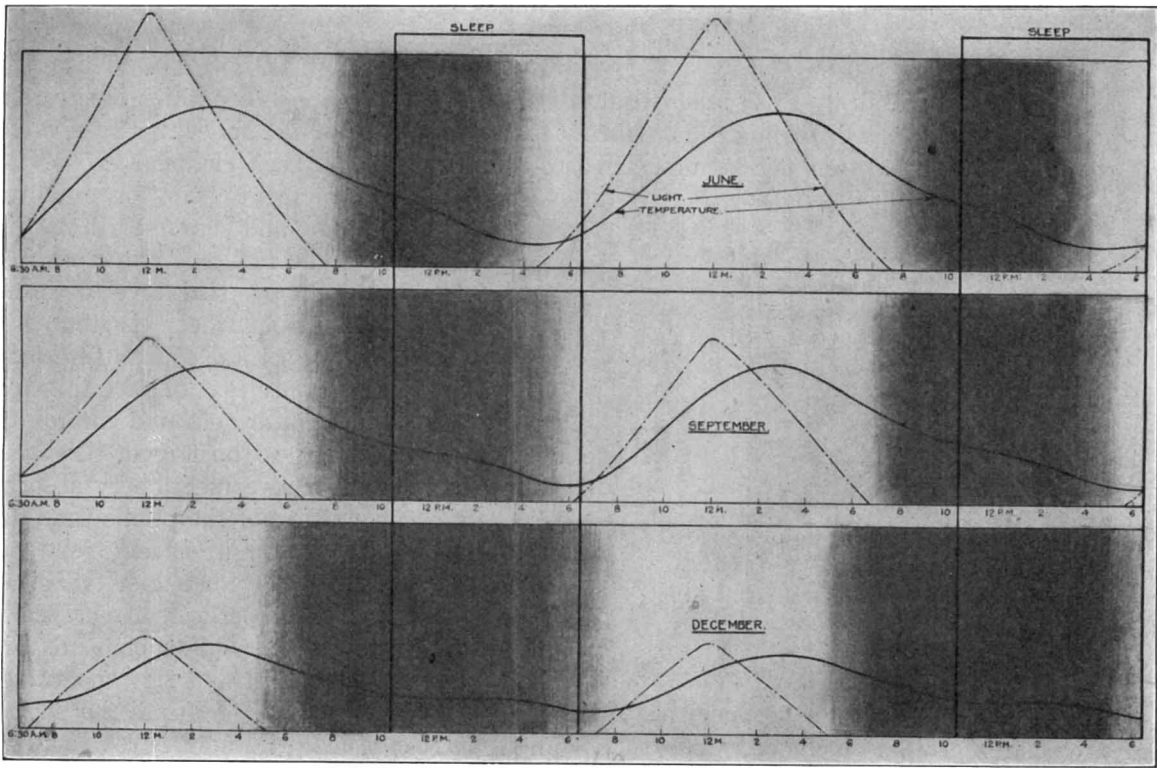


FIG. 12

mass of the people in summer time would prefer to rise and retire later instead of earlier.

*Class Thinking.* Most persons whose opinion the author has asked on this subject, and probably most persons in this audience, express themselves as in favor of daylight saving. These are people in general whose hours of business are from 9 a.m. to 5 p.m., who have some opportunity for devoting to outdoor recreation leisure time after business hours. This likewise is the class from which advocates of daylight saving come. The subject appears to have received but little comprehensive consideration along national lines. Those favoring and those disfavoring the plan appear to have consulted their own experience and predilection and to have devoted little attention to the other side of the case. The literature as put forward by advocates of daylight saving fails to recognize any disadvantage as accruing to the plan.

attitude toward daylight daving. It looks something like this—

Favoring	Opposed	Indifferent or Inarticulate
Well-to-do urban and suburban dwellers	Farmers Dairymen	
Officials of the American Federation of Labor	Majority of delegates to convention of American Federation of Labor	Less well-to-do and poor city dwellers
War Garden Commissions	Truck gardeners	
American Medical Association	Miners	

While the foregoing doubtless falls short of full accuracy and completeness, yet it conveys a fairly good idea of the known views on this subject. In the author's judgment there can be little hesitancy in reaching a conclusion after weighing the advantages

and disadvantages. The success, convenience and economy of the producers of food and fuel are of much greater moment to this country than is the added opportunity for outdoor recreation by the class of people which by and large is in a position to secure its own opportunities for recreation.

An unweighted count of urban versus rural populations falls far short of affording a right indication as to the advantages or disadvantages to the country. The urban population is by no means a unit in deriving benefit. Of that part of the urban population which does benefit it is to be said that their convenience or pleasure is not to be weighed on equal terms with a reduction in efficiency in the conduct of an industry which is fundamental to the country's welfare.

### ECONOMIC RESULTS

*Coal Saving.* It is estimated in this paper that the saving in coal accomplished through daylight saving is of the order of 495,000 tons per annum. In

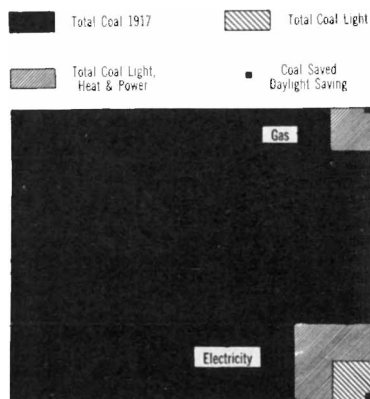


FIG. 13

order to consider this quantity in its proper relation to the coal problem, Fig. 13 is included. The total area of the large rectangle represents the total coal consumption of the country for 1917; the small cross-hatched rectangle in the lower right corner represents the coal estimated to have been consumed in electric lighting. The small black rectangle in the field of this cross-hatched area represents the coal estimated to have been saved in 1918 or 1919 as a result of the reduced use of electric light under daylight saving.

The small cross-hatched area in the upper right-hand corner of the rectangle represents the net coal consumption estimated to have been used by the gas industry in 1917. The small black rectangle in the cross-hatched field represents the saving estimated to have been effected in 1918 through daylight saving. It will thus be seen that the aggregate reduction in the consumption of coal in advanced summer time, while large and important, yet relatively is but a fraction of one per cent of the coal consumption of the country. It may be compared with the figure of 1,250,000 tons usually stated to represent the saving

which is effected.<sup>26</sup> The advantage of the Daylight Saving Act as a fuel conservation measure is therefore less than it has been stated to be.

*Saving in Expenditure for Artificial Light.* Advocates of daylight saving have claimed a one-quarter reduction in cost of artificial light. It would appear probable that their views have been based upon reduction in hours of lighting in the evening which, as shown in Fig. 8, are of the order of 29 per cent. The same diagram shows that in reality the reduction in cost of electric light is only one-quarter of that which might be indicated by this line of reasoning. Estimates of the saving in expenditure of the public for artificial light have ranged from \$40,000,000<sup>27</sup> per annum to \$100,000,000<sup>8</sup> per annum. In this paper it is shown that the total for electricity and artificial gas is of the order of \$19,250,000. This comprehends probably most of the saving which is effected, so that the benefits to the public under this head would appear to be less than has been claimed. If we ignore the reasons previously mentioned for qualifying this statement of saving and assume that the public receives the full benefit of this reduction in expenditure for artificial light, we still have to consider what such a reduction means when distributed over the country. The public's total expenditure for artificial light is only 1 to 1½ per cent of its total expenditure; any saving which can be effected out of this small expenditure is bound to be trivial. Tobacco,<sup>28</sup> soda fountain products<sup>29</sup> and confectionery absorb a larger part of the expenditure of the public than does artificial light. One would not esteem very highly the saving of the expenditure for one or two cigars or one or two ice cream sodas per person per year, yet this is all that is saved in reduced expenditure for artificial light. Therefore without decrying the value of small savings, it may be asserted that the saving to the public in cost of artificial light is too small to be considered as an important factor in weighing the advantages of daylight saving.

On the other hand, when considering economic results, it is necessary to take into account losses suffered by the public as well as saving effected. Some idea of these is obtained by considering interference with agriculture, dairying, and truck gardening. Obviously the estimates of agricultural losses are rough approximations and are probably of a less reliable order than are the estimates in this paper of the effect upon use of artificial light. There appears to be no doubt, however, that the agricultural losses are many times greater than the savings in artificial lighting and it is therefore justifiable to contrast the two estimates in order to emphasize this fact. Thus:

#### Gain to Public

Estimated savings in electric light.....	\$14,000,000
Estimated savings in gas light.....	5,250,000
Estimated savings in other forms of artificial light....	Probably negligible

*Losses to Public*

Agricultural losses estimated at .....	\$1,000,000,000
Dairying losses.....	?
Truck farming losses.....	?

By those so situated as to be familiar with the facts, it is asserted that daylight saving has made agricultural life less attractive; it has interfered with the "back to the farm" movement; it has probably contributed somewhat toward increasing the cost of living.<sup>30</sup> The economic losses thus involved run so high that the saving in artificial light by comparison sinks into insignificance.

Only one side of the economic phase of daylight saving is presented by advocates of daylight saving. The agricultural disadvantages apparently failed to attract attention when the project was first considered. They proved so serious, however, as to occasion overwhelming adverse sentiment among the members of the House and Senate which led to repeal of the Federal Daylight Saving Act.

*Undesirability of Local Action.* Whatever the advantages or disadvantages of advanced summer time as a national measure, it would appear that its adoption in particular localities is subject to additional disadvantage. Where such action has been taken the citizens, in the adjustment of industry and of their daily movements, must choose between federal time which will be followed by post office, custom house, railroads, national banks, United States courts, etc., and municipal time which is one hour different and which will be followed by municipal courts, police and fire departments, municipal departments, etc. There is no compulsion upon the public to be guided by either. The attendant confusion, however, is bound to be serious.

## CONCLUSION

It is a fallacy to think that in order for one class to benefit, change must be imposed upon the whole people. It is important to "think nationally." To secure the greatest advantage to the whole people should be the aim.

The very obvious solution of the problem appears to lie in diversification of hours of industry. There are certain classes of people in the cities and suburbs who are in a position to derive benefit from advanced summer time. Without molesting the customs of an entire nation let them undertake an educational propaganda in favor of early rising and early retiring in summer time, together with advancement of the beginning of business hours from say 9 to 8 a.m. It will probably follow that where the advantages of such altered practise seem sufficient, business hours in certain kinds of work will be advanced with consequent diversification of the traction peak, bringing greater comfort to those who must travel in the rush hour. This will avoid local misadjustment of clocks with the attendant confusion which will arise

from difference between federal and local time. Education leading to intelligent selection of hours for work, sleep and play is much to be preferred to arbitrary legislation compelling official misrepresentation of time which has the effect needlessly of imposing the will of one class of the population upon another class.

## REFERENCES

GENERAL. Hearings before Sub-Committee of Committee on Interstate Commerce, U. S. Senate (S 1854) May, 1917; Committee on Interstate and Foreign Commerce of House of Representatives (H R 3854) June, 1919; Trade journals; letters in response to inquiries addressed to persons likely to be informed.

1. F. A. Annett, Associate Editor *Power*; letter to author December 1st, 1919.

2. P. R. Moses, November 13th, 1919; letter to author.

3. Fifteen per cent increase over 12,500,000,000 kilowatt-hours estimated by author for 1917 in connection with paper "Lighting Curtailment." *Transactions Illuminating Engineering Society*, March 1918, page 111.

4. Report of Committee on Daylight Saving Plan of Boston Chamber of Commerce cites \$200,000 saved in Cleveland in six months and similar saving for Detroit. \$350,000 reduced revenue of Pacific Gas and Electric Company, *Journal of Electricity*, May 1st, 1918, page 446. Brunet estimated \$62,000 saving for Providence, hearing on Senate Bill 1854.

5. Four estimates by central station engineers for as many cities.

6. E. B. Myers, *Transactions Illuminating Engineering Society*, 1918, page 159.

7. "Artificial Gas and By-products in 1915," U. S. Geological Survey.

7A. *Journal de Paris*, April 26, 1784, "Economical Project for Diminishing the Cost of Light."

8. "An Hour of Light for an Hour of Night." Report of Special Committee of Boston Chamber of Commerce.

9. Report of committee appointed by the Home Department to inquire into social and economic results of the Summer Time Act, 1916.

10. A. N. Gitterman, Chairman War Garden Committee, Borough of Manhattan, New York; letter to author November 14th, 1919.

11. "The War Garden Victorious"—Chas. Lathrop Pack (Lippincott).

12. E. H. Lewinski-Corwin, Executive Secretary, The New York Academy of Medicine.

13. Dr. Chas. Bolduan, Chief Section of Public Health Education; letter to author, November 13th, 1919.

14. Dr. Alex. H. Craig, Secretary American Medical Association, letter to author October 25th, 1919.

15. Dr. F. E. Sondern, proposer of the resolution in letter to author November 15th, 1919.

16. Dr. E. L. Fisk, Director Life Extension Institute; letter to author.

17. For example, Congressman Esch of Wisconsin, Congressional Record June 18-24, 1919, page 1369 stated that among those favoring repeal of the Daylight Saving Act are over 300 farm papers, magazines and organs, every farmers' organization in the United States, and the National Grange.

18. C. W. Burkett, Editor "American Agriculturalist," letter to author November 28, 1919.

19. Collingswood, Editor, *Rural New Yorker*.

20. Atkeson. *Congressional Record*, June 18-24, 1919, page 1369.

21. *Literary Digest*, June 14, 1919, page 17, and letter to the author in which Senator Capper says: "I believe I made a conservative estimate when I put the probable loss at a billion dollars a year."

22. W. W. Hinshaw, letter to press May 28th, 1919.

23. In one instance daylight saving occasioned a strike of miners. This was adjusted by making the hour of beginning work 8 a.m. instead of 7 a.m. Hearing before Committee on H B 3854, pages 25 and 80.

24. Search of the literature and inquiry brought to light only one allegation of reduction in accident rate which was said to have been experienced in the State of Pennsylvania. Further inquiry brought the information that this was incorrect. Letter from John H. Walker, Acting Chief Inspector, Department of Labor and Industry, Harrisburg, Pa., November 25th, 1919.

25. Similar attitude for example in editorial *Greater New York*, (organ of Merchants' Association) March 3, 1919.

26. Marcus M. Marks; letter to the press May 28, 1919, and others.

27. Brunet. Hearing on Senate Bill 1854, May, 1917, page 23.

28. Annual expenditure for tobacco shown to be \$490,000,000 in Statistical Abstract, U. S. Department of Commerce, 1914. Editor of *Tobacco* estimates tobacco business to be of the order of \$1,000,000,000 per annum.

29. *Soft Drink Journal* April-May, 1918—amount of money estimated to be spent annually by the public at soda fountains, \$640,000,000.

30. Congressman Sweet of Iowa, *Congressional Record*, 1. c., estimated that daylight saving had increased the cost of living from 5 to 12 per cent on account of reduced production.

## A New Form of Vibration Galvanometer

BY P. G. AGNEW

Secretary, American Engineering Standards Committee

*Vibration galvanometers are very useful in null measurements, but have not been much used in industrial laboratories on account of their being sensitive to external vibrations and requiring delicate adjustments. The present instrument, which has a sensitivity higher than other forms of the moving-iron type, but less than that of the most sensitive forms of the moving-coil type, has the advantages of sturdiness, quick responsiveness, and freedom from the effects of external vibration. It consists essentially of a fine steel wire, mounted on one pole of a permanent magnet, and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes.*

THE vibration galvanometer is a very useful instrument in alternating-current measurements where null methods can be used as, for example, in an almost endless variety of bridge measurements, in various applications of the alternating-current potentiometer, and in testing instrument transformers. As in the case of direct-current galvanometers, there are two general types of vibration galvanometers, the moving-coil type and the moving-iron type. In each type the moving element is mechanically tuned so that its natural period is the same as that of the alternating electromagnetic forces produced by the current to be detected, thus using the principle of resonance to produce a relatively large motion for a very small current.<sup>1</sup>

The reading is usually made by observing the image of an electric lamp filament reflected in a very small mirror attached to the moving system, by means of a telescope, or by a projection upon a screen. When current passes through the instrument the vibration of the moving element causes the image of the filament to appear to broaden out into a band.

It is evident that a vibration galvanometer of either type is simply a specialized form of synchronous motor, the whole mechanical output of which is used in overcoming air friction and elastic hysteresis.

*To be presented at the Midwinter Convention, New York, February 20, 1920.*

1. For a general discussion of vibration galvanometers, see: Laws' *Electrical Measurements*, 1917, p. 434; F. Wenner, *TRANS. Am. Inst. Elec. Engineers*, 31, p. 1243; F. Wenner, *Bull. Bureau of Standards*, 6, p. 347, 1910; A. Campbell, *Proc. Physical Society of London*, 26, p. 120, 1914.

The vibration galvanometer has been used but little in industrial laboratories, its principal use being in physical laboratories, and principally in precision work. The chief reasons for this limited use are that it is easily disturbed by external mechanical vibrations, and that delicate adjustments are necessary. In the present form of instrument these difficulties are greatly reduced. It is not, however, as sensitive as some forms of the moving-coil type.

*Principle of Operation.* The present instrument is of the moving-iron type. It consists essentially of a fine steel wire, mounted on one pole of a permanent magnet, and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes. If an unmagnetized steel wire, *W*, is held near the pole of an electromagnet, as in Fig. 1, the end of the wire will be pulled toward the pole of the electromagnet during each half wave of the current flowing in the winding of the electromagnet. That is, the wire will vibrate with twice the frequency of the current. If the wire be magnetized by mounting it on the pole of a permanent magnet, the free end of the wire will be alternately attracted and repelled by the alternating flux of the electromagnet. That is, the wire will vibrate with the same frequency as that of the current. But what is of more importance, the alternating mechanical pull will be very much greater than with an unpolarized wire, since the total flux from the wire is much greater.

The permanent magnet plays the same role in increasing the motion of the wire that the permanent magnet in a telephone receiver does in increasing the