SLAVES BY THE BILLION

THE STORY OF MECHANICAL PROGRESS IN THE HOME

With an Introduction by Katharine Fisher, Director of Good Housekeeping Institute

by SILAS BENT

$2.50

SLAVES BY THE BILLION

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THIS competent study of man's progress will remind us of our present good fortunes by recalling the drudgery of the housewife in the homes of yesterday, by showing the advantages available in the simplest of homes today, and by painting a rosy picture of a new domestic existence in the future. We of this age are apt to think that civilization has gone into reverse. This book is proof that mankind has at hand instruments for better living.

In a simple, direct way which any intelligent homemaker can understand Silas Bent presents a comprehensive survey of the uses of electricity and gas in farm, village, suburban and city homes. He shows how we have been liberated from a condition of servitude by devices that have contributed to cultural progress and spiritual opportunities, a full life. He takes account of family blessings in this era of political, economic and social conflicts outside the home.

Homemaking is the world's biggest business. It has the largest financial turnover and vitally affects the greatest number of lives. Until the present century, it was backward,

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By SILAS BENT

AUTHOR OF *Machine Made Man*

WITH AN INTRODUCTION

BY KATHARINE FISHER

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LONGMANS, GREEN AND CO.

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BENT

SLAVES BY THE BILLION

FIRST EDITION

PRINTED IN THE UNITED STATES OF AMERICA

To

My Sister

OLIVE BENT TAYLOR

ACKNOWLEDGMENTS

Ralph Borsodi, economist, and Mrs. Borsodi were first to clarify my nebulous notions about what sort of book this would be. Lester Moffett, editor of *Electrical Merchandising*, was generous with counsel and material; so were the editors of women's magazines. To Lillian Church, senior clerk in the Department of Agriculture at Washington, I owe much of my background material for the chapter on farming. Executives of concerns manufacturing domestic appliances were invariably helpful although they knew I would not mention their brands. Elizabeth Sims Bent, my wife, was patient in assistance and wise in advice.

SILAS BENT

Old Greenwich
Connecticut
June 1938

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INTRODUCTION

A quarter of a century ago Thomas Edison in discussing "the woman of the future" declared that, "The housekeeper will give less attention to the home because the home will need less; she will be rather a domestic engineer than a domestic laborer."

He was only half right. For while she is able to pay less and less attention to housekeeping because of her increasing number of mechanical servants, she is paying much more attention to *homemaking* and all that it connotes. There is, as every wife and mother knows, a vast difference between the two.

It seems to me that here is an answer to the question so often raised in this mechanical age of ours, whether man rules the machine or the machine rules man. Today there is little doubt that most of the ills which beset the world are due to man's blind adoption of the machine without heed to the social significance of what he is doing. But I think that these are merely growing pains which the future will see cured by a higher culture, a truly civilized civilization fostered by the greater leisure and freedom from drudgery which the machine is making increasingly possible in the home. Future generations will attain once again the ideal of ancient Grecian civilization with the difference that it will be enjoyed by the many instead of the few because it will be borne by mechanical, not human, slaves.

Silas Bent has given us a book here which should help speed that day. It supplies a bit of what we all need so much to win mastery over the machine – a sense of perspective of the constant changes it is making in the pattern of our lives. While I cannot always agree with Mr. Bent's interpretations, I am in hearty accord with the sincerity of his purpose.

KATHARINE FISHER

New York
June 21, 1938

SLAVES BY THE BILLION

CHAPTER I

"CIVILIZED TO DEATH"?

One of the most influential divines in the United States, the Rev. Dr. Harry Emerson Fosdick, complains that "we have tried to civilize our apparatus of living till we are well nigh civilized to death." After citing Thoreau's lament that we are engrossed in the invention of "improved means to an unimproved end" he added: "The phrase suggests today the way we create the cinema and degrade morals with it, create the radio and give nonsense a wider hearing with it, create the automobile and implement gangsters with it, and in countless ways watch the old vulgarian and the old barbarian reach out controlling hands for the new devices."

Here was a frontal attack upon our favorite boast, that we enjoy the highest standard of living in the world. "Nowadays," Dr. Fosdick said, "mankind stands, his hands full of amazing devices, but as confused, bewildered and unhappy as mankind has ever been. . . . Men have immensely improved the means of civilization but there has not been a corresponding improvement in the spiritual culture which alone can lead men to worthy ends."

Clearly, our social and political progress has not kept step with technological advances. We are familiar with the contention that industrial mass production tends to rob us of initiative, gives capital an unfair advantage over labor, regiments and stereotypes us, devalues personal

and manual skills, and imparts a wholly materialist attitude. These are the criticisms which have been leveled most frequently and most eloquently at the Machine Age. I have tried elsewhere to answer some of them, as have many others.

Dr. Fosdick's indictment is noteworthy not merely because of his eminence but because the chief counts are directed at the motion picture, the radio and the automobile, all closely associated with the family and the home. Earlier objectors had dealt with the machine in the factory and the mill. He has a mind too fertile, cogent and incisive to be content with a mere rehash of what others had said, and so he struck into the subject from a novel angle, so far as the pulpit is concerned. He was concerned about the effect of the machine upon the spiritual fortunes of the family.

It might be argued that Dr. Fosdick represents a vested interest, and that if we have become devotees of a new metaphysics, clustering about the machine, regarding it with adoring awe and prostrating ourselves at the altar of machine-made success, then men of the cloth must call the thing a devil. But to charge him with pleading the cause of a salaried group would be unfair. It is enough to say that he once refused to let his wealthy congregation double his income, and that he rides in New York subways rather than boast an automobile.

Or we might retort that Dr. Fosdick said nothing about the refrigerator, the washing machine and ironer, the automatic mixer, the vacuum cleaner, the automatic furnace or the electric fan ; but to that he might reply that a physician who finds his patient has typhoid fever

and coronary thrombosis is under no obligation to say that he is a good provider, a faithful father and husband, and wears a Phi Beta Kappa key. It is clear, however, that a diagnosis such as Dr. Fosdick made can bring us out nowhere save at the cemetery, the "well nigh civilized to death" which he foresees. Granting that there is a debit side, and conceding a willingness to deal with it in due season, let us look at the credit side of the ledger.

At an outlay of one dollar a week, the average family in the United States can enjoy the services of eleven slaves. These servants may be at work in the basement or the bathroom, in the kitchen or in lighting the whole house. They are on duty day and night, they are never tired, never lazy and never impudent; they never demand higher wages and do not require to be clothed nor fed. There is no need to train them, because they are efficient from the first.

The cost of procuring and operating domestic machinery has fallen remarkably. In the seven years preceding 1938, for example, the rate for electric current fell off by more than one-fifth in some localities, and in other communities the price of gas declined as rapidly. In certain areas one penny will operate a good reading lamp for two hours, run a sewing machine all afternoon, fry the morning eggs and bacon or toast twenty-two slices of bread, make the coffee for several meals, iron a nightgown, two slips, two step-ins and six handkerchiefs, or operate the vacuum cleaner throughout a five-room house.

Yet despite these extraordinary economies, a survey of housing conditions in sixty-four of our largest cities,

made in 1937, revealed that only two-thirds of them were equipped to cook with gas or electricity, and that only about one-seventh had automatic refrigeration. These facts were gathered in communities where living quarters were wired for electricity or piped for gas, or both, and where the costs of these utilities were reasonable. What shall we say of our high standard of living when we know that one-fourth of these homes had neither tub nor shower, and that about fifteen per cent of them had no indoor toilet? That familiar boast should be qualified.

It is true that two-thirds of all our buying is done by families with incomes of less than two thousand dollars a year, and it is evident that such families sometimes cannot afford to economize. The householder who does not take advantage of modern equipment is in much the position of the man who borrows from a pawnbroker at extortionate rates because he cannot establish credit at legal interest. But poverty has not been the sole deterrent; there was the sheer conservatism which shrinks from trying out anything new, anything with which we are not acquainted.

From the first machinery has been suspect. Leonardo da Vinci, who was a mechanician and engineer as well as a past master of painting, suppressed his invention of the submarine because "it was too satanic to be placed in the hands of unregenerate men." In part, mechanical progress has been opposed all along on religious bases, so that Dr. Fosdick stood on sanctioned ground. Clergymen denounced the railroad in its early days because it

had not been foretold in the Bible, and one vowed that the sight of locomotives, running with nothing to pull them, would drive spectators mad with terror. Later, "automobilitis" was berated as deleterious to morals. England required that the motorist hire a runner to precede the machine waving a red flag.

There were other objectors, too. Daniel Webster argued that frost on the rails would prevent trains from moving, or from stopping if they did start; and in 1895 Samuel Bowles II, editor of the *Springfield Republican*, declined to ride in an automobile as beneath his dignity. Chauncey Depew warned a nephew not to invest in Ford stock because "nothing has come along to beat the horse." As late as 1908, J. P. Morgan and Company refused to pay five million dollars for a block of motor stock which subsequently rose in value to two hundred millions.

An extreme exemplar of that spirit of distrust, skepticism and resentment resides at a street corner in the heart of Russellville, Ky. She is an elderly lady, the survivor of an old family, socially solid and well-to-do, who has permitted the introduction into her two-story house of no modern improvements, not even running water. From a well in the yard servants labor back and forth with brimming pails, and at eventide the mistress, obsequiously attended by a Negro maid, dines alone by candle light. Not even kerosene lamps are permitted in that household. The slums which blight and disgrace our great cities have more conveniences. Yet this dowager, regarded by her friends and neighbors as an amusing eccentric, is seeking the good life in surroundings as

primitive as those which confronted the early settlers on this continent.

Not until we cast back to the colonial homestead do we realize how fully mechanized it was, how self-sufficient the family, how much more independent and more nearly secure than today. This was true especially in the New England settlements and in Pennsylvania, where the hooded fireplace served for a century as the only source of warmth during severe winters and was the only reliance for cooking a meal. Its turnspits, bake ovens, cranes large and small, waffle irons and half a dozen other handmade utensils were a revelation of ingenuity in meeting domestic needs. The wrought waffle iron, at the end of a long rod, weighed some fourteen pounds, and to hold it above the flames required sound muscular equipment. The flour and meal were ground in the house, the cotton woven there, the wool carded and spun. There were churns for buttermilk and cheeses, sausage guns, vats in which to make syrup and others for soap, barrels for cider and vinegar, a shed for smoking meats, a cobbler's and a carpenter's bench.

It mattered not that Samuel Slater set up a cotton mill at Pawtucket in 1793 ; even a quarter of a century later ten times as much cotton was woven in the home as in all the mills. Oliver Evans obtained from Pennsylvania in 1786 rights on steam-driven flour-mill machinery, and in the following year rights from Maryland, but not one miller in Maryland, Pennsylvania, Delaware, or Virginia would spend good money for "such rattletraps." In Lynn, Massachusetts, the introduction of automatic shoe

machinery was vigorously opposed. Eight years after the Pilgrims touched Plymouth Rock they set up a grist mill, then Neponsit built a sawmill, and at Dorchester there was a water-power mill as early as 1629. Boston boasted a tidewater gristmill, and in Pennsylvania water power was utilized to make paper, grind corn and saw lumber. Most of the colonies either owned their mills or subsidized them, and Vermont fixed the prices of their products. All regulated them. Three centuries ago we had price-fixing, government in business and a planned economy. But the enterprises made poor headway, not because of interference and regulation but because the settlers stuck obstinately to their own lasts.

Yet the machine in the mill made itself subtly felt. It took out of home work some of its adventurous spirit. It cast a shadow over those handmade devices in the household, and gradually undermined the colonial thrift which gloried in the economies they made possible. Thrift is a creative talent, seldom seen to better advantage than in the early New England home; but by the middle of the nineteenth century women there were content to buy their linen, wool and cotton goods ready made, and in another quarter-century they were abandoning the sewing machine. Why bother to grind the flour and bake the bread when the baker supplied an ample loaf — as he did in those days — for five cents? Why smoke a ham and have all that meat to store when the butcher was ready at hand with a pound? With the rise of the canning industry the rout of the kitchen was almost complete.

It has been said, with some show of reason, that the civilization south of the Mason and Dixon Line before the Civil War was the highest this country has seen, our nearest approach to the culture of the ancient Greek City States, also built on the backs of slaves. But it is worth noting that the leisure and the culture of the plantation was confined mostly to the males. Once the beauteous belle – each of them was beauteous, of course – became a wife her hardships began. The plantation was like the New England farm in this, that it was an almost self-contained unit economically ; and however competent the agent employed as supervisor, the mistress was the general manager. Martha Washington supervised sixteen spinning machines, a task requiring no small executive ability. To her the slaves looked for cabins, for food, for medication when they were ill, for mediation of their quarrels, for the wherewithal to celebrate their weddings. What with seeing that the spacious chambers of Mount Vernon were kept spick and span, that the tables were crowded with good food, she had a full day ; and the same thing was true, at least until the outbreak of the war, of thousands of other Southern plantations.

It was the masters of those plantations who had time for reading, writing, drinking and good conversation. Whatever literature, statesmanship, music and painting came out of the South in that day came almost exclusively from the masculine side. The men were concerned with those activities once described by Justice Oliver Wendell Holmes as an invitation to starvation, since they contributed nothing to the absolute neces-

saries of life, produced nothing anybody was compelled to buy. The women were preoccupied with those chores which were either a prerequisite of existence or an amelioration of its difficulties and discomforts.

We are a young race, but an arm's length removed from the New England fireplace and Martha Washington's spinning wheels. Sociologists seem to agree that the frontier, in the usual acceptation of that term, did not disappear until 1890. Whether or not one is willing to draw a sharp line across the calendar in that fashion, and set down as an absolute an extremely nebulous proposition, it is certain that our frontier days still exercise their sway over our practices, our attitudes and our thought. Pioneering meant a scarcity of women, and this meant that women were valued more highly. No other men, I venture to say, are so considerate of their womenfolk, and at times so obsequious, as North Americans on either side of the Line. I do not even except France, where gallantry seems to be largely oral. That women shared the hardships, the toil and the dangers of settler life and of the westward movement endeared them the more to their mates. Thus it has come to pass that men in this country, as in no other, bestir themselves to win the approval and contribute to the comfort of the other sex.

Our men earn most of the money; their women own most of the wealth and spend nine-tenths of the outgo. As purchasers, mere males are almost negligible. In recognition of the fact that the consuming public is dominated by women – even in the matter of their husbands' and sons' clothes – the vice president of one of

our greatest department stores has tabulated fifteen reasons why women have become more alert, more competent and more exacting as buyers. It is not necessary to set down these findings verbatim, but it is interesting to note that one of them is the "increased influence of the 'movies,' automobiles and radio in keeping women informed and their interest aroused." This successful business executive discovers hidden virtues in the very agencies Dr. Fosdick denounced.

More women are engaged in business, and hence manifest aggressiveness and self-confidence, our vice president continued: the enforced economies of the depression taught them "the fun of getting their money's worth," and perhaps something of the creative value of thrift; the vote had given them a new realization of their power and importance; the introduction of synthetic materials had taught them to be more cautious; competing services and high-pressure advertising, campaigns against misleading claims and practices, and better education in home economics were among the other reasons listed. I might add, on my own account, that the Good Housekeeping Institute has accomplished wonders in making women more wary and more efficient.

In the transition from the colonial farm and plantation to the modern home the first step was a movement of machinery out of the household into the factory and mill. This was what is called by common consent the Industrial Revolution. Very well, there is now under way what Ralph Borsodi calls a counter revolution. Back in 1928, in *This Ugly Civilization* — a bitter ar-

raignment of the Machine Age – Mr. Borsodi perceived this trend, and it has gained accelerated momentum every year since then. The mechanical processes relinquished to the factory are being recaptured by the homemaker. The Machine Age is in reverse gear.

It is astonishing to contemplate the multiplicity and ingenuity of the appliances produced to lighten the burden of housewifery. Most of the machines invented for use in and around the house are of equal value to all members of the family, to be sure, although we think of them usually as exclusively for the woman's use and enjoyment. Seventy practical ways of using gas and electricity in the home were demonstrated in a house set up by the Public Service Electric and Gas Company of Newark, New Jersey, and the place was described in an English newspaper as "an American housewife's dream of Heaven." It was a dream also for the man of the house, for it included an automatic razor, drink mixer, soldering iron, lathe, jointer, knife sharpener and garage-door opener. The "electric eye" which opens a door may be employed also to close windows against a sudden shower, and spare the harassed male a hurried return trip from a party ; or it may lower window awnings against the sun.

No one who inspected the *House Practical* at Newark could leave it without a strong impulse to modernize the whole domestic scene overnight, Fosdick or no Fosdick. I shall not set down here the better known of the devices on display there, but shall confine myself to a few. Garbage was consumed by an "electric pig," but there was a gas incinerator also. The door chimes served as a me-

lodious summons to the table. The illuminated house number, visible seventy-five feet away, was a reminder of a courtesy too often neglected. The fans for cooling and ventilating, the panel which did away with bothersome electric fuses, the coffee grinder, meat chopper, potato peeler, pea sheller, clothes driers, coffee makers, fireplace heaters, toasters, grills, the bell for the maid, the egg cooker, chafing dish, ranges, dishwashers, spray gun, device for electrocuting insect pests, sewing machine, percolator, curling iron, sun lamp, vibrator, box to keep milk and cream from freezing, heating pad, even an electric train for the youngsters, were on hand in full working order. There was no burglar alarm, although this was available. There is a device which will notify the police, photograph the intruder and dose him with tear gas.

Any expert laborer with an assured job might equip his house with all these conveniences, even to air conditioning summer and winter. A study of the costs of electric energy in the home, made at Iowa State College, showed, for example, that an electric range used only twenty-five kilowatt hours per month per person, a refrigerator but eleven, a washing machine but half a kilowatt an hour. The actual pennies involved can be estimated easily by consulting the rate card of local utilities. These servants in the house attend us faithfully and cheaply.

If we were to measure civilization, as one engineer has suggested, by the number of horsepower we generate for each individual, our social status could be computed

easily. A single automobile concern turned out in one year motors capable of an energy equivalent to two billion servants. By utilizing water power and by burning coal, gas and oil we create continuously on this continent more slaves than all the world has known in human guise. Civilization, it so happens, is not so easily calculable as is horsepower. It involves imponderables and intangibles.

These imponderables flow from the inner being. They depend, as Dr. Fosdick perceived, on the uses to which we put our modern marvels, and our employment of the greater leisure they confer upon us. In a population as large as ours, with an average intelligence rated by psychologists as that of a fourteen-year-old child, it is inevitable that a deal of nonsense will be disseminated by radio; but the voice of that thoughtful cleric reaches countless listeners on Sunday during his vesper services, and grand opera, once the possession of a small plush-covered class, is now common property the country over. If gangsters have evolved a two-car technique, and now ditch the automobile in which they have committed a crime to make their getaway in another, thus befuddling our lawful guardians, it is nevertheless true that the radio police car works wonders for our protection, that the motor-ambulance serves as a speedy messenger of mercy, that millions of workers ride to and from their posts, and that the competition set up by this machine has brought us streamlined trains, aye, verily, has even reduced the discomforts and the obscenities of the Pullman car. If there are motion pictures that de-

grade our morals, it is still true that two-thirds of those pictures that win the biggest box-office return are of precisely the opposite character, for they constitute the best the screen has to offer.

Although the motion picture is a family institution, it is not always a part of the home equipment, as for the most part are radio and automobile. In the last quarter of a century our use of the horse has fallen off but half, while our use of motor vehicles has jumped from twelve millions to nearly thirty, and twenty-four millions of those are pleasure cars, housed largely in a garage at home. I am free to own that all three of these agencies, abetted by the bridge table, have distracted the national mind from the printed page and have introduced a greater triviality into our lives, but I deny that anybody is competent to audit their account. And I am confident that the multiple machines for use in the home show a vast credit balance.

Thanks to those domestic devices, a new leisure and a new self-respect have come to the women of the United States, or to such of them as could afford the slight outlay and enjoyed the sound common sense to install them. No longer is there any approval for the martyr who "works her fingers to the bone." No longer is housekeeping regarded as a menial occupation. Dean Gildersleeve of Barnard has announced that the crop of graduates from women's colleges – all of them, not hers alone – was more interested in homes than in careers.

Since the turn of the century, when household appli-

ances began to be plentiful, college girls have multiplied tenfold. Among those who preferred careers, say as lawyers or teachers or physicians, the marriage rate remained about stationary, at less than forty per cent; but among the others the marriage rate rose, curiously, almost as rapidly as domestic conveniences multiplied. As the downright drudgery of the home decreased, wifehood became more attractive.

There was published in Boston, a century ago, a book, *The Young Wife, or Duties of Women in the Marriage Relation.* A perusal of its stern pages is enlightening, for the wife of that day was expected to mind her p's and q's. Thus she was warned gravely against tea and coffee, which "loosen the tongue, fire the eye, produce mirth and wit, excite the animal passions, and lead to remarks that we should not have made in other circumstances, and which it would be better for us and the world, never to have made." The wife of today shares as a matter of course the contents of her host's or her husband's cocktail shaker without a blush, despite warnings that alcohol may do the very things once threatened by tea and coffee.

The wife of today, moreover, would scorn to be caught in the kind of clothes her grandmother wore when those warnings were being circulated, or in the Mother Hubbard her grandmother wore when sweeping or dusting. She is likely to do her morning work in a frock as gay as a garden, change to sportswear in the afternoon, and preside over her dinner table in a modish gown. Plautus complained that women sought only to

please one another, not the men, and in the matter of apparel there appears to be a deal of truth in this; but housewear at least appears to be a concession.

That the transfer of effort from muscle to machine must debilitate all of us, men, women and children, making us in time a race of weaklings, is another bogy sometimes summoned from the dark. How much healthier to push an old-fashioned lawn mower, for example, than to pilot one of these automatic gadgets; what fine exercise for the arms and shoulders of Milady to run the family laundry over a corrugated washboard, and how excellent for her wrists to wring it out, instead of putting it into a machine to be rinsed gently, and then through a wringer which will not damage the finest fabric. The old involuntary calisthenics are going into limbo; we are soft.

Yet the plain fact is that the young men of this generation jump higher, hit harder, put the shot further and run faster than their forebears. They run faster than the legendary Greek who took the news of victory from Marathon to Athens. Some of them ride polo ponies like centaurs. The sexes vie on the golf course, and not many men could beat Helen Wills Moody at tennis.

William James noted that Norwegian women, after taking up the ski, became "lithe and audacious creatures . . . actually taking the lead in every educational and social reform." In this country they have taken up the ice skate, the bicycle and the putting iron. Even skis are now a two-million-dollar industry. A white-haired schoolmarm, having passed "with flying colors" a course

in baseball at Columbia University, has been named baseball coach in Kansas City. She knows the ins and outs of drop curves, sacrifice bunts and errors. She has mastered the American male's principal pastime. Some of her sisters have swum the English Channel, whereas only Leander swam the Hellespont and Hero didn't even try. Most modern women are ready, like those Norwegian damsels, to lend a hand "in every educational and social reform."

They are alert, too, in cultural movements. The vast multiplication of women's clubs dedicated to literature, current trends and the arts has been made possible by the machine. The number of boy and girl scouts has increased from dozens to thousands. For the leisure and the clothes which have made possible this auspicious growth we have the machine primarily to thank. "I loaf," Walt Whitman sang, "and invite my soul"; the good gray poet spoke for the male contingent, for he died before women had time to extend the invitation. Their new mental and ethical and spiritual stature they owe in large part to domestic machinery.

Only a fraction of our women, to be sure, enjoy the mechanical devices to which they are entitled, which would prove an actual economy once they were installed. Of those who do, and who have been liberated from the worst trials of the household, many may spend their added leisure unprofitably. But all of them know that household appliances have broken three centuries of hardship, toil and physical disability. They know that children are better sheltered and nourished, that pupils in school are better clothed, that they themselves can

prolong their attractiveness because back-breaking burdens have been lifted. If this process is damaging their souls, which I do not for an instant believe, they appear willing to take the consequences. Most of them will agree, I think, that machinery in the home has been the means unmistakably of extending human life, promoting health, advancing enjoyment, deepening and enriching the possibilities of the American scene.

CHAPTER II

FEMININE FREEDOM, THEN AND NOW

Gilbert K. Chesterton once observed that the housewife was the world's greatest amateur ; she was expected to do a multitude of things without professional training. The reproach is too broad to bear close scrutiny, but it has behind it a deal of truth. As regards the United States it applies undoubtedly to all but one in a thousand.

Now, we exercise governmental supervision over those who motor, regulate their deportment and put them through tests, more or less searching, before they are permitted to take the wheel. The automobile is deadlier than warfare, and the precautions are justified ; but it can be shown conclusively that the management of a home has a more imperative bearing on human life. It is not a wild stretch of fancy, surely, now that we are exercising in some states care about the physical condition of applicants for marriage licenses, and undertake to prevent ill-considered ceremonies in the flush of an after-party exhilaration, to expect that some day the bride-to-be will be required to exhibit a diploma from a school of domestic science, and the groom to produce, say, bills of sale for a refrigerator, range, dishwasher and vacuum cleaner. The institution of monogamy is on a footing too precarious, and Reno-vation is too nearly a social convention, to ignore any safeguard within reason.

Those four appliances suggested for the couple about to set up a new home are but a mincing step toward a

modernized household. The manufacturer has written for the housewife an emancipation proclamation more noteworthy, in several respects, than the proclamation of that immortal born in a log cabin, whose mother, Nancy Hanks, enjoyed not one of those conveniences which have freed women from domestic slavery.

Combined, mechanical conveniences for use in and around the home constitute a sort of robot brain, actually superior to the brain of any housewife. Lucius Beebe has commented on machinery "so superior to the human intelligence which devised it as to provide a really splendid problem in essential paradox for the metaphysicians." Setting metaphysics severely aside, we may find an essential paradox in the fact that millions of families fail to take advantage of the savings in money, energy and time which eagerly await them. When Uncle Sam spends more than twenty thousand dollars at a clip for dishwashers, in order to spare the hard-boiled tars of our navy from a menial chore, husbands should profit by the example.

Not long after Mr. Chesterton had decimated feminine ranks with a single broadside, Leslie Hore-Belisha, Secretary of State for War, wailed that he was a bachelor because his taste in food was so exacting that he had never been able to find a woman who measured up to his standards. This, someone observed, had "the pathetic ring of a noble but harsh statement of truth." Well, these gentlemen have said it, and it's greatly to their credit, that they both are Englishmen ; and their animadversions appear to be justified to some extent by the confession of

Margaret Farrand Thorp, a fellow citizen, about their domestic inadequacies.

Mrs. Thorp admitted that during an absence of her cook she discovered that nothing but cold water could be coaxed from the kitchen tap, that most of the cooking utensils must be removed from the oven before it could be used, and that "it does not occur to the English housewife that there may be anything beautiful in her profession, that it might be done with grace, with finesse." The Englishwoman "had none of the American impatience or ingenuity which invents labor-saving devices and sells them;" she recorded that she could buy in Springfield, Massachusetts, a toaster made in Springfield, Illinois, but that if she moved across the street in London she might have to equip her house from basement to wireless aerial.

To this depressing array let me add the commentary of Casanova, who groaned that a British dinner was like eternity, without beginning or end, because there was neither soup nor dessert. Walter Hines Page said they had but two vegetables, both cabbage. Yet it would be unjust to leave an impression that Englishmen are oblivious to the importance of the table. No, Joseph Conrad — although not of English birth — has expressed with eloquence a sentiment he found in his adopted land.

Conrad wrote a preface to his wife's *Handbook of Cookery for a Small House* in which he vowed that of all books "only those that treat of cooking are, from a moral point of view, above suspicion." The object of such a work "can conceivably be no other than to increase the happiness of mankind." He regarded good cooking as

an enemy of gluttony. "The decency of our life," he added, "is for a great part a matter of good taste, of the correct appreciation of what is fine in simplicity." Our own Red Man, he asserted, was ferocious because of indigestion. His squaw did not know how to cook, and the wigwam was "clouded with irritability." Thus there arose fraudulent medicine men and quack nostrums. "We owe much to the fruitful meditations of our sages," Conrad concluded, "but a sane view of life, after all, is elaborated mainly in the kitchen."

According to this enthusiastic view, the kitchen is much more than the stomach and the viscera of the domestic organism; it is the heart and soul. Small wonder, then, that it has been a focus and cynosure of progress. Even the arrangement of its equipment has been charted to save steps and stooping. The cabinets, racks and shelves for commissary and for plates, mops, knives, what not, have received detailed attention. Doors and drawers are free acting, in symbolism of the freedom they help make possible.

Martha Washington served thirteen dinner courses at Mount Vernon, but in an earlier day the gluttony against which Conrad inveighed had been worse. Queen Elizabeth started the day carnally, with a stew of mutton, a joint of beef, one of veal, a rabbit pie, chicken and fruits, bread and wine. Already great ladies were becoming effeminate, however, as M. K. F. Fisher tells us in *Serve It Forth;* they carried gold and silver forks to banquets instead of eating with their fingers, as good Englishmen had done for centuries. In France things were no bet-

ter until Catherine de' Medici married the young King Henry III and took Florentine cooks to Paris. She founded the great tradition there of good cookery, and induced the nobility to abandon dormouse pasties and pies of snakes, porpoise, swan and crane. Napoleon gobbled his food and in his haste sometimes flipped an omelet to the floor. But Mrs. Fisher criticizes Americans to this day ; she asserts that we "eat, collectively, with a glum urge for food to fill us. We are ignorant of flavor. We are as a nation taste-blind."

Let us return for a moment to Martha Washington's kitchen. It was paved with brick, and in the wood-burning brick fireplace, which served for cooking as well as heating, were cranes for kettles, pots and pans. Above the fireplace was a rifle and powderhorn. As up-to-date as anything in the colonies, Mrs. Washington doubtless was proud of it. She must have regarded herself as a fortunate woman, liberated from the drudgery of her predecessors. Already good Ben Franklin had grown the first broom corn in this country, and had lightened somewhat the labor of cleaning floors. (If we had been satisfied with that we never would have invented the vacuum cleaner.) George and Martha Washington were wealthy, and owned slaves aplenty ; she was happily free as compared with her servants. She could not know, for one thing, that instead of the fireplace where the blacks sweated through midsummer heat, there would rise one day in gleaming magnificence at the White House a range twenty-four feet long, so expertly insulated and ventilated that the kitchen was almost as cool as a cucumber.

Amelia Jenks Bloomer shocked her sisters no less than the menfolk in their nankeen britches, near the middle of the last century, when she undertook to dispel the mystery surrounding feminine locomotion by wearing a bifurcated skirt, a sort of Turkish trousers, as a declaration of the rights of women. She was a "strong-minded" woman, in the vanguard of the movement for the emancipation of her sex. This struggle was to continue three-quarters of a century, and the political enfranchisement of woman was to flower concurrently with her liberation from domestic serfdom. Carrie Chapman Catt, who took up where Mrs. Bloomer left off, and carried on right valiantly to victory, vows that this is still a man's world ; but that is a generalization subject to many exceptions and qualifications. Politically, socially and mentally woman is the co-equal of her mate, and economically she is his superior, if mere wealth be the test. Ten million strong, she vies with him in industry, and even helps tend the machines which have contributed to her triumph. Certain prophets have won a hearing for their forecast that we shall not have a matriarchy for another thousand years, but there are others who insist that it is implicit here and now.

And why not? The conditions which contributed for centuries to woman's sense of inferiority have been overcome. The change has been so recent that many of the sex appear not yet to have awakened to it, but the change is there that all who run may read.

Dr. William H. Robey, Emeritus Professor of Medicine at Harvard, thinks that the women of Martha Wash-

ington's day lived longer than men because they led "quieter" lives, had no financial worries to speak of and avoided bad habits. The coming of the Machine Age altered their status for the worse, he says, but adds hopefully: "Now that the new freedom has removed many of the restrictions and inhibitions which formerly existed, there is a possibility that a hundred years hence the comparative age expectancy may show a different ratio."

Removal of restrictions and inhibitions, obviously, has brought financial strain and has opened the way to certain bad habits, involving late hours, tobacco and alcohol. As for the "quieter" life, it seems to have gone into limbo for all of us. "We are not so much speedier, in locomotion or morals or music," Sinclair Lewis observes, "than our grandfathers. But it would be nonsense to say that we have not made impressive, life-molding mechanical changes." And a newspaper, discussing in superlative our nervous tempo, avers:

Long ago people were taught while little to sit still as a regular feature of social behavior, but the art was lost about the time emotional outlets were invented, and today guests who for a fugitive instant are not drinking, eating or playing bridge tear up whole drawing rooms in a frenzy of disoccupation. Some pick at chair arms, others rend curtains or seize lamp pulls to unravel, make wads of tapestry or any fabric within reach, twist the corners of cushions, leaf through books without looking at them, fray the edges of magazines, tap teakwood, strive to cut rugs with spike heels — twiddle, twiddle. In China, once, twiddlers were given jade beads to finger, but American hostesses found that the jade wore out.

Our proclivity to fidget, squirm and twiddle can be laid nowhere but at the door of the machine. "Every age," J. B. Priestley notes in *Midnight on the Desert*, "has its own peculiar perils, and ours seemed to be a tendency to believe in machines rather than in persons, to sacrifice what belonged to human personality to what belonged to mere machinery, so that the very people who began rebelling against some moloch-machine only ended by building another one themselves and sacrificing persons to it."

It is to be noted at once that neither Sinclair Lewis nor the newspaper nor Mr. Priestley had in mind the machine as it is found in and around the home, excepting, perhaps, that Mr. Lewis referred to the automobile with a specific plea in extenuation of its speed. The context of all these passages shows clearly that laundry irons, nursery heaters, electric pads, sun lamps, mixers and beaters and automatic cleaners, were outside the picture.

Reverting to Dr. Robey's age expectancy, the lives of all might be prolonged by new foods and better balanced diets. Lewis E. Waters, a research executive, believes the nation's eating habits have been revolutionized and that the housewife has profited most. We have nearly fifty thousand competing manufacturers of food, and the result ought to be lower prices, more nutrition, higher quality.

Not the least remarkable of our advances has come from the use of cold in treating foods. If frozen properly meat can be kept in an edible condition for thousands of years, a virtual immortality can be conferred on

fruits, on vegetables and on lobsters. Developed after the panic of 1929, this is a young industry, about where canning was half a century ago. It has taken sea foods, for one thing, out of the months with an R, so that we may eat oyster stew in August. We may have asparagus or strawberries with the Thanksgiving dinner, and they will taste as fresh as though gathered yesterday. We have a new way of meeting the Biblical command to prepare during fat years for the lean years to come. Quick freezing thumbs its nose at the seasons, the calendar and the decades. It is a part of the new freedom.

In *Man, Bread and Destiny*, Americans are taken to task for spurning dark breads. This is a primary point in general malnutrition. The authors, C. C. Furnas and S. V. M. Furnas, do not say so, but well qualified economists say we spend fifty millions a year more than we should for bread "in spite of relatively low wholesale prices of bread ingredients." Payrolls in flour mills and bakeries are somewhat better, but "wages are only a part of the enlarged spread," certainly not more than one-fortieth. We eat ten billion loaves annually of a product nine-tenths of which is inferior in food value. A recent survey in fifty-one cities showed that the price was the highest in seven years, and the cost of ingredients the lowest in three years. The average loaf sold for a bit less than nine cents, but Winston-Salem paid nearly eleven for it and Denver less than seven. Kansas City, Pittsburgh, Dallas and Milwaukee had been victimized by sharp increases without apparent justification. The variations had no basis in economic strains or stresses; they could be accounted for only on the ground of

greed. None of the profit went to farmers. Here is a cause worthy of the steel of militant women's clubs and of consumers everywhere. It is not neglected, praise be, in schools of domestic economy.

For domestic economy the Greeks had a word, *oikonomia*, and the celebrated Xenophon was not above writing a treatise about it. Katharine Fisher, Director of Good Housekeeping Institute, was educated with a view to teaching Greek and Latin, but made herself a lot more useful. She may suspect, therefore, that the ancients ate better bread than we get as a rule, that they had fewer food foibles, and that the Romans had vomitoriums off their banquet halls, because they dined not wisely but much too much. She knows that our faddishness about foods is due mostly to ignorance and, still the educator at heart, she is trying to teach us better. So is a battalion of other intelligent women.

The human stomach is located, not inappropriately, on the left side where most of us think the heart is. Empty, it is not much larger than the forefinger ; full, it is about the size of a football. It breaks up our meals, converting a mashed potato, for example, first into dextrin and then into grape sugar. William James called it "the sounding board of the emotions," because it reacts disconcertingly to our nerves. Love affects it no less than hate, and stage fright may ruin a banquet for the speaker of the evening. Anger and worry are just as bad. To get the best of our food we should approach it in a tranquil spirit.

An early visitor to Lexington, Ky., entranced with the smoke-cured and aged ham, the water-ground corn-meal

bread, the jellies and intricate desserts, no less than with the amiable spirit in which his hosts sat down to eat, noted "a distinct and striking moral physiognomy in this people ; an enthusiasm, an ardor of character, courage, frankness, generosity that have developed with the peculiar circumstances under which they have been placed." Kentuckians, indeed, pay as much attention to the table as to politics, and hospitality is a sacred rite with them. It may be that their guest overstated their virtues.

William Thomson, grandson of an Irish farmer, was an inadvertent benefactor of the Twentieth Century homemaker. One of the most variously gifted men history has known, he played a French horn to teach his students the principles of sound transmission, was first to light a stage with electricity – for a performance, bless his heart, of Gilbert and Sullivan's *Iolanthe* – carried a thermometer always in his traveling kit, and air-conditioned his home as nearly as the mechanics of his day would permit. The American household today is heir to what he learned about heat and ventilation and cold. He was knighted for his achievements, and made Lord Kelvin of Largs. One of his favorite phrases was, "I've thought of a better way," and his precept has encouraged thousands to think of better ways.

For many years men tried to think of a better way of making garments than by hand. The first to do this was Walter Hunt, who, according to records of the Smithsonian Institution, "somewhere between the years 1832 and 1834 . . . made in his shop on Amos street, New York City, a machine for 'sewing, stitching and seam-

ing cloth.' " Even in those days, however, there was a dread of what is now called technological unemployment ; so many persons complained that Hunt's machine would throw seamstresses out of work that he did not get a patent. Elias Howe, who took out a patent in 1846, got all the credit. This sort of thing has happened more than once in the world of invention.

That stride forward, a century ago, was notable ; but the housewife now may buy at little cost a small motor which can be attached by a belt to her sewing machine and relieve her of pedaling ; or, if she prefers and has about three times as much money to invest, she can buy an electric machine in any of several types, perhaps one which folds down into its case, leaving a flat worktable for her. It may have an air-cooled motor and a sewing light attached which will not hurt her eyes with the glare. It may pleat, quilt, sew backward and forward. With the movement of mechanical processes from the factory and mill back into the home, electric sewing machines gained in popularity. It was accompanied in some instances by the weaving machine, a hand loom of beautiful wood.

In pursuit of Lord Kelvin's aphorism, better ways were found of making fibers and fabrics for these machines. Dante's prophecy that "all things may be woven, even the sands of the sea," has been fulfilled. Gloves are now made of sand ; that is, we have a textile glass out of which may be fashioned napkins, draperies, garments, even wall paper. Yarn made of glass is soft, lustrous and flexible.

Silk and cotton and wool are now made waterproof

by a method which adds little to the cost. Curtains, upholstery and carpets are made fireproof by spraying them with a liquid which can be applied in the home or office. Springy materials are impregnated with a chemical which enables Milady to shake out the wrinkles from velvet, silk and other fabrics, saving thereby the difficult work of ironing refractory fabrics.

From the *Atlantic Monthly* we learn that silk stockings are women's "symbol of liberty, democracy and an undisputed self-respect." It may be unbecoming to rake up the fact, but the first knitted silk stockings were worn by Henry VIII of England, who got them from Spain ; Henry would have been the first of his day to deny to women liberty, democracy and self-respect. His stockings were knitted by hand ; Queen Elizabeth wore the first pair knitted on a machine.

Certainly Henry VIII did not discredit the silk stocking. In this country women scorn lisle. Their homes are less luxurious by far than their legs. In April, 1938, it was estimated that of the thirty-one million families in the United States, ten millions had no electric light, twenty millions no electric washers, vacuum cleaners or toasters, twenty-four millions no electric refrigerator, twenty-eight no electric range, twenty-nine no electric water heater, no air conditioning, and no automatic central-heating system. Industry was electrified by eighty-three per cent, the American home somewhere between five and ten per cent. It was said that three million, two hundred and fifty thousand homes were no better than those built two hundred and fifty years ago.

This was in spite of the investment of five and one-half

billion dollars in electric appliances. Based on eighteen devices listed in *Electrical Merchandising* for January of that year, it was estimated that the investment by home-owners in kitchen equipment was two and one-half billions, in radios one and one-third billions, in home-laundry appliances nearly a billion and in vacuum cleaners, pads, heaters, clocks, Illuminating Engineering Society lamps, one hundred and ten millions.

In gas appliances at that time the investment was around five billions. Of those who did not have electric ranges, sixteen millions had gas for cooking and more than a million used gas for refrigeration. The American Gas Association reported that its latest figures were for 1931, when its members sold seventy-one million dollars' worth of equipment. But it expected great things of a new range, which in design, insulation, speed, and automatic features surpassed considerably anything put on the market before 1938. Manufacturers had spent more than a million dollars to equip their plants for its production ; and Ruth Soule, Director of Home Service for the Brooklyn Union Gas Company, confessed that the machine had aroused her enthusiasm "to a high pitch."

In the Greece which produced a Homer a woman trained in domestic duties was rated at four oxen, then the medium of exchange ; an athlete might win one prize worth three times as much, for physical prowess was valued far more highly than a housewife or a Homer. Edward Everett Hale said that civilization should be measured by the difference between the worker who used his body and the worker who used his mind. On that basis a woman trained in domestic duties now, and

properly equipped for them, is more highly civilized as well as more free.

Wood or coal was the fuel for the mothers of some of us. Women had a daily chore, a generation ago, of cleaning the globes of kerosene lamps, and counted themselves blessed if they owned a carpet sweeper, which gathered dirt instead of scattering it, and did away with the worst of the dusting after the morning housecleaning. Men in search of Lord Kelvin's better way improved on the carpet sweeper, the oil lamp and the old-fashioned range. They have improved all the appurtenances of that elder day, and have even gone out of their way to pacify the infant with a rattle ten times as interesting as the pottery goats, filled with pebbles, which quieted Mesopotamian children in Homer's time.

Industry and research, its good man Friday, contribute better ways on every hand to a better and more gracious life. Although nine-tenths of the housewives in the United States do their work without human aid, they have at their disposal, if they will but summon them, multitudes of servants ready to work tirelessly and efficiently in every part of the home. They can accomplish their duties with but a tiny fraction of the effort Martha Washington exerted, in spite of all her slaves. They are rich beyond the dreams of the richest colonial dames.

Compared with women across the sea, on the continent of Europe, where but few innovations have found a footing, homemakers in this country are blessed indeed. They are mistresses of more comforts and conveniences than their grandmothers could have imagined. They

are queens in a sense which might well have turned Victoria of England, Maria Theresa of Austria or Catherine of Russia green with envy ; for their dominion is in their own realm, theirs by right and not by might of arms. They exercise instead of statecraft the higher faculties of housecraft. They govern their own world, the home.

CHAPTER III

WHITE SLAVES

Cleopatra's bondwomen, and the helots of the Byzantine Empress Theodora, cooled wines for the royal table by waving fans above shallow earthen containers on the roof of the palace. Evaporation, two thousand years ago, was a cooling process. It is the process at the heart of refrigeration today, whether by ice, gas or electricity ; but the modern American housewife relies upon no such crude apparatus as a Cleopatra. Her kitchen, if it is up-to-date, is adorned by a regal porcelain cabinet, where the temperature may be regulated pretty much to order, where meats and vegetables may be stored in compartments dry or moist, where ice is manufactured and food kept secure from spoilage.

Yet there are now more than thirteen million homes in the United States, wired for electricity or piped for gas, or both, which have no automatic refrigeration. About seven out of ten are backward, and an independent survey has disclosed that in more than nine-tenths of the ice boxes still in use the temperature runs above fifty degrees, a condition which, by common expert consent, encourages food spoilage. Ninety-one per cent of the boxes, to be precise, are a menace to health.

Food may become dangerous in a temperature which keeps butter quite firm. Taste and smell and sight do not suffice as a warning. The milk for the baby or the foods for grown-ups may harbor harmful bacteria with no change perceptible to the unaided senses. The only

safeguard is a mechanism guaranteeing a temperature where these microbes cannot flourish.

Automatic refrigeration is a Twentieth Century product. One of the major manufacturers did not begin turning out "ice machines" until 1916, and his output during the first year was fifty. He had a hand-milling machine, two lathes, a shaper, a drill press, a tool grinder and some minor implements. Just as the "horseless carriage" had imitated the vehicle it was destined to supplant, so his product and the product of other makers in that field imitated the ice box. It was of painted wood, and its machinery of compression was in a dome on top. Around the ice trays was a brine tank to serve as a cooling medium. The brine promoted rust and leakage, the machinery had to be taken all the way to the factory when it got out of order, and it is amazing that all fifty of those early contraptions were sold for $600 each or more.

From paint to porcelain, from trips to the factory to servicing on the spot, from the noisy two-cylinder compressor to an hermetic model of compact elegance, manufacturers moved in seven-league boots. Their advance was marked by reductions of three-fourths in price, even on time payments. Thus there was created a market which has made the automatic refrigerator a blue chip in the household equipment game. But to this day there are men and women who cling affectionately to the old ice box, and in recent years it has been vastly improved.

That ice box itself was not so old. The first ice ever harvested in the United states was gathered from a pond

at the foot of Canal street in New York City in 1799, a quarter of a century after Dr. William Cullen had invented an ice-making machine in England. The relation of heat and cold to the preservation of foods had been known for several thousand years, and from colonial days we had cooled meat and milk in springhouses, cellars and wells. We knew temperature was important, but we did not know why. We even supposed that heat actually caused spoilage, whereas it was merely favorable to the plant growths which caused it.

Neither in England nor in this country did Dr. Cullen's ice machine catch on, nor did others which followed during the second half of the Nineteenth Century. But as early as 1805 Frederick Tudor, a Boston merchant, had shipped natural ice to Martinique, where yellow fever was raging; and the venture proved so profitable that ere long the United States was the leader among all countries in this export. Thus in 1833 the English in Calcutta, India, were buying our ice at half the price they had to pay for it if manufactured in Bengal; and our clipper ships were bearing their cold cargoes even to China.

We not only shipped ice but used it freely. We built double-walled storehouses capable of containing thousands of tons, and at the beginning of this century it was estimated that companies supplying the eastern seaboard and the middle states stored annually two million tons. Of this, New York City alone consumed half a million tons a year, three times as much as all England. Britain, by the way, had dropped from our list of export customers, and was buying from Norway.

Here we had a large and useful industry. Did the purr of the first automatic refrigerator sound its death sentence? No, it is a hardy business, and during the decade from 1926 to 1936, when the annual sale of refrigerators was increasing fivefold, from a quarter of a million to a million and a quarter, the production of commercial ice fell off only about eleven per cent. Largely this was due to increased industrial consumption, for the sale of domestic ice boxes during that period fell off from more than one and a quarter million to a bit more than a quarter of a million. The automatic refrigerator and the old-fashioned ice box, so far as the domestic market was concerned, changed places precisely. In 1936 the sale of ice was considerably more than forty million tons, an increase by one-seventh over the preceding year. This was a quarter-billion-dollar business.

Doubtless the microscope afforded the first step toward the modern refrigerator. Yet when we contemplate how long it took man to avail himself of the knowledge thus opened to him we are appalled at his ineptitude. The usual time lag between an invention and a perceptible social effect is calculated at thirty years, but the time lag between the magnifying glass and the refrigerator must be measured in millennia. Why, in ancient Nineveh and in the palace of Nimrod artisans ground convex lenses from rock crystal. The grinding of glass for magnifying purposes dates back at least six centuries. But it was not until the day of Anton van Leeuwenhoek, who was born in 1632, that microscopes became truly a scientific instrument of value. Leeuwenhoek discov-

ered red corpuscles, the capillary circulation of the blood, spermatozoa, infusoria and minute plant growths.

That man had an incorrigible curiosity about our invisible environment. Inasmuch as he denied the current scientific theory that weevils in granaries sprang from wheat, recommended fumigation before the eggs could hatch, and vowed that the flea was not "bred from corruption" in sand or dust or dung, as his contemporaries supposed, some of them thought him a crackpot. Inasmuch as he pored painstakingly over the tail of a newly hatched tadpole, say, or the ear of a white rabbit, or the fins of tiny fishes, or the hind feet of small crabs, he was suspect among his neighbors in the Dutch village of Delft. Yet he knew that rain water, collected in cisterns, might be contaminated by organisms borne on dust blown about in the air; he saw that everything was swarming with "little animals," even our hands and clothes and mouths and food.

There it was, duly set down in Leeuwenhoek's four-volume life work. Yet it remained for a man born two centuries after the Dutch scientist to begin applying practically what he had seen. Louis Pasteur carried on almost spectacularly where his predecessor had left off in the study of bacteria and fermentation. Pasteur even inoculated for hydrophobia as early as 1885; and because he found that a high degree of heat would destroy the microbes responsible for disease and food spoilage we speak, for example, of pasteurized milk. Other scientists, taking a cue from his demonstration that heat was fatal to hostile microbes, found that cold was just as deadly.

These microbes are not "little animals," like the Leeuwenhoek infusoria, but yeasts, molds and bacteria, all of them plant life ; and the harm they do arises from the wastes they discharge. Not all of them are hostile, only a few of them. No one who has made bread scorns or fears yeast, yet yeast causes fermentation and waste, especially in foods containing sugar. All who love good cheeses will rejoice that there are molds, which enhance their aroma and flavor. Every gardener should bless bacteria, for many processes of plant growth are dependent on friendly bacterial action. Every dairyman needs helpful bacteria in making butter. The bad bacteria are in the minority, as a fact, but we hear more about them just as we hear more about gangsters than about church goers.

Refrigeration is not the only way, of course, to protect what we eat from yeasts, molds and bacteria. With some kinds of food the drying process is effective, and it is perhaps the oldest method we have employed ; with some, preservatives may be used, some may be canned. It so happens that there are certain insects which especially enjoy fruits, and infest them in warehouses or in drying yards, so that elaborate traps and sprays have been devised to combat them. But even so we have in every market dried meats, fruits and vegetables.

It may be that the use of preservatives is as ancient as drying. Salt, sugar and spices have served their purpose since the dawn of history, and the Old Testament is replete with references to them. Mostly the spices of antiquity were obtained from Arabia and the East Indies,

and it is commonly accepted that Christopher Columbus discovered this continent by chance while trying to find a shorter route for these shipments. The effect of salt and spices and sugar was to dry the microbes, thus preventing their growth, but spices had the additional advantage that they disguised the taste of foods which had begun to spoil. Chemical preservatives were employed, too, although some of those used in an earlier day were harmful to health, and were one of the reasons why Congress passed the Pure Food and Drugs Act. But we still pickle meats and vegetables in brines and vinegars, although the process alters their texture, flavor, and sometimes their color.

We have Napoleon Bonaparte to thank, at least by indirection, for the canning process. He had difficulty provisioning his armies, and the French government offered a prize of twelve thousand francs — a large sum in those days — to the person who devised the best mode of keeping food fresh. François Appert, a confectioner, hit upon the idea of canning and won the prize. Nowadays most Frenchmen, so it is said, contend, with other continentals, that the American family feeds entirely out of tin cans.

Even with drying, preserving and canning, most perishable foods were consumed necessarily within a few miles of the production point and within a few days. It was impossible to enjoy in winter the fresh foods which were abundant in spring and summer. Here in our temperate zone the fruits of the tropics were either forbidden or a rarity. Even the old-fashioned ice box did not help a great deal, because it seldom maintained for long

a temperature below fifty degrees ; and the watchful discovered that diarrhea and obscure intestinal troubles began to bother those who ate meals too long entrusted to it.

Now, food spoilage is not an abnormal but a natural process. Dead plants and dead animals decay and return to the soil by a process which is simple and actually necessary. New generations of plants live on the substances thus returned to the earth, and new generations of animals subsist on the wealth thus brought out of the enriched soil. It is indeed a friendly cycle ; and so we find Stephen Phillips putting into the mouth of *Marpessa* a question why she should not —

> Accept the perfect stillness of the ground ?
> Where, though I lie still, and stir not at all,
> Yet shall I irresistibly be kind,
> Helplessly sweet, a wandering garden bliss.

Fancy what this world would look like if there were no decay of plant or animal ! Try to picture dead animals and trees and other vegetation all around us, incapable of putrefaction ; how could we dispose of them ? All our food is dead, subject to the law of decay, and so we must protect it and thus ourselves constantly against that process. The only effective way to do this is to keep it in a temperature between thirty-two degrees — for many foods are ruined by slow freezing — and fifty degrees, the heat at which microbes begin to thrive. In fifteen hours, under favorable conditions, a billion bacteria are produced by one bacterium as a starter. The method of averting that is to produce unfavorable con-

ditions, that is, by avoiding the degree of heat, moisture and in some cases darkness or sunlight, as the case may be; and we avert them with finality through automatic refrigeration.

Let us see just how the gas or electric refrigerator works. (There have been attempts to make refrigerators which utilized only compressed air, but they have proved so far impracticable.) At the heart is the process of evaporation, the change of a liquid into vapor. When a liquid such as water, say, becomes a vapor at two hundred and twelve degrees, heat goes into the steam and is subtracted from another area. Alcohol, ether and ammonia, for example, change form much more readily than water; ammonia, indeed, will evaporate even at twenty-seven degrees below zero, and was one of the early refrigerants used for "ice machines." It is hard on containers, however, it has a frightful odor, it is poisonous and in some circumstances it is explosive. Nowadays refrigerant compounds are used which have none of these faults and which evaporate somewhere between zero and twenty-five degrees above.

Refrigerators are cold then, not because they have made ice which remains in the trays, but because they contain chemical compounds which vaporize and absorb heat, this heat being carried away in a gas. But if the vapor escaped, we should be under the necessity of refilling the tank frequently, which would be bothersome and expensive. So it is drawn away from the cooling unit and piped to a compressor, operated either by gas or electricity, where it is condensed — returned to its

liquid state – under high pressure. Then it goes through the circle again. The units are hermetically sealed so that none of the gas or liquid may escape. Reduced to its simplest terms, we have here the mechanics of automatic refrigeration.

But those terms are simple indeed! They give no hint of the uncanny ingenuity lavished by research laboratories on the improvement of one of the most important adjuncts of modern civilization. Moving parts in the compressors have been reduced apparently to a minimum, and in some there are no moving parts; there is pressure lubrication, automatic internal lighting, a quiet operating mechanism all but free of vibration. The door is sealed with a rubber gasket which makes it airtight. Since one of the functions of a refrigerator is to act as a storage closet, there are compartments of moist and dry air, one for vegetables and the other for meats. The skill in utilizing shelf space and in providing adjustable containers deserves almost the term inventiveness. It has the aspect to a layman of creative inventiveness, because it does appear as though more stuff can be put into the cabinet than its interior cubic footage justifies. Its pistons ground to an accuracy of one ten-thousandth of an inch, its walls of steel clad nobly in porcelain, its hinges, handles and lock adorned with chromium or some metal as beautiful, it supplies a décor in the home of the white-collar worker or the thrifty ditch-digger which any multimillionaire might envy.

And the wife of the white-collar man or the ditch-digger, who can buy these things for a dollar a week or less, has been pampered like a court darling. If she ap-

proaches her refrigerator with her hands full, she may open it with the pressure of her foot against a pedal or a touch of her knee against the handle. If she bungles in managing her luxury — for she is likely to regard it as that rather than as a necessity — she is assured of free service over a long period. On the theory that women do bungle in handling machines, most of these inventions have been made virtually foolproof. And some refrigerators are actually so constructed that they are guaranteed not to interfere with the radio !

Coddled thus by the manufacturer, the operator of the modern refrigerator yet undertakes to prove on occasion that it cannot be made foolproof. She may dent the tray beneath the cooling unit, containing ice cubes, by trying to hammer the ice out with a knife handle instead of putting the tray under a dribble of warm water to loosen the cubes. Certain manufacturers have found ways to circumvent that form of foolishness by providing devices which loosen a few or all of the cubes, as may be. The housewife may neglect to oil the machines at long periods, if that is required, or she may remember and use squirts instead of drops of the lubricant. She may be too indolent to close the door promptly, and so increase the slight operating cost, or she may neglect to clean the contents before putting them in, or to wipe off the bottles.

Against such negligence the manufacturer, for all the pains he takes, has no recourse. He and his salesman can guard against the common mistake of buying a refrigerator too small for requirements, and he can warn of the possible need for multiple ice cubes. A good re-

frigerator nowadays will make at least three hundred and fifty ice cubes between eight in the morning and cocktail time, seven hundred of them – eighty pounds of ice – before the after-theater highball jamboree. Of course space must be provided for storing all this in anticipation of high wassail. The space will serve also to take care of frozen desserts prepared ahead of time. Whether or not the purchaser asks for it, he is likely to get a machine in which the temperature can be lowered if need be by touching a button or turning a lever.

Not even the automobile illustrates more clearly than the refrigerator the methods of the up-and-coming manufacturer. While reducing the cost of ice machines to less than one-fourth, he has improved his product at least fourfold. To be entirely satisfactory, the modern machine should pay for itself within one year. That is, it should make possible economies which will offset the original investment and meet the cost of current or gas as well. A primary factor in these savings is the possibility of long-range marketing, when day-to-day ice-box buying goes into limbo. The housewife, if she discovers a "special" or a good bargain on the counters, may purchase as much as she needs, if the fancy strikes her. She can buy canned vegetables and fruit juices in the larger cans, which are more economical, even though she will not use an entire can for a meal, because now she has a safe place to keep the left-over. And she can use other left-overs at a great rate, too.

Mrs. Ralph Borsodi tells us in *Electrical Merchandising* that buying meat in quantity may well mean a saving

of twenty-five per cent; this, she estimates, means a saving of $32.50 a year in average families, and "it is conservative to say that the savings on canned goods generally will range from ten per cent to thirty per cent."

Any housewife can calculate offhand the difference between the cost of four half pints of cream and one quart. She knows, as every observer of business in any of its phases must recognize, that quantity buying means economies. This is true even when there are no tempting bargains on display. With an automatic refrigerator she may buy when both price and quality are tempting.

The refrigerator does a good job, too, in preventing wasteful spoilage. It can be operated on the current required for an incandescent bulb, and it has been said with some show of reason but with no documentary proof that enough food is thrown away in the United States, owing to spoiling, to feed a city as large as New York. The United States Department of Agriculture has lamented the losses on that score, but has not made that comparison. What the nation's medical bill amounts to, as a result of eating food which has begun imperceptibly to spoil, is not subject even to a guess, and manufacturers do not make this a talking point. Yet surely sounder health by reason of sounder food is not to be sneezed at.

In the maintenance of sound health nothing can be more important than the abundance and purity of our milk supply. It constitutes about one-fifth of our nourishment; in this country each person, it has been calculated, uses an average of sixty gallons a year. Dietitians dilate upon its content of fats, carbohydrates,

mineral salts, proteins, and our readiness in assimilating these ingredients from it. It is our most digestible and generally used item of physical sustenance.

Exacting in its requirements, milk becomes a dangerous food unless it is handled with scrupulous care from cow to consumer. Containers must be clean inside as well as outside, and their contents subjected to minute inspection at every stage. The containers themselves, now in a state of transition, reflect the practices and processes of industrial revolution.

Ten years before the Pilgrims landed at Plymouth Rock, glass was being exported from Jamestown, Virginia, some of it in the form of bottles. Most of the product went into beads for trading with the Indians, but all of it was of sand on the spot, fluxed with the potash from ashes. There we had the beginnings of our milk-bottle industry, as a strictly localized enterprise. Although the Supreme Court of the United States assures us that manufacture enters only indirectly into interstate commerce, we find that the bottle set on your doorstep of a morning, commonplace as it seems, is made with soda ash from Ohio, limestone from Michigan or Indiana, feldspar from North Carolina, cobalt from Canada, selenium from Montana, and niter from Chili. Thanks to the perfection of mechanical glass blowing, these bottles are cheaply produced ; but they are breakable, so that most distributors require a deposit to guarantee their return ; and an elaborate system has been set up of gathering the used containers, rinsing and cleaning them.

Since it costs almost as much to return a bottle to the channels of use as to manufacture it, for years there has

been a search for some other means of delivering milk. Not until 1934 was a practicable substitute found, and chemical engineers made it possible. Paper containers are now manufactured which are designed to be distributed but once. By the use of paraffin heavy paper was made proof against the moisture of milk ; and since the market for these more economical containers is almost unlimited, the main question confronting the manufacturers appears to be an adequate supply of paraffin. In some states there has been official objection to these containers, not on the ground that they were insanitary, for they were not, but on the ground that they were an example of unfair competition. About this there was an odor of politics as a factor in business rivalry ; but there is the prospect that paper containers are destined for wide use not only in delivering milk but many other liquids, including oils. Refrigerators are likely to gleam less and less with the luster of glass.

Milk bottles were unknown in ancient Tyre, and Nubian slaves rode camels to distant mountain tops, to gather snow for the king's sherbet. Yet the luxury, the magnificence and the sins of that city, after it had surpassed Sidon as queen of Phoenicia, drew a deal of tongue-lashing, doubtless well deserved, from the prophet Ezekiel. It was there that *mene, mene, tekel upharsin* was written on the wall of Nebuchadnezzar's banquet hall. Now, after Tyre had paid tribute to one conqueror after another, she settled down properly and prosperously to metal work and the manufacture of the finest textiles known in that day. Her dyes became famous

by the time Rome was ruling most of the world, and even in the Middle Ages only the rich ruling classes and the church could afford Tyrian purple. Nowadays Milady can buy textiles as fine, impregnated with dyes as splendid, over the bargain counter. And she need not send to distant mountains for the wherewithal of sherbet.

However vain Milady may be, neither the marvel of modern textiles, even of silken fabrics from cellulose, nor the richness of modern dyes, can compare in importance with refrigeration. Our civilization is enmeshed astonishingly with artificial cold. Seldom do we realize our dependence on it. Reams have been written about steel construction and the automobile as factors in the growth of our immense metropolises, and almost nothing about the fact that they could not long endure without the automatic ice box and refrigerated transportation. If all our cold-storage plants, all our natural and artificial ways of getting and keeping ice, all our chilled trucks and freight cars, suddenly were to be discarded or to become unavailable, our large cities would confront an emergency worse than the most disastrous flood. Certainly even smaller cities would be affected in time. The farmer might begin setting a covered pail of milk in the spring house once more, and might even keep his fowls and cuts of meat there for a little while, but in the country at large chaos would reign.

There is no likelihood, praise be, of such a catastrophe. Only a violent earthquake, continental in scope, disrupting our gas mains, leveling our storage plants, shattering our electric generators and disrupting our transportation, could cause it, and we are in no danger of this. That

being so, we are likely to accept somewhat too complacently the advantages of a modern necromancy. We take it for granted just as we take for granted electric lights instead of kerosene lamps.

But in the sun-baked palace of an Indian rajah, or on obscure islands such as Munson, twenty-five miles off Key West, there is nothing matter-of-fact about a mechanical refrigerator. It may be found in either of those places and in others even more out of the way. Members of the Bowdoin expedition to the Bay of Fundy did not take it for granted, because it was a life-saver. It kept in good condition their canned orange juice and seal meat, and they blessed the coal oil which they used as fuel for their machine. Scientists such as these, and residents of remote tropics, appear to be better informed than two-thirds of the householders in this United States, whether home-owners or tenants, who have not yet mechanized their refrigeration. All of us would do well to make this gracious, dignified and health-guarding cabinet the central shrine of our lares and penates.

CHAPTER IV

GOOD COOKING, BETTER THINKING

In this country we have a public eating place for each nine hundred of the population, not excepting the bedridden and babies at the breast. One hotel boasts two score dining rooms and banquet halls. We spend some four billion dollars a year in restaurants, at soda fountains for food, in cafeterias, clubs, "diners" and that sort of thing. Even when the national income is opulent, this outgo is a substantial item. What do we get?

It may be said to begin with that the customer in most places gets bad coffee. (An almost universal item of diet, coffee is consumed at the rate of thirteen pounds per person every year.) He gets bread from which the nutritive elements have been pretty thoroughly processed. He gets vegetables which have been demineralized and devitalized in cooking, so that they lack the vitamins, the iron and so on which our bodies need; these elements have gone down the sewer, for the most part, with the water in which they were boiled. He gets meat fried in substitute fats or treated otherwise with synthetic materials.

Most of that four billions, in brief, is either misspent or wasted. A. Victor Donahey, as State Auditor of Ohio, perceived this and made life miserable for those who submitted expense accounts. That he was elected thrice as governor and then as United States senator he ascribed in part to his refusal to pass an item of

thirty cents for a portion of potatoes, when farmers were getting thirty cents a bushel for them. The voters saw that he was more frugal and straightforward than the hotels.

Perhaps it was a small-town Ohio hotel which offended the state auditor in that instance. In our larger cities quite good food may be procured at some of the public eating places; and there are restaurant chains which charge low prices yet serve food which is both palatable and nutritious. A great deal of intelligent work is being done outside the household to improve the processes involved in day-to-day living; and since so many of the population of this country insist on eating one or more meals in public places the demand for food of better quality, prepared under better conditions, is being gratified in some instances.

Hotels and restaurants have their trade publications which advise them ably in these matters. If they cook the more valuable elements out of the food they offer and serve execrable coffee it is because they will not listen to their sagest counselors nor heed the complaints of their customers. The consumer is making himself heard, however, and the more forward looking *restaurateurs* are sure to make their influence felt.

When we do get bad food in public eating places it is in spite of the fact that the United States leads the world in the accouterment of good cookery. If we entertain in roadhouses it is not because the facilities of excellent entertainment are lacking. If hospitality has descended from an intimate, congenial and formal rite to a second-rate public exhibition, it is not the fault of authorities on

better living, of our schools of domestic economy, certainly not of the manufacturers of ranges and culinary accessories. That we do much of our eating gregariously is a reflection on our national *mores,* an infringement of our right of privacy and an affront to our modesty. Some of the more bitter complaints against the candid camera have come from those who discovered themselves in the public prints taken unaware at the table, mouth wide open for an approaching victual.

No less than the refrigerator, the kitchen range may be a thing of dignity and beauty. It may do as much to safeguard health and to abet the family budget. Charm, economy and efficiency are its handmaidens.

Kathleen Robertson puts it thus : "We may only hope that our living rooms are authentic Queen Anne, but we are likely to insist strongly that our kitchens be Very Latest American." In spite of that utterance, which voices doubtless the sentiment of most women in this country, it is estimated on the basis of a wide survey that we have three million, two hundred and fifty thousand homes which are no better than the houses built two hundred and fifty years ago.

Is male perversity responsible for that condition? More probably it is ignorance of "the seven wonders" of modern cookery, which have been set forth as "better tasting, more healthful foods, more uniform results, less kitchen time, cool, clean, fast, cheap." Flat surfaces and rounded corners lend cleanliness not only to the range but to the kitchen walls and curtains ; highly insulated ovens keep heat and odors inside and the kitchen cool ;

down-to-the-floor construction in many models affords graceful lines and more storage space ; push-buttons, levers and switches emulate the automobile dashboard ; automatic lights illuminate the oven when it is open and go out when it is closed, just as in the modern refrigerator. Thanks to expert insulation, preheating temperatures up to five hundred degrees may be reached in ten minutes ; simmerers save either gas or electricity.

Regal in porcelain enamel and chromium, the range of today is touchy and a trifle high-hat. Now, porcelain is a kind of glass, enamel on metal, and it is subject to chipping unless treated with respect. Complaints have been made that it cracks or "crazes" too easily. This is a bugaboo which can be exorcised with reasonable care, based on an understanding that the range, although steely in strength, is outwardly as fragile as a mirror. Certainly it is immensely superior to the japan finish once widely popular. Japan was a sort of varnish made of shellac, linseed oil and metallic oxids with turpentine, used as a medium in which to grind and dry pigments. It had more faults every minute than porcelain in a whole day, and now is happily obsolescent.

The lining of modern ranges is not subject to rust, and is durable against alkalies or food acids ; as a rule it is a vitreous enamel in light or dark colors. The heat units affect the entire bottom of the cooking vessel, and the heat is directed inward instead of toward the sides. Often there is an automatic thermostat, with an accessory timer, which enables the housewife to play bridge while a roast is getting its dues. Of the thermostatic controls there are several makes, and it should be said at once that they

are subject to maladjustment from one cause or another in any range, so that they should be tested occasionally with a good thermometer, lest they mislead the cook into blunders of baking or broiling. When in good working order, any one of them is a robot chef, with better brains than most humans can boast. The time control is a clocklike device, or an actual clock, which regulates or shuts off the heat. There are stop-and-go lights as for the motorist; there are pilot lights, drip trays and utility drawers. The top of the range, whether gas or electric, may be opened or closed; in the one, grates or coils uphold the cooking vessel; in the other there is a flat surface, useful as a work table when not otherwise employed, resembling the old coal range. When gas is the fuel, there are two steps of combustion, the first indicated by an inner light blue or green cone, the second by an outer cone, almost colorless, and both cones should develop before the cooking vessel is put in place, as its surface tends to cool the gas.

All burners should be cleaned regularly, and enamel should be wiped with a moist cloth or soft paper while cool, not hot. These and other common-sense precautions are eagerly explained to purchasers by the manufacturers. Insofar as the implements are not foolproof, there is abundant warning against foolishness. Why, for instance, lay a dirty used spoon on enamel?

Fully aware of the importance of beauty in the kitchen, the makers of ranges offer them in hues to harmonize with any color scheme; they may be white or ivory, ebony or shell green or tan or red, and agreeably adorned. Fully aware that the nose should not be of-

fended, and that broiling was long a sort of stepchild of the cook, because of smoke, fumes and sputtering fat, they have devised the enclosed smokeless broiler. This has apertures to let the fat run into a pan below. And since no fat comes in contact with the flame — if gas is being used — there is no smoke. Many ranges are equipped, too, with ventilating fans.

If there is widespread complaint about the quality of restaurant coffee, there is hardly less ground for objection to the kind of coffee we are likely to get at home or in the homes of our friends. Most of us, too listless to install an automatic grinder, buy coffee of quite good grade, ground coarse or fine as may be, but are careless in the making. Inaccurate proportions of water, wrong timing in cooking, and passé pots, contribute often to a decoction which is an affront to the palate. Yet there are available pots for drip coffee and percolators which automatically shut off the heat when enough has been used, automatically stir the mixture if need be, and automatically keep it warm when the heat has been stopped. These eliminate re-heating, which spoils the best coffee, and avert the need of special brews for the lazybones who is late to breakfast. A sixth cup of coffee may be served at the same piping temperature as the first, during the meal or after dessert.

If a range is out of reach, a portable roaster and a percolator or drip coffeepot may make possible complete kitchen operation for a family. A good roaster will bake, broil, steam and stew the food, and is of proportions which make it a favorite in the apartment kitch-

enette. It is a favorite, too, as an auxiliary or for use in summer homes or camps, for lawn parties and picnics. There are egg cookers which scramble, boil or poach evenly throughout and automatically, sometimes made with handsome fittings. There are machines which turn waffles out to taste, soft or blond, crisp or brown ; there are toasters, casseroles and sandwich grills. Even a corn popper is available. There is, indeed, a bewildering array from which to surprise the June bride. Only now is the idea of a kitchen trousseau seeping into the national consciousness.

Nor need the June bride puzzle her pretty head about what she shall have for dinner when her groom returns from the office or the mill. From a score of sources she may obtain tested suggestions, menus and recipes for this or any other meal. She may learn with ease about good meats meant for any pocketbook, about how to cook for two or, somewhat later, how to prepare meals for children which the whole family will relish ; how to buy, cook and serve poultry or fish. She can get without cost tables of measurement which tell her, for example, that a cupful is half a pint, and that a cupful of confectioner's sugar weighs six ounces, whereas a cupful of granulated sugar weighs eight. Since the flavor and nutritiousness of foods depend on the temperature and time of cooking, she can get charts directing her in detail on those points. She can learn whether palatability and quality are promoted by cold or preheated ovens. There are minute instructions on how to cook bread and biscuit, cookies, pies, vegetables, custards, meats, and precisely how much water should be used.

She can learn how to can foods at home if she chooses. A culinary encyclopedia awaits the asking either from her manufacturer or from an up-and-coming magazine.

Your Uncle Sam is not remiss in that regard. Although he charges at times for his pamphlets, some of them have been best sellers. His instructions on *Infant Care*, prepared by the Children's Bureau, Department of Commerce, was issued back in 1914 and has been given to some, to others sold at ten cents; about ten millions of copies have been distributed, which makes *Gone with the Wind* look like a piker. There are booklets about canning and cold storage, and recipes galore. The Bureau of Home Economics has issued publications on foods ranging from caviar to sauerkraut. In the Agricultural Adjustment Administration there is a Consumers' Counsel Division, which gets out a biweekly illustrated *Consumer's Guide*, free for the asking. It had one hundred and five thousand "subscribers" when this was written. The Bureau of Fisheries gives specialized information.

The world eats eight billion bushels of potatoes every year. There are more than two hundred varieties of this vegetable, according to Uncle Sam, and perhaps one hundred wild species in regions the botanist has not penetrated. Mankind has known about the potato as food only a century and does not yet know its origin. As a rule it is mostly water, about twenty per cent starch, and is undigestible when raw. In cooking the cells explode. The ideal potato, sought by earnest breeders, will have extremely shallow eyes, for one thing, to save expense in paring.

In the Department of Agriculture at Washington there is an experimental bakery, where a man wearing earmuffs and mittens may be studying ice cream, another, not so weirdly attired, may be prodding a pear, another testing the colors of tomatoes and others making pastes of vegetables and grains. These students have found that high prices and high quality do not always go hand in hand, that bad cooking destroys nutritious elements and often makes food look unappetizing, which is bad.

Even cities sometimes lend a hand in that field. In New York, for one, the Department of Markets conducts classes in settlement centers and elsewhere, and the lessons are mostly replies to questions put to demonstrators by puzzled housewives. There are daily news reports on fresh foods in the markets, too, tables of comparative prices and radio talks.

When husbands get a taste by inadvertence of dishwashing they are likely to insist that machines be installed at once to do this, the most unpopular and tiring of the kitchen chores. Women get little or no credit when they do it by hand, and the damage it does in wear and tear is difficult to calculate. "The most valuable asset we have," says Eloise Davison, "is human energy; to use it when we could use labor-saving machinery is wicked."

To stack dishes in one of those machines, and see them washed into spotlessness by water hotter than the hands could bear, then dried automatically, gives the housewife a genuine lift of elation equivalent at least to the joy of

a new Easter frock. No matter how hard she scrubbed and rubbed she could hardly get the dishes as clean and dry as that. Even in a small family the dishwashing machine saves nearly an hour a day.

Muscle power can be saved, and weariness averted, too, by the use at small cost of automatic mixers and beaters which have often the strength of a thousand arms. They contribute substantially to better cooking. Cakes, muffins, cookies, mayonnaise, icings, mashed potatoes, whipped cream and egg whites are better fitted to become ingredients of dishes – or dishes on their own – when treated mechanically rather than manually. The beater does not slow down when the product thickens, as the muscle does. Both beaters and mixers may be procured in heavy, stationary types for the large household, or in compact and portable designs for the smaller family. Some have attachments, such as fruit-juice extractors, potato peelers, or meat grinders, cheese and vegetable graters, choppers and slicers.

Since many of the junior appliances in the kitchen are electrical, there should be an ample number of outlets. Sometimes electric ranges are equipped with them ; and since cooking requires accuracy, a set of good scales should be handy to weigh materials. Racks for knives and cabinets for mops, brooms and brushes and what not are a vast convenience. Places for can openers, trays, chopping bowls, dish drainers and dishcloths, garbage and paper liners, measuring cups and spoons, scoops and ladles, pot and pan holders, vacuum bottles and insulated jars, wax for sealing jars, an ironing board, and so on, are desirable. The list sounds as though the kitchen

must be extremely spacious, but it can contain all these and still be compact.

Gas has been in use for more than a century as a fuel and for lighting, but for less than half that time for cooking. The first electric range was invented by George A. Hughes in 1910. The conveniences of the streamlined kitchen are surprisingly recent, with the separate centers for storage of food, preparing it, cooking it, serving it, cleaning up, and a little library for planning. The chemistry of cooking is a science in its youth, and what is news today is likely to be a commonplace tomorrow. Vitamin C, for example, the most nearly invincible enemy of scurvy, is an elusive constituent, late research reveals, and all but disappears from our apple pies. Scientists at the New York State Agricultural Experiment Station in Geneva assert that about eighty per cent of this needed ingredient is lost in cooking, part of it in paring the apples ; and applesauce loses a third.

It may be said, almost categorically, that our bodies are what we eat : and it was in the pursuit of food that man's senses were gradually developed. This interrelation between food, physique and brain confers upon the kitchen and its general manager, the housewife, a singular distinction.

Dr. Victor G. Heiser has called attention to the relation between tuberculosis and abstention from milk ; the more milk drunk the less of the White Plague. In Germany and Austria during the World War the rate of this disease rose rapidly, but after the war, when milk and

butter could be obtained, the rate fell rapidly. Stones in the bladder, it has been found, are more frequent among those who do not get a fair ration of milk, say one pint a day.

Dr. Heiser has called attention to other striking dietary facts. In the north of India the Sikhs and Pathans, although reared amid a filth as great as was to be found in Madras, grew to tall and robust manhood while the population of Madras was stunted and unhealthy. The Sikhs and Pathans ate little meat but a lot of sour curds, vegetables and whole wheat bread, whereas the others were given to rice, red pepper, tamarind and dried fish. A physician in the Indian Medical Service experimented with white rats of one stock, feeding to some the ordinary British diet and developing a bellicose lot, to others the diet of Madras, which stunted them, and to still others the diet common in northern India, which produced powerful, but sleek and gentle creatures. He even reported that a characteristic French diet brought out wide middles, "oily hair and whiskers twirled to fine points."

In Japan, where the national foods lack Vitamins A and B and certain inorganic salts, Dr. Heiser reports, the Imperial Institute of Nutrition tried drying certain fish containing these elements, ground them to a powder and prescribed it as a noonday seasoning for a group of school children ; after four years it was found that this group suffered fewer childhood maladies, weighed about five pounds more than the average pupil, and were taller.

Sovereign in its sphere is the stomach.

Ten or twelve thousand years ago, neolithic man in Europe sowed the first seeds of a sort of agriculture there, quit eating horses, domesticated certain animals, such as cattle, sheep, goats and pigs, devised pottery and began cooking after a fashion. If we accept the word of scientists that man in somewhat his present state, erect and with glimmers of intelligence, began fifty-eight million years ago, the continental discovery of cookery is as yesterday ; yet even so there was a long row to hoe before human beings began to behave intelligently about food. We read in Genesis of "all manner of baked meats for Pharaoh," who was a contemporary of Abraham about two thousand years before Christ, but the Mesopotamians had learned about culinary arts long ere that, and before they became manifest on the continent. In Pompeii there were wheels driven by water and capstans driven by animal power for kneading dough. The Romans built ingenious machines, long before the Christian era, and early in this era their biremes landed armored legions on the shores of Britain to get tin from Cornwall mines, which first had been worked by the Phoenicians of Tyre and Sidon, so that they might coat copper cooking vessels. In New York City there is a Greek restaurant to this day where a sweet cake called kattaifi is made according to a recipe two thousand years old, with just the equipment used in that elder day.

It is probable that the rude pot which was part of that equipment was not an invention but a discovery, that wovenware baskets covered with clay and set above the fire hardened, revealing that pots might be made without the wovenware. Thus it became possible to boil water,

a giant forward stride. Man has difficulty assimilating food without water. In his earlier days he crushed wheat and ate unleavened bread ; we are not sure whether he used yeast first to improve the staff of life or to ferment his drinks.

Whether by accident or under the spur of need, our progress in the vital processes of cookery was at a snail's pace until near the turn of the last century. In the Metropolitan Museum of Art, in New York City, there is a painting by the elder Teniers, "Dutch Kitchen," which is an acute commentary upon the thrifty, intelligent and progressive Dutch people. At one side is the housewife with a pail at the well, at the other the huge carcass of an ox, suspended by thongs from a rafter, and in the foreground a dog, alert for a bone. On the floor are pots, pans, vegetables. It was a well-to-do kitchen, undoubtedly modern in its day. The place could have accommodated with ease one of our four-room flats, and doubtless the stout and industrious *frau* walked miles daily in her duties.

Until half a century ago the kitchen Marathon was an American convention. One of the requirements in 1837 at Mount Holyoke, which is in the vanguard of our colleges for young women, was that "No young lady shall become a member of Mt. Holyoke Seminary who cannot kindle a fire, wash potatoes, repeat the multiplication table and at least two thirds of the shorter catechism." Another, apparently in preparation for the Marathon, was that "Every member of the school shall walk a mile a day unless a freshet, earthquake, or some other calamity prevent." It was a stipulation that not

more than an hour a day should be devoted to "miscellaneous reading," and there was a stern order that "No young lady is expected to have gentlemen acquaintances unless they are returned missionaries or agents of benevolent societies." Subdebs and Junior Leaguers would scratch the eyes out of a dean who tried to enforce such rules now.

When those rules were a polite expression of good form, kitchen drudgery was compounded largely of sweat and elbow grease. The sadiron, heated on a coal range for the weekly clothes pressing, was indeed sad, not to say lugubrious. A certain magazine for women devoted thousands of words to stoking technique and the tactics of removing ashes. There were a few who set themselves up loftily as authorities on cookery, and sought to instruct their sisters, but the culinary paraphernalia were woefully deficient. Women aged rapidly because their housework broke their backs and brought lines into their faces. The mistress of the home now is a pampered pet and an idler compared with her grandmother. If she fails to give thanks daily for the persistent research and amazing ingenuity which has lightened her burdens, she is a downright ingrate.

CHAPTER V

WASHDAY

Automatic washers and ironers are the backbone of an equipment which is helping free women in the United States from their most devastating drudgery. Scores of manufacturers produce, each of them from two to seven models, washing machines of the cylinder, gyrator and oscillator types. Nearly all have self-reversing gears, and they may be driven in various cases by hand power, by gasoline engines, by water power or by electric motor. They may be constructed of aluminum, steel, nickeled copper, monel or porcelain enamel; but it has been found that strong soaps discolor aluminum, and that it is hard to keep clean. The other metals and enamel do not have this disadvantage.

In a fashionable suburb of New York there bobbed up not long ago what promised to prove a new social diversion. The wife of a Wall Street lawyer acquired an automatic washing machine, and was so enraptured with it that she forswore bridge parties to devote her afternoons — although never before had she washed so much as a handkerchief — to deterging everything she could lay her hands on; and she invited her friends to join these soapsuds parties.

"Bring along your blankets," she urged, "they're just no trouble."

Then, in sudden aggrieved wrath, she announced a discovery.

"To think," she complained, "that Helen and Louise, who pose as my dearest friends, have had washing machines for years, and never once invited me to do my washing with them!"

Another woman, with a new ironer, put it to more practical use. She paid for it by renting it to her neighbors; she instructed them in its use and served tea at the end of the ironing. Hardly had her machine been paid for when she had to look around for new customers. Her first pupils had bought ironers of their own.

There are instances where mechanical washing and ironing in the house is not an actual economy. This may prove true when women spend their week days in an office, and cannot profitably intrust their laundry to servants, who are often difficult to instruct in the uses of domestic appliances. Moreover, there are commercial laundries which turn out excellent work at rates which are not prohibitive. In this field, as in the restaurant, notable progress has been made outside the household. There are those, for one thing, who think well-organized commercial laundries can get clothes and bed linen cleaner than they can be done in the house.

There is not much difference between washing machines in their capacity to clean clothes, but there is a difference in the time required. Most of them are equipped with wringers, which help pull the wet wash from the tub and squeeze out the water without breaking off buttons or stretching the material. Instead of wringers, some machines are equipped with centrifugal driers.

If the tub is stationary, it is emptied through an attachment with the drain ; if on casters, a hose should be provided, unless there is an automatic pump to remove the water.

Streamlined electric irons, so light as to be handled with ease and in many cases provided with an automatic heat control, so that they cannot scorch the fabric, are now a commonplace in the home. Automatic ironers, whether made with rollers or pressing on a flat surface, are not so generally used as they deserve to be. At the beginning of 1937, according to *Electrical Merchandising*, there were more than twenty million electric irons in use in this country, covering ninety-seven per cent of the wired homes, and more than a million electric ironers. By the end of that year more than fourteen million gas and electric washing machines were in use. Yet even so the United States Bureau of Home Economics found that the average American woman spent seven hours each week in the laundry. That was too long a washday.

When one takes into consideration the deterioration and downright damage due to commercial work, and the extravagance of resorting to most commercial laundries, despite their price-cutting wars, it is surprising that household machinery for this purpose has not come even more rapidly into use. Mrs. Ralph Borsodi, a frequent magazine contributor and an authority in this field, is a convincing witness as to the economy of doing the washing with machinery at home. She has itemized the cost of using the power plant for everything but the finer and

filmier materials as against doing all in the house ; and she found that even when paying $2.16¾ to the agency, the housewife spent five hours and forty-two minutes working at home ; whereas, allowing six per cent on the investment of $130.00, for domestic appliances, and ten per cent for deterioration, the entire job cost but $.70½ and required but five hours. The annual saving in money she found to be $76.05 and the saving in time thirty-six hours and thirty-four minutes.

A curious fact developed by an extensive survey, Mrs. Borsodi noted, was that "the women who sent out most of their washing to the laundries, and who owned neither washers nor ironers, spent more time each week puddling out odds and ends and doing up the expensive things they would not trust to laundries, than those women who did every bit of their washing and ironing at home, but used washers and ironers in doing this work." A lot of involuntary servitude is compact in that phrase, "puddling out odds and ends."

The least the average woman spent in commercial laundries, Mrs. Borsodi found as the result of a widespread inquiry, was $45.24 a year, the highest average $136.24. The average bundle ranged in value from $50.00 to $75.00, and she found that the wear and tear was twice as rapid as on work properly done at home. Even on a $50.00 bundle the extra expense, on linen and clothes sent to power plants, averaged $19.76 a year. She refrained from commenting on the fact that many laundries substitute cotton for linen handkerchiefs, or that few of them pay willingly and honestly for damage

or for misplaced articles; perhaps in time all of them will be licensed and bonded against such misfeasance. They are charged with a public service, and should be regulated as other public utilities are regulated.

A pitfall for the uninformed housewife is the quality of water supplied to her. Even soft water, when slightly acid, corrodes tanks and pipes of certain metals, but the chief difficulty is hard water, such as goes into about one-half the homes of the United States. It has been filtered through limestone or some other geologic stratum so that it contains calcium, magnesium or iron, and these form deposits, unless neutralized, on the inside of tanks and pipes, even to the extent of clogging the water system. Any large manufacturer of soap is glad to analyze a sample of water, if the state geologist will not attend to it.

A once-familiar phrase is disappearing from our language. It was not, like Main Street, the coinage of a thoughtful novelist, but sprang from our folklore, and its obsolescence is noteworthy because it indicates a deep-seated social change. The drab conditions which it described are passing out. How often nowadays do we hear of Blue Monday?

That phrase expressed inadequately the terrors of the old washday. Even as late as the middle nineties of the last century the home laundry consisted of an equipment which cost around $15.00: Two wooden tubs, a clothes boiler, washboard, wringer, basket, clothespins, line, ironing cloth, skirt board and three heavy flatirons.

Coal was regarded as a superior fuel for the laundry stove. The washing was done on Mondays and the ironing on Tuesdays.

It was a two-day drudgery. On Blue Monday the housewife rose with Phosphor, the morning star, or at least with the sun, which, according to Thoreau, "is but a morning star." She had no time, however, to revel in the beauties of daybreak. If she was blessed with a water reservoir on the stove, or a round tank containing a pipe coil and connected with the fire box, still it was necessary as a rule to carry water in a bucket from the stove to the table. The average pail of water weighs around twenty pounds, from four to six were needed to fill a washtub, and even if there was a faucet to fill it there was the job of bailing it out. First and last, hundreds of pounds were lifted about. Muscular power for this, and elbow grease for the corrugated washboard, were prerequisites of laundering in that day. Heating the irons to the right temperature on the stove was haphazard, and too often resulted in scorching.

And how were pretty hands to be protected from the ravages of hot soapy water? Often as not the lather came from overstrong cleaners. How were delicate hands and arms to wring out heavy garments and bedclothes? Yet somehow the laundry got done, and three meals were prepared to boot. A part of the price was a headache and a backache. But women are the conservative sex; they have been slow to take advantage of the benefits at hand in modern machinery.

The chemist has done teamwork with the engineer and the inventor to move the washday load. Between

them, they offered to American women release from a form of slavery which was a reproach to Nineteenth Century civilization. Every home, whether piped for gas or wired for electricity, or even so isolated that power must be manufactured on the spot, may find a mechanical solution now for the most doleful of its problems. The mechanical way out, fortunately, is self-liquidating, because the machines pay for themselves. They pay for themselves in dollars, in a rich harvest of energies conserved, in greater mental alertness. Dishwashing may be the most monotonous chore in the home, but the laundry, when done by hand, imposes the greatest hardships; and from present indications it is a form of manual bondage from which the women of this country mean to be emancipated. This is a matter to which their menfolk may well devote serious attention; for the head of the household, however hard pressed he may be, is bound to discover that he can do himself a good turn, while doing his wife a good turn, by providing a sunny and well-arranged laundry fully equipped with starches, bluings, soaps, softeners and so on, as well as the handsome machinery now readily available on easy terms. Then indeed the whole family may smile at the recollection that once upon a time there was in the calendar a Blue Monday.

No domestic chore is more homely and timeworn than laundering. In early days clothes were rinsed in a stream or pool, a little later they were rubbed, or trodden with the feet, in a bowl, and dried on a wooden frame. But Jeremiah warned the sinful of Judah, six

hundred years before the Christian era, that "though thou wash thee with nitre and take thee much sope, yet thine iniquity is marked before me, saith the Lord God ;" and Malachi, a minor successor in prophecy, spoke of "fuller's sope." It is probable that these were glycerin soaps, made from the ashes of plants.

Pliny, who commanded a troop of cavalry in the conquest of Gaul, recorded in the twenty-eighth book of his *Natural History* that the cleanly Germans had hard and soft soap ; he thought it was a Gallic invention originally, *rutilandis capillis,* for giving a bright hue to the hair. The acquisition of this accessory was a part of the Roman spoils of conquest. During the entire empire there were commercial laundries which made yearly contracts with noble and wealthy families to take in their wash for a pittance. Yet it was not until the Nineteenth Century that England and the United States boasted such laundries.

It is true that in 1787, during the Philadelphia convention which framed the Constitution, George Washington recorded on September 3 in his diary : "Visited a Machine at Doctr. Franklin's (called a mangle) for pressing, in place of ironing, clothes from the wash. Which machine, from the facility with which it dispatches business, is well calculated for table-cloths and such articles as have not pleats and regular foldings and would be very useful in all large families." Evidently the device did not catch the fancy of the colonists, another instance showing Benjamin Franklin to have been far ahead of his day ; and later, when washing machines operated by

crank or treadle were offered to the public, there was a prejudice against them so deepseated that salesmen tried to offset it by saying that the devices could wash the baby as well as the diaper.

California, after a fashion, led the movement to repudiate the commercial power laundry outside the home. During the gold rush of '49, hundreds of men found themselves with no facilities for washing their clothes and no women to do the work. A canny prospector built a machine turned by hand with the help of a wagon wheel, and took in laundry for gold dust payments. He did this in his cabin, so it was a crude illustration of the employment of economical power in the home. It was not economical, however, for the customers, because the charges were as extortionate as might be expected of a monopoly.

There was no such thing as a commercial laundry in the English-speaking world until 1832, when there was a disastrous epidemic of cholera in London ; to prevent its recurrence laundries were authorized where clothes could be sterilized. Charles I farmed out a monopoly of soap manufacture – which had begun in the Sixteenth Century – to a corporation in London, and got himself into hot water thereby. Afterward heavy taxes, amounting sometimes to more than one hundred per cent, were levied on this industry, dedicated to sanitation, and in 1852, the last year of the impost, the Crown derived a revenue from it of about five and one-half million dollars. Meanwhile the poor went perforce without soap.

In this country there were a few steam laundries by

1860, doing a shirt-and-collar business only. The first wash wheel, one of the early mechanical devices in this field, was patented here in 1863. Not until 1915 did commercial laundries generally begin to get other material than men's collars and shirts ; at that time they began their wet-wash service, by which the clothes were returned damp to be ironed in the home. This is the cheapest type of laundering, and curiously is well patronized by the rich, whose servants will condescend to iron but not to wash clothes and bed linen.

So rapid was the movement of the family wash into power laundries that within fifteen years we were spending with them and with dry cleaning plants about three-quarters of a billion dollars annually. Only in Chinese laundries was there much work by hand. The tendency was constantly toward mergers and corporate ownership, but the quarter of a million wage earners in these places worked long hours, under conditions frequently causing disease, and got as low wages as any known to our industries, an average of less than $15.00 a week and sometimes as low as $8.00. Frequently the plants themselves were unsanitary. As the laundries and dry cleaning shops were oftenest non-unionized and were highly competitive, they paid the price of rugged individualism not uncommon in this country — racketeering. Price wars and campaigns for patronage were accompanied by the bombing of delivery wagons, which were an important part of the capital equipment, and by the blowing up of the plants themselves.

Meanwhile a counter-movement against this disordered, unhealthful and turbulent industry was under

way. It has been estimated that about one-third of the homes wired for electricity in 1931 had electric washing machines, and we are buying gas and electric machines at the rate of considerably more than a million a year.

CHAPTER VI

SEEING, A NEW SCIENCE

Lighting affects not only our eyes but our health and emotional stability. Until within the last decade or so no competent study was devoted to these facts ; even in the knowledge of the best opticians there were wide gaps, and heart specialists did not realize that bad light might reduce the pulse rate. It is possible that a man working under severe eyestrain may exert more nervous muscular tension than a ditchdigger ; that indigestion, mental indolence, moodiness, nervous irritability and fatigue may be by-products of inadequate and improper lighting.

We still have eyes adapted to outdoor use. There, on a clear day, we get a thousand or more times as much light as in the average living room of an evening. Washington Irving, taking no account of this, wrote an essay a century ago in admiration of western plainsmen, whose day began at dawn and ended at dusk, who knew nothing of spectacles and could descry on the horizon antelopes invisible to his eastern eyes. We have begun working and reading indoors, in terms of the evolution of mankind, so recently that our vision is not yet conditioned to the values of illumination that are so prevalent with artificial lighting. Squinting along a rifle barrel on the prairies is by no means so exacting as darning socks or reading a newspaper.

In most of the places where we study, work and live,

no adequate provision has been made for that failure in adjustment. That nearly half the adults in this country require glasses is a challenging condition; only about three per cent of them have eyes which were defective at birth. Civilization has lifted countless burdens but has increased profoundly the severity of visual tasks, and human resources are being unnecessarily taxed through ignorance of the new science of seeing.

In the second decade of this century, when a million homes were being wired annually for electric lighting, Dr. Matthew Luckiesh reflected that these millions of homeowners were entitled at least to primary lessons in what light meant, what it could do, how to handle it. To him was due in large measure the founding and development of the new science of seeing. Through millions of tedious tests on subjects of normal average vision, in the lighting research laboratory of the General Electric Company, he learned about the obscure internal costs to the individual of inadequate and improper lighting. He wanted to pass this knowledge along to the people who were paying those intangible costs. It was years before this was done effectively.

About the time that Franklin D. Roosevelt entered the White House, a young woman journeyed from Cleveland. She had a kit, but she had nothing to sell. In the kit were a light meter, a reflector and certain other devices to help her determine whether houses were properly illuminated. Dr. Luckiesh had sent her.

Hardly had this lone emissary of an army, which was to number thousands, reached the scene of her work

when the Roosevelt bank holiday was declared. A drastic step had been taken to meet the emergency of a disastrous depression and there was nothing for the young woman to do but cool her heels until the banks were reopened. Then she began knocking at doors, gained the confidence of homeowners, and looked over the lighting arrangements. She might discover that a dark lampshade was absorbing one-third or more of the light from a bulb, and by inserting a white paper lining demonstrate with the light meter how appreciably illumination rose. She might discover the advantages of convenience outlets and plugs in various rooms. She might propose the alteration of portable lamps, or suggest that a diffused light would be an improvement over a glare. In any event, she was there merely as a friendly counselor, and the homeowner could take her advice or leave it, buy new fixtures or alter the old according to preference and pocketbook.

Within four years, during the depth of the depression, six million new sight-saving lamps were purchased for use in American houses. Within five years more than two thousand feminine home-lighting advisors were at work, meeting homemakers all over the United States to spread a message of enlightenment. A new profession had been created for the sex. The American homemaker had her first experience with improved lighting in accordance with the principles of the science of seeing and she found it good.

Dr. Luckiesh was free of any ambition to put dollars into the pockets of retailers or to improve the annual statements of utility corporations. He began his career

as an instructor in the State University of Iowa, and he did not cease thereafter to be a teacher. He dedicated himself, moreover, but unostentatiously, to public service. The scientist can be our most valuable public servant.

Vision, teacher, taskmaster, benefactor, subtle and complex, was the branch of public service to which Dr. Luckiesh mainly devoted his mind. "In normal times," he says, "the annual casualties due to poor seeing in the everyday peaceful activities in this country exceed the total number of casualties in the World War." Every few minutes, he reminds us, a person is accidentally killed in this country, and studies indicate that at least one-fifth of these fatalities are due to poor seeing. Spoilage in industry and other property damage from the same cause run into millions annually. If crippled eyes, due mostly to bad lighting and ignorance, were transformed into crippled legs, "what a heart-rending parade we would witness on a busy city street!"

Not only the rational faculties but the emotions of this scientist were touched. He proceeded, however, on a rational rather than an emotional basis. He invented a machine to test in his laboratory the amount of energy expended when reading under poor light, he found that under tension the heart rate was decreased, he even numbered the blinking of eyes, which increases when the eyes are weary. He made exhaustive research into the fatigue due to visual strain.

Now, most eyesight specialists had been doing good work within their limits, but they had treated what Dr. Luckiesh calls "threshold vision," without regard to the

human seeing-machine. They had corrected defects of the eye and sent the patient back into a world which was reading and working by as little light as would do, instead of adequate lighting. They had not dealt with causes. The eyes are but tools, and they had merely sharpened the tools. Many of them were distrustful and resentful when Dr. Luckiesh began telling them that seeing involved human muscles, nerves, organs, mind. They were scientifically trained but they did not enjoy the open and receptive scientific mind.

That there is an appalling prevalence of heart trouble in this country is due in part to poor lighting. When the laboratory work at Nela Park showed Dr. Luckiesh that the heart rate decreases under the tension of bad vision, many heart specialists were skeptical ; their main business was to lower blood pressure and get the heart rate down to normal, and it was difficult to interest some of them in pulses below normal. In that they were not unlike many of the opticians.

Among the architects and the interior decorators other offenders were found. The architect worked with a view to pleasing exterior lines and agreeable interiors but without regard to good residential lighting, the elements of contrast, diffusion, location and balance. He was disposed to ignore the fact that degrees of light and shade have an effect upon architectural design. As for interior decorators, Dr. Luckiesh says: "Notwithstanding the fact that the age of candles was left behind with other primitive practices of hygiene, sanitation and heating they persisted in copying fixtures from that age for the new age of electricity and its brilliant light sources."

He derided their portable lamps and central fixtures as "relics of the Renaissance ornaments." He urged them to become designers instead of mere decorators, and to see the living picture rather than a dead ensemble.

Mr. Roosevelt sent for Dr. Luckiesh to look over the executive offices in the White House, and the result was an improvement so radical that the President, who still had a soft spot in his heart for Annapolis, having been an assistant secretary of the navy, sent him thither. The visitor found that antiquated reflectors had been in use for years at the academy, and that after graduating with good grades a disturbing number of students were being disqualified for a commission because of defective eyesight. In the 1934 class of four hundred and sixty-four graduates, a little earlier, fifty-nine had failed to enter the navy because of visual defects developed after they entered the school. With the co-operation of the senior medical officer good lights were installed and this grave condition was remedied.

Dr. Luckiesh has written twenty books and nearly two hundred articles for magazines, all with a soft pencil, which makes erasures easier, on yellow paper, because it is easier on the eyes than white paper. Offhand he describes color as "a dramatic drapery," but he has written a book about it in technical terms. His *Seeing and Human Welfare* is in non-technical terms, and is intended for the layman, the first attempt to make the new science available to all.

All of us are born somewhat farsighted, but this condition is adjusted as a rule by the time we are nine years

old. After we reach maturity, the pupils of our eyes tend to grow smaller and we also start again toward far-sightedness. Nearly half the adult population of the United States needs glasses, which deal with symptoms and not with causes, and most of those who wear spectacles return to work unwitting of the conditions which caused them to go to the oculist. One-fifth of the children in our elementary schools have defective vision, an excellent topic of discussion for parent-teacher associations. Children are taught to admire Abraham Lincoln, who was so eager for knowledge that he read by a log fire, but their parents and teachers do not want them to emulate the Great Emancipator in that regard. Creditable grades depend in a measure upon good lighting, and we read in Proverbs that "the light of the eyes rejoiceth the heart ; and a good report maketh the bones fat ;" but the children cannot hope to fatten on good reports unless the light for their eyes is good. Two-fifths of our college graduates, half of our thirty-year-olds and nearly all our sixty-year-olds have defective vision.

Sir James Jeans, astronomer and physicist, has noted whimsically that a symphony orchestra playing fortissimo emits but one-tenth of the amperage of the female glow worm, which flies a green light in her abdomen to attract the male. "I often wonder," he told the British Academy of Music, "whether in one hundred or one thousand years there will be some kind of electrical device by which we will produce the energy we want, and look back upon these days as benighted." The heatless light of the dragon fly or the lightning bug, he might

have added, is more efficient by far than any that man has been able to generate.

Daylight, which is still normal to human eyesight, ranges on a clear June day from 8000 to 10,000 foot candles. These values are still around 500 foot candles on a dark cloudy day. A foot candle is to lighting what the Fahrenheit degree is to temperature, the ounce to weight, the inch to distance. It represents the amount of light thrown by a standard candle on a square foot of surface one foot away. Under a shady tree sunlight may measure but 1000 foot candles, on a porch half as much, in the house beside a window less than half of that. Fortunately, we require no such high illumination for our day-to-day diversions or duties. To read this page at least ten foot candles is recommended as a minimum, but to read the evening newspapers thirty are recommended as a minimum, and if we are interested in the stock market quotations we should have sixty. The housewife sewing with dark thread on dark goods is materially benefited by at least 100 foot candles, and even so should not prolong the task too long.

A forty-watt bulb in the ordinary reading lamp does not produce significant values of illumination throughout a room. At a distance of but one foot from the lamp, to be sure, one may get forty foot candles, at a distance of two feet only ten, and at three feet but four or five. Ordinarily we require from twenty to fifty for the closer visual tasks, depending upon how exacting the conditions and the duration of the work. To be equally visible, an object must be twice as large under one foot candle as under one hundred.

The Illuminating Engineering Society, usually abbreviated as IES, has set up fifty-four specifications covering the design of a good study and reading lamp; twenty-nine deal with the construction of the lamp, fourteen with safety, eleven with lighting effectiveness. We may be sure that an electric light tagged with those initials is worth buying. It may cost more than another not so certified, but it represents a real economy. Poor illumination is as bad as poor ventilation. Raw light and raw colors should be modified, just as raw air, too wet or too dry, should be modified. Its quality can be controlled by shading, by diffusion and by other methods.

To maintain the original efficiency of light bulbs and reflectors, they should be cleaned often. An engineer has estimated that this country wastes about $300,000,000 a year through its failure to observe this elementary form of tidiness.

Although engineers and eyesight specialists have learned and have imparted to others during recent years a vast deal about lighting, it still is true, as Sir James Jeans foresaw, that we are on the threshold of a new era and that in all probability our grandchildren, if not indeed the next generation, will marvel that a brotherhood which boasted unblushingly, as this does, of its technological achievements, was so backward in conserving its eyes. Nine-tenths of the world still relies on guesswork.

As a part of the contribution of specialists in illumination, we are blessed at last with instruments which measure light as accurately as the thermometer measures heat, or as the compass indicates direction at sea. Dr. Luck-

iesh and Frank K. Moss have devised a meter which classifies visual tasks in terms of the light required for them. This task, the pair of eyes at work and the lighting are the three factors involved. The visibility meter tells whether more light or less light is needed. It enables teachers or the school board to rate with accuracy two textbooks, for example, or two sets of charts, so far as visibility is concerned. It tells the shopkeeper what kind of merchandise can be discerned easily by a prospective customer. It helps the manager of a factory to supply the proper illumination for his workers.

Lillian M. Gilbreth noted that in one factory girls were much more fatigued when folding mourning handkerchiefs than when folding white ones, so that a rest period must be arranged when they shifted from light to dark material. Typists tired less easily when their machines were all white, so that there was no contrast between the frames and the keys. She found that paints which reflected glare, and shiny metal finishes, although they might be attractive in appearance, detracted from efficiency. "Eyestrain," she said, "is the greatest of all fatigues."

Offices, schools and factories should have their own light meters, now made in portable types to carry in the pocket. Stenographic work, as the tests show, necessitates at least twenty foot candles ; dental work, thirty to fifty ; studying lessons, twenty ; machine work, fifty.

Engineers of the Illuminating Engineering Society have created specifications for floor and table lamps that provide good lighting, in forms agreeable to look at as well as to see by, and millions have been sold to Ameri-

can householders. Bulbs are provided in many sizes and shapes. The pear-shaped bulb with which most of us are familiar may range from fifteen to one hundred watts, and there are special lamps in somewhat that shape which range from one hundred and fifty to fifteen hundred watts. There are double-end lamps, from twelve to eighteen inches long, ranging from thirty to sixty watts and round bulbs usually of smaller power. They may be obtained in clear glass, plain or colored, or the inside may be frosted. A single lamp, it has been found, is more efficient than two whose combined wattage is the same.

One may balance light as skillfully as pieces of furniture. For guidance the Residential Lighting Committee of the Illuminating Engineering Society has established the present minimum recommendations.

Operation or Location	*Foot candles*
Reading —	
Ordinary type	10–20
Prolonged, with fine type	20–50
Sewing —	
Ordinary, on light goods	10–20
Prolonged, on light goods	20–50
Prolonged average sewing	50–100
Fine needle work, dark goods	100 or more
Writing	10–20
Card playing	5–10
Children's study table	20–50
Dining room, when used for reading and writing	10–20
Kitchen —	
General	5–10
Work counters, sink	10–20

Bedroom —	
General	2–5
Bed light	10–20
Dresser, vanity and table mirrors	10–30
Sewing machine	10–30
Bathroom mirror	10–30
Children's playroom —	
General	5–10
Local	10–20
Work bench	10–30
Laundry tubs, ironing machine or board	10–20
Stairways	2–5

In two admirable pamphlets issued by Purdue University under the general heading of *Better Homes in America* — Nos. 29 and 30 — the matters of electrical installation and good lighting receive expert attention. (Since virtually all the household lighting in the United States is done by electricity, even on outlying farms, it seems hardly worth while here to deal with petroleum and gas.) Research at Purdue has demonstrated the percentage of light reflection from various surfaces, ranging from ninety or ninety-five from white plaster down to five or ten per cent from walls painted walnut. Olive green reflects but twelve or fifteen per cent while a pale green reflects from forty to forty-five.

For stairways, the painstaking faculty at Purdue finds, there should be three-way switches at top and bottom, and halls should have one or more outlets, depending upon their length, with convenience outlets for table lamps and vacuum cleaners. In the living room one or more ceiling outlets are desirable for general illumination, controlled either by a single switch or a pair of

three-way switches. Convenience outlets are recommended for radio, table, piano and floor lamps, the vacuum cleaner, portable lamps, air conditioning. Thus in detail the comfortable equipment is described throughout the house. Extension cords, switches and plugs of good quality are recommended as a matter of safety and economy.

Utilities supplying light and power sometimes have been little less careful and thoroughgoing than schools of domestic economy in supplying to the housewife information about lighting and convenience outlets. One of them, for example, offers a chart giving the number of outlets advisable for each part of the house, but warns that some of the figures denote a minimum, and that additional sockets may be found advantageous. This is a good illustration of salesmanship through moderation, even understatement.

According to this table there should be one ceiling outlet in the entrance to the house, or two wall outlets; the stairs should have two, the halls one or more, the living room, den, library, reception room, bedchambers and recreation room a ceiling outlet or wall bracket as a minimum, the kitchen a light for each working area. For closets it advises an automatic door switch. Convenience outlets are separately tabulated. The basement, attic and garage are not neglected.

Few householders are likely to neglect to light the garage, but some may neglect to provide a convenience outlet for an automatic tool, even if it remains to be procured in the future. Few will overlook the need for a light at exterior entrances, but some may neglect weather-

proof convenience outlets at terraces and in the gardens. Even the cords can be obtained in waterproof materials, so that there is no danger of a short-circuit during a rain. Wiring may be underground, out of reach of the spade. Floodlighting the walks and gardens may prove a summer boon to the man just returning from the office or shop.

A floodlight with a one hundred-watt lamp will take care of a small garden. Experiments with colored globes have not been as satisfactory as uncolored light, and so clear lights are in favor. Enthusiasts illuminate their trees and hedges, pools and fountains, and the rock gardens unknown to their grandparents, with reflectors and small silhouette shields.

Every homeowner should safeguard against the false economy of buying small-gage equipment to do duty heavier than it was meant to undertake. A small wire doing the job intended for a strand of slightly larger diameter burns up current getting hot, and may become a menace. It may blow out a fuse, too.

In few cases is the glare of unaltered, direct light encouraged. Indirect lighting from wall fixtures and stands which throw their rays first to the ceiling is gaining in popularity. As for diffusion, on approved lamps it is provided by a globe or unit of glass or of a translucent plastic material. Plastic materials are somewhat cheaper, but glass can be utilized with higher wattage. Lamps with open tops are favored since the upward light aids in providing general lighting.

A recent development to avoid glare is the use of

polarized light. All illumination, whether artificial or from the sun, moon or stars, contains polarized rays ; but to utilize them one must filter out the rays which produce glare. Until a material was compounded of quinin and iodin crystals not enough light remained, after the filtering, for reading and working. The new material, which is as clear as glass, can be obtained in sheets large enough for the biggest searchlights. It can when properly used eliminate the shiny effects from glazed paper. The glaze itself is innocent ; the glare is due to the kind of rays which fall upon it. By reducing these to polarized light the print on glazed paper emerges in sharper detail and, if it is in color, in richer hues.

From the first it was perceived that if the incandescent bulb contained air, the oxygen would vaporize and "burn" the tungsten filament. At first an effort was made to create a vacuum within the bulb, and the glass sometimes collapsed under the outer pressure with startling if not with injurious effects. To prevent this the interior was filled with nitrogen, a gas nearly inert ; but it was found that if a small amount of argon, a much rarer gas, were introduced with the nitrogen, the efficiency would be increased. For nearly half a century this was the practice.

An improvement on the nitrogen-argon bulb came, not from the research laboratories in this country but from France. André-Nicholas Claude of Nanterre obtained a patent here to substitute xenon and krypton for those gases, and thereby to reduce still further the "burning" of the filament, in addition to increasing the efficiency by some forty per cent.

Xenon and krypton are called rare gases because they exist in minute quantities, although they are present wherever we breathe air. Krypton is one one-millionth of the atmosphere, and xenon is but five one-hundred-thousandths of one per cent. The use of these gases had been suggested but had been thrown aside because of the cost of procuring them. With krypton alone an increase in efficiency of thirty per cent could be obtained, with xenon an increase of fifty; combined, the theory was that the increase would be forty per cent, when there was one part of xenon to nine of krypton. By an ingenious liquefying process the French scientist was enabled to "mine" them from the air at reasonable cost, and so proposed another revolutionary improvement.

In this country about the same time fluorescent lamps were invented which afforded an approach to natural daylight, with one hundred and twenty times as much illumination, under favorable conditions, as could be obtained from current in the old types. These lamps, moreover, produce pastel tints, and radiate less heat. They are tubes coated inside with certain fluorescent powders, which, when bombarded by the ultra-violet rays from the arc operating inside the bulb, act as transformers and produce cool, colored lights. The powders differ, of course, to produce different tints. In addition to the daylight lamp white light, gold, red, blue, pink and green lights have been produced also, primarily with a view to decorating theaters, bars, show cases and advertising signs.

In addition to an invention which ingeniously pre-

vents electric fuses from blowing out, there is now obtainable a fuse which uses mercury as the contact element; if it blows out, it can be renewed simply by shaking it. And to economize in the use of current we now have lamps which can be dimmed for use in the nursery, in dark halls or in the sickroom. The regulation is by pulling a chain; any socket or bulb may be used. Soffit lights are enclosed in metal boxes built into the wall, often with reflectors of silvered glass, to increase the attractiveness of entrances, window seats, or fireplaces.

"Light is sown for the righteous," sang the Psalmist; and Job noted gloomily that "from the wicked their light is withholden." The Old Testament identification of light with virtue and the absence of light with evil has its merit to this day, but wickedness may take the form of a willful ignorance of the giant strides which have been made within the last few years in our control and use of illumination.

That these strides have been belated is a commentary upon the backwardness of humankind. Man has known about electricity for almost three thousand years. Thales of Miletus, one of the seven wise men of Greece, a philosopher, astronomer and geometer, recorded six centuries before the Christian era that the ancients had known how amber, when rubbed, would attract or repel light bodies; and Theophrastus, a disciple of Aristotle, noted the same thing. Our word "electricity" is derived from the Greek word for amber.

Pliny the Elder, a Roman naturalist and a martyr to

research, who perished trying to observe more closely an eruption of Vesuvius, wrote that the electric eel, when touched with a spear, paralyzed the muscles and "arrests the feet, however swift." By its shocks a freedman of Tiberius was cured of gout ; two thousand years ago the Romans anticipated the electric vibrator common to our homes.

Experiments at the New York Aquarium have revealed that the electric eel has known all along the principles of Ohm's law, relating to voltages and current, although man did not discover the law until the middle of the last century. This queer creature has the uncanny power of paralyzing others at a distance ; that is, it can induce an electrical anesthesia, and maintain it at will. But its victims, when it does not care to eat them and releases them, appear to suffer no ill effect. Scientists who noted this thought it might be the clue to a new anesthetic, superior to the drugs in use.

How does the eel generate electricity strong enough to kill a horse fording a river ? About all we can say is that it has membranous tissues of different electric potentials, arranged like the cells in a battery, and that the currents it generates are not unlike the currents in the human nervous system.

For centuries and centuries man was content to observe the singular effect of rubbing, on amber and kindred substances. He did indeed reflect quite early that the spark and crackling sound from amber were like thunder and lightning, but he did not try to find out whether a kite in a storm might produce a shock like an electric eel. The effect of atmospheric conditions on

the production of electricity was not observed until the middle of the Sixteenth Century, and the possibility of electric light was noted about the same time. But the study was still a matter of theory and experiment.

Not until near the turn of the last century did man begin to make diverse practical application of what he had been learning for nearly two and one-half millenniums. It was seen, indeed, as early as 1873, that electric power might be transmitted, but it was not until six years later that twelve carbon arc lamps were erected in the public square in Cleveland. Edison built in 1882 the first central power station, from which electricity for lighting was supplied to twelve blocks in New York City, although he had introduced his incandescent lamp two years earlier. Not until 1890 did electric irons come into use, not until three years later cooking appliances, such as the coffee percolator, toaster and frying pan.

After nearly three thousand years of observation and speculation man knows nothing about the real nature of electricity. During the last two generations he has learned a great deal about how to produce it, how to control it and how to utilize it for his comfort, convenience and advancement. Compared with his rate of progress, the tortoise is a Man o' War.

Even as late as 1890 the electrical industry in the United States boasted but one hundred and forty-six thousand customers. Today nearly every householder is on its list. At that earlier date the capacity of all the plants was about three hundred thousand kilowatts ; now

more kilowatts are generated than there are houses to supply. The fact is that our houses, to our shame, are inadequately planned and equipped for it. Yet this sort of planning promises rich returns in future satisfactions and pleasures. Here is an invisible energy ready to our hand, eager to serve and obey. It can do more than minister to our comfort and avert muscular effort; it can even relieve our surroundings of ugliness, which is a cause of eyestrain, fatigue and revulsion. It heightens our mental activity, and sharpens our physical responses so that we work better and dance better. It contributes substantially to the gaiety of the family, the community and the nation.

CHAPTER VII

MR. HANDY MAN

Berea is a town in Madison County, Kentucky, seat of a small college which bears its name. The institution is unusual in that it undertakes to make handy men of its students. There, in a room built as part of the training, the young men learn the manual arts of driving nails, sawing wood to a line, using a monkey wrench, pliers or a plane, and repairing electric fixtures. At odd hours, between classes in the academic courses, these fellows are equipped to invest with a new dignity an old and discredited phrase, Jack-of-all-trades.

In that region, many men still kill their own meat and smoke it, chop wood, hoe corn and guide mule-drawn plows. They wear, in some instances, homespun clothes. From childhood they are trained in the use of their hands for purposes other than eating, dressing, motoring, shaving and writing, that is, for purposes rapidly becoming obsolescent in urban communities. Henry Fairfield Osborn, one of our more eminent scientists, warned his fellows years ago not to be overproud of their intellects. They should never forget, he reminded them, that man had made himself master of the earth with his hands, and that the development of brain power was quite secondary.

Those Kentuckians respect their hands. At Berea they take an extension course in what began at home. They learn how to mix and spread concrete, lay bricks

and install plumbing, activities usually beyond the scope of city-bred men, but all of us might profit from the commoner things they learn. We achieve the use of hammer and saw, if at all, by a process of trial and error. An error, likely as not, may mean a mashed thumb or a botched piece of timber; but it need not mean using a good screw driver as a crowbar, nor trying to plane the heads off nails, nor chipping the blade of a tempered chisel. We can treat our tools, if we are lucky enough to have them, with as much consideration at least as we treat a fountain pen or a pipe. And whether one of us happens to be the head of the house or its elder son, he can prove himself in hard times a pillar of strength and in good times a joy to the hearts of those around him.

Perhaps we are not ambitious to shine as handy men because tinkering has come somewhat into disrepute. It is commonly supposed to indicate an offhand readiness to do small jobs after a makeshift fashion. This is because we have allowed the word tinkering to keep slovenly and shiftless company. Yet the man who has the will and can take the time to tinker ingeniously around the house will discover that the art is a mantle to cover a thousand shortcomings. Nearly anything can be forgiven in a good handy man.

A kit of tools, moreover, can be a delight while it is paying for itself many times over. Plato spoke of man as a tool-using animal; the fact is that man began using tools before he learned to make them. The old puzzle of the hen and the egg does not apply here, for it is clear that tools could not be fashioned until there were tools to work with. Natural objects, such as stones and flints

which happened to be shaped favorably for use as wedges and cutters, may have been used first. Wherever traces have been found of the Stone Age, there have been hammers, chisels, planers, awls, knives, scrapers, axes and so on. Probably the first combination tool was a stone with a sharp point for boring and edges for cutting ; this is at least five thousand years old. It may have been centuries before the lever, the angle and the plumb were devised, but centuries are brevities in the history of this earth, which is roughly three billion years old.

To the use of tools, as Plato perceived, the race owes its protection against the hostile forces of nature and its advance into civilization. Tools have an honorable and a distinguished past, an important present. No able-bodied man should strut or swagger who doesn't know how to sandpaper a bureau drawer when it sticks, replace a broken window pane or build a set of bookshelves.

For about fifty dollars any man can equip himself to become a doubly welcome member of the household. If he has the gumption to build his own workbench in the garage, the laundry or the cellar, it will cost a good deal less, even with first-rate tools. He should have at least one vise, a brace and bits, chisels, saws for wood and metal, a square, screw drivers, pliers, wrenches, drills and a businesslike hatchet. He should know enough to feel the heft of a hammer when he buys it and to look a gift saw in the teeth. He will need sets of nails, brads and tacks and screws ; a tape measure and a rule, a glue pot and brush ; a roll of friction tape, a few electric fuses

and a few feet of cord ; some washers to use in case of leaky faucets.

Tape, fuses and cord need not indicate that the man of the house means to pose as an electrical engineer. In nearly two centuries, since Ben Franklin drew lightning from the clouds with a kite, we have been unable to learn the nature of the electric current or its elemental constitution, and the engineer is as ignorant in that regard as the man in the street. We know how to generate this mysterious energy, guide it into certain directions, measure it and make it do the work of billions of slaves. We suspect that it does part of the work of our thinking, if not all of it, for there are electrical discharges in the brain, but how that electricity is generated we do not know, and the man of the house, praise be, need not bother his brain with trying to explain it. About all he needs to know is that there are good conductors and non-conductors ; there are alternating and direct currents ; there is a meter in the cellar which he should learn to read ; there are appliances at hand, such as the range, toaster and iron, which consume more power than motor driven equipment like the vacuum cleaner and the dish washer ; and there is a fuse panel which may sometimes require attention.

If a fuse "blows out" because of a short circuit somewhere in the house, caused perhaps by wetting a cord or by loose wiring in a fixture, it can be replaced without sending for an expert ; and to splice a cord or attach a new appliance is not a recondite matter. The utility concern which supplies his power will be glad to in-

struct him, if need be, in such fundamentals as avoiding the bending, twisting or wetting of cords, and trying to make a lamp cord do heavy duty for a kitchen appliance.

Mr. Handy Man need not learn, as students at Berea do, how to install a bath ; but he can become proficient quite easily in small chores which will avert a call on the plumber, who charges for his time from the moment he leaves his shop until he gets back, and sometimes forgets his tools, so that he can charge up a double trip. To repair that leaky faucet, for example, is a simple matter as a rule. Mr. Handy Man should shut off the water, to avoid a flood, drain the water in the pipe, use a monkey wrench on the faucet screw, lift off the handle and replace the worn leather or rubber washer on the stem with another like it. Then the faucet handle can be replaced, the screw tightened, and the job is done.

Let us suppose that the drain and trap beneath the kitchen sink have become clogged, say through the hardening of grease. Sometimes this can be flushed out with potash — *not* caustic soda — in hot water ; but if it proves obdurate there is a rubber suction pump, procurable at many chain stores, which breaks up the mass below and permits hot water to drain through. It may be utilized also to clear the traps beneath laundry tubs and wash basins. But if there is some obstruction which does not yield to these measures, then nearly any water trap, excepting the old-fashioned, can be emptied. At the bottom of the "U" pipe there is a screw cap which can be removed, so that the contents will flow into a container underneath. For an old-fashioned trap it may be necessary to call the plumber, who will use a force pump

on it ; and of course if there is a broken pipe or other organic disorder in the system, his services will be required.

Exposed pipes may freeze in winter, and if they do not burst should be thawed promptly, with an electric heating pad, bags of hot salt, a candle or wet hot cloths. The plumber would use a blow torch, but this is seldom necessary. If the pipe lies beneath a tiled floor in the bath, it is just too bad, for this is beyond the powers of Mr. Handy Man.

It is a man's job, rather than the housewife's, to look after the oiling and maintenance of the automatic equipment, nor need he be a mechanical engineer to do this. Sad to relate, many women are neglectful about oiling their appliances when this is necessary — many appliances are sealed in lubricants and need no such attention — and others do not know the difference between a drop and a squirt. A vacuum cleaner may refuse to function for no more serious reason than that it is clogged with dirt, and needs to be shaken out.

Those are some of the chores around the house which promise not much greater satisfaction than the sense of a job well done and effort well applied to the maintenance of the budget. There has arisen a busybody, in the person of a vocational expert, Dr. Robert Hoppock, who vows that men should do the cooking, wash the clothes and clean the house, because these involve heavier physical labor than women should undertake. He told the National Federation of Business and Professional Women's Clubs that there was "no sound psychological reason" why women should do these things, and that

their flight from the home into jobs was to enable them to delegate their domestic duties to servants. He proposed that Mr. Handy Man be Mr. Housewife also.

Now, there may be a sound psychological background in the fact that man has been the hunter, the provider of food and shelter and the warrior for the family, while the tasks requiring less physical stamina, courage and strength have fallen to the woman ; and it is fruitless to say that if the system and efficiency applied by the male to his business were available in the home things would run more smoothly, for the management of a home requires high executive ability and there are domestic engineers who have reduced to a minimum the movements in the kitchen. But, without undertaking culinary or other functions, the man of the house can make himself a jewel of usefulness.

Other activities with the hammer and saw offer greater pleasure, usefulness and profit than trying to learn how to time a meal and operate a vacuum cleaner. To make a knife rack for the kitchen requires ingenuity and may provide a lot of fun. The thing can be bought for a small outlay, but its purchase can give no such enjoyment. It has been estimated that the average housewife uses a knife for some purpose or other 129 times daily ; and if, instead of fumbling in a drawer, she can select the kind of tool she needs readily from an open rack it is a distinct advantage. A rack for pots and pans is just as convenient, provided a place can be found for it. If the laundry is done with machinery at home, as it should be, then Mr. Handy Man can have some fun making bins for the wash clothes, and put casters on

them so they can be rolled about. He can put casters, for that matter, on a small table, and win a benediction.

Lighting and plumbing, obviously, are for the comfort and convenience of the whole family, and it is as much the man's job to look after them as the woman's; but there has been so much emphasis in publicity and conversation on the miracles which have been wrought to lift the burden of the home from feminine shoulders that the male appears to be the forgotten man. This is far from true. He may have an electric razor, sun lamp, automatic lawn mower or hedge clipper, even a machine, if he is baldish, to stimulate the growth of his hair. Best of all, he may have an automatic furnace, whether his fuel be coal, oil, gas or electricity.

Unmistakably, tending the furnace is a masculine duty; and there can be no ground for disputing that many a man, after wrestling with a shaker and shovel and the ash can, sets out for his office afoot or in his car or by the seven-eighteen in a quite different frame of mind from the man who has an automatic stoker, or a mechanical oil, gas or electric furnace regulated from the living room. Stokers make possible the use of a cheaper grade of coal, but they do necessitate the cleaning out of clinkers three or four times a week, and refilling the coal bin once in every so often. The man of the house may lose his morning and evening job at the furnace and be the richer, not only in a new cheerfulness and animation but in his purse.

Studies have been made of the comparative costs of coal and other fuels. Taking into account the hired labor to clean the furnace and chimney, ash disposal, re-

pairs, the injury to house furnishings from dust and ashes, and other "hidden" costs, these inquiries tend to show that coal is our most expensive fuel. The mining and distribution of coal is assuredly our most backward major industry, excepting possibly farming. It need not surprise us that we must pay a high price for the product. On the other hand, the production of gas, oil and electricity for heating represent today American business functioning at a high efficiency, and we may rightly expect economies in these fields. Even bigger returns are promised in the intangible harvest we reap from escaping that battle with the demon in the basement.

After vanquishing that demon, the man of the house faces another morning chore in shaving. Nowadays any one of several electric razors will shave him dry and shave him close. Thus he may save the time formerly devoted to lathering, changing blades, slapping lotion onto his face and dabbing a styptic pencil at small cuts.

An electric razor is a fair example of a machine which is an elaboration of a tool. Commonly it has been said, and I confess to have fallen into the error, that all machines are combinations or complications of tools, but locomotives and dynamos cannot be so classified. The motor which operates the kitchen refrigerator, if it is of that type, does not fall into the category of tools; nor does the crane, which is one of the older forms of the machine. The tool deals with material and to some extent alters or transforms it; the machine makes available other than muscular power.

We live in an era distinguished by power other than muscular. Ours is the Machine Age. No one has com-

plained that in the modernized home woman has too few burdens to bear, but there have been frequent protests that man has grown soft because he no longer depends on his personal heft for security and a livelihood. No longer, for example, is he compelled to fetch water from wells or springs, or provide illumination against the coming of nightfall. He can still, however, stretch his muscles in a daily dozen exercises, at badminton or golf, and he is healthier than ever before in his history. If he no longer heaves coal he has won his reprieve.

For it is the male who has done the lion's share of the laboratory work which made possible the myriad modern devices to lift the labor load in the home. It was he who devised food containers which would not corrode, he who took the lead in sanitary precautions, he who gave us Vitamin C as a synthetic chemical, he who taught us to electrocute household insect pests, he who fashioned heat-proof ovenware, he who has found the best water-softeners and kitchen soaps. Rightfully he is the senior and the major partner in the family firm. Nothing is more natural than that he should express his partnership by becoming an invaluable handy man.

CHAPTER VIII

ARTERIES IN THE HOUSE

Agnes Repplier, one of the American commissioners to the international exposition in Seville in 1928, reported that King Alphonso, resplendent in uniform, opened the American exhibition. "The rooms from which he refused to be driven," she observed, "were the kitchen, the cellar, the bathrooms and the toilets. Never had I dreamed that plumbing, good up-to-date but ordinary American plumbing, could be so interesting to anyone but a plumber. For three quarters of an hour his majesty asked rational questions, and for three quarters of an hour anybody who knew anything was called upon to answer him."

To surprise a touch of naïveté in the most erudite and discerning essayist of her day was a bit disconcerting. Miss Repplier should have known that American plumbing, and probably the furnace in the cellar, too, could not fail to fascinate a European potentate; in that mechanically backward land both must be the object of curiosity, the more rational the deeper.

Just as running water is the greatest labor-saving improvement in any house, so adequate plumbing and heating doubtless are the greatest contribution to good living on the physical plane. The rooms from which the Spanish ruler refused to be driven were the rooms needing heating as well as hot and cold running water. In the

loveliest of cities, old Madrid and fabled Seville, running water in the house was a rarity.

In this country, houses without plumbing and heat might be compared with Pittsburgh's elegant new post-office, built without a letter drop. They might even be compared with a human body lacking an arterial system, for we cannot live without water, warmth and ventilation. A human body weighing one hundred and forty pounds contains about ten gallons of water, and cold is a frequent simile of death. But we are a pampered people, and pay less attention to these matters than they deserve.

They merit attention if for no other reason than because the cost of installing plumbing and heating in the average house is about one-fifth its total cost. A good plumbing system is estimated at one-tenth, and it is no place for the practice of economy, because inadequate piping and poor fixtures entail an aftermath of expensive replacements and repairs. Strangers and prospective purchasers, too, rate them more contemptuously than bad finger nails. The United States Department of Commerce has recommended a maximum expenditure for the heating plant of one-tenth of the total, with elaborate calculations of cubic footage to be warmed, the probable heat loss if insulated or uninsulated, and so on, but without regard to air conditioning. The figure is largely dependent, of course, upon climatic conditions.

A famous industrial executive, whose interests do not extend to heating and plumbing, has said that housekeeping is the greatest American industry. Until this century it was one of our most backward industries, com-

parable to farming and textile mills. It is a group enterprise, touching the life of every unit of the population of whatever age, and undoubtedly it involves a bigger financial turnover by far than any other industry. That its importance has been so late coming into recognition was due in part to the fact that the homemaker worked without stated salary or wage. In part it was due to the fact that it was she who occupied the house or apartment more than the others, and was slow to demand her rights in heating and plumbing, which are primary necessaries. So she continued to get hot water from a teakettle or a pail.

In any enlightened view, to waste energy is criminal. Industrialists have employed the engineer and the psychologist to do teamwork in making tasks more interesting and less tiring. Nowadays it is beginning to be perceived that homemaking is interesting and should not be fatiguing. Katharine Fisher of the Good Housekeeping Institute declares that the dustbin is the only prosaic thing about housekeeping, but most of us will agree that the ash can is far from romantic and that no Cinderella wants to carry out the slops.

Those about to build houses can have heating and plumbing fixtures to accord with a pre-arranged color scheme. Those who rent can see to it that their quarters are satisfactory in that regard or can ask the landlord to meet reasonable demands. Those already established can do wonders with varnish or lacquer or by replacements. Humble as are the uses of the plumbing system, it can be made an adornment in favorable cir-

cumstances. Even the lowly furnace may assume a presence almost regal.

It should give any family a strong sense of aggrandizement to have a heating system "with battleship steel boiler, sapphire jeweled burner and tankless hot water supply, all combined in a single, handsome cabinet." It should contribute to the well-being of the whole group to enjoy a twenty-four-hour system which "needs no attention, makes no dust or muss, noiseless, no odors, no breakdowns, no increase in fuel cost, no servicing, no fuel storage, no depreciation, no worry." These are excerpts from advertisements of two types of furnace. To keep the house comfortable we may use hot air, hot water or steam; for fuel, coal, kerosene, gas or electricity. It has been established that the automatic furnace involves less expense for fuel than the old-fashioned, hand-stoked heater, a trial by day and often a traitor by night.

To heat the house costs "the price of a pack of cigarettes a day," one manufacturer assures us. In addition to the automatic refrigerator and range in the kitchen we may as well have automatic furnaces and water heaters. At the Massachusetts Institute of Technology tests have been made which show that for a family of five in an average six-room house but $2.53 a month was spent in heating water with gas, whereas with coal at $10.00 a ton the cost was $3.36. In communities where electric rates were reasonable similar results have been demonstrated. But rates are fluctuating rapidly, almost invariably downward, so that comparisons are ephemeral. As a rule three-fourths of the cost of artificial gas to the

consumer goes into distribution, only about one-fifth in actual manufacture. Its more general use is reducing the cost, and the more general use of electricity has the same salutary effect.

Water heaters can be procured in sizes ranging from one-gallon capacity to 140 gallons; and they are so thoroughly insulated that the heat stays in the tank. For dishwashing, laundry, bathing and shaving these heaters are well-nigh indispensable, and the temperature may be maintained at any desired height from 130 degrees to 190. Water is cold at 50 degrees, lukewarm at 85, very hot, perhaps too hot, at 190 degrees. From a good tank it issues as pure and sparkling as from the cold water faucet.

Faucets may be of brass, copper, nickel or chromium, and we have the combination type, which mixes hot with cold water. At chain stores one may buy movable nozzles, with tiny levers to cause a spray when it is needed. There is a great variety of sinks, filters, drains and drainboards, basins and washtubs.

In ten years the cost of bathtubs decreased by half. It was as well, because many families of three or four were demanding two bathtubs where before they had been content to worry along with one. Whether or not there is provision for showers, sitz and foot baths, the tub remains the cynosure. Like the handbasin and toilet, it may be of marble, vitrified china, porcelain or enamel ware, but china and porcelain are preferred because they are impervious to cleaning agents and acids. None of these materials, sad to relate, is impervious to

stains, cracking, crazing or chipping, and we can only hope that in time the technologist will make them so.

Whether a furnace or hot water heater is needed, it can be purchased on time payments, covering periods of five years or more, if need be. The Department of Commerce at Washington has found that nine-tenths of all heating and plumbing appliances are sold on a credit basis, and that installment sales increased more rapidly than cash sales. The average account, according to this survey, was cleared in seven months.

Prior to the collapse of 1929, Professor E. R. A. Seligman and other "classical" economists assured the public that installment buying was a benison, and that this country had entered upon a new era of prosperity in which overproduction was impossible. The sad years which followed the collapse did not appear to shake public confidence in that contention, for in 1934 and thereafter time sales increased at the rate of a billion dollars annually. Homeowners continued to mortgage their future incomes, without regard to unpredictable demands on account of disease or other disasters. Many of them were enabled thus to provide for their families comforts which would have been out of their reach otherwise, and for them, when they were able to meet their commitments satisfactorily, installment sales were indeed a benison ; but millions lamented the competitive urge which drove the manufacturer and his salesman to overestimate their paying capacity.

Heating and plumbing were not alone in the install-

ment field, of course, and doubtless the lamentations were louder when the income had been mortgaged for improvements less necessary than these, or even for dispensable gadgets. Not only comfort but health is dependent upon warmth in winter and sanitary plumbing. Supplies of water and the disposal of organic and inorganic wastes were comparatively simple in primitive societies, but with the enormous growth of population which the Machine Age made possible, and with the tendency toward more congested centers of residence and work the problem became acute. In urban communities we are prone to accept the solution of these difficulties as a matter of course, and to consider a reliable water supply as well as the sanitary disposal of garbage commonplace rights. They are by no means matter of fact nor commonplace. Every citizen owes it to himself to exercise caution about them.

Those who build houses might well think the water supply and the sewage system available for the site vastly more important than the quality of the neighborhood or the outlook from the front porch. The contract with the plumber, provided the site is acceptable, should safeguard against an invasion of the local building code, and the contract for heating, too, should guarantee satisfactory temperatures even in a blizzard.

Manufacturers of plumbing fixtures co-operated in 1926 with the United States Bureau of Standards to set up a code for the output of the industry, specifying dimensions and providing that imperfect pieces should be marked.

Even the cellarless house, which is not rare, may have its furnace and its water heater. As a rule this means an additional room on the first floor, which must have space for pipes and ducts, as well as for the heating plant, tanks and laundry tubs. It might well be regarded as a general-utility room to store garden tools, buckets, and toys to be used outdoors. "Arguments for and against the basement are valid," says a bulletin issued by Purdue University dealing with small houses. "Personal preferences, the site, the plan of the house in general influence this question." The economies in excavation, foundation walls, waterproofing and a stairway are noted ; there is a saving, too, in human energy. Against these there are the considerations of an increased outlay for ground floor area to include the utility room and storage space, and the cost of protecting the first floor against damp. More economical plumbing arrangements are often possible in a basement, and the space there may be made to include a playroom for children.

In spite of the carefree atmosphere thrown around advertisements of plumbing and heating, whether for the cellarless house or one with a basement, it remains true that soft water corrodes pipes of wrought iron and steel, and may cause poisoning when lead pipes are used. Hard water deposits minerals in the pipes and tends to clog them. Brass pipes, which are less susceptible to corrosion and clogging, are more expensive. As to the automatic furnace, although it may not cause dirt and dust in the house, still it is subject to rust. The fire box, boiler and pipes may accumulate soot, which contains

an acid that "burns" them. Soot even one-eighth of an inch thick reduces heating efficiency by more than one-quarter. Dirty chimneys, moreover, cause about nine-tenths of our fires.

In those houses which boast an open fireplace, the chimney should be kept clear, and the andirons waxed before they are stored for the summer. The apparatus of good living demands attention, frequent cleaning and occasional inspection, whether one lives in a three-room flat or a mansion.

Bathing in the Ganges and the Nile was a common practice in the East, according to ancient records. The oldest bathtub was "so old that Helen of Troy may have bathed in it," according to Wilfrid J. Funk's *So You Think It's New,* and was "a photographic reproduction of one of our own." Much doubt has arisen about the existence of Helen, and about the whole boy-meet-girl story in the *Iliad;* but at any rate Homer tells us that warm baths were refreshing when one was fatigued. The Lacedaemonians appear to have invented the bath of hot air ; both Greeks and Romans recognized the virtues of sun bathing.

The ancients, indeed, seem to have had plumbing much more on their mind than heating, which was less important in the sub-tropic regions whence our historic fragments are derived. Alexander the Great vastly admired the luxurious baths of Darius. Maecenas, patron of the arts and counselor to an emperor, built public baths in Rome at his own expense. It remained for Agrippa, before the Christian era, to establish his own Public Works

Administration by lavishing the public revenues on enormous buildings which contained suites of baths; and his example was followed by Nero and half a dozen despotic successors.

Some of those baths were adorned with beautiful marble and statuary. They became centers of amusement and even of license. Early Christians condemned them for that reason, but admitted that bathing for cleanliness and health was permissible. This may be the basis of our adage that cleanliness is next to godliness; perhaps the motto sprang up later, when returning Crusaders contributed largely to the spread of baths in European cities. In England they made slow headway; sometimes they were called hothouses, even bagnios.

We associate the steam boiler with Fulton's steamboat and the locomotive, but it has a bearing no less important on efficient plumbing and heating in the house; and if we give credit to James Watt as its originator we are mistaken. Miriam Beard tells us, in *A History of the Business Man*, that while Germany did not join England, France, Holland and America in the scramble for mechanical improvements and for markets during the eighteenth century, speculation and philosophy were uppermost there. "Where the economic imperative was lacking, the categorical imperative might be discussed." Thus Britain thought she ruled the waves, but it was Leonhard Euler, a Swiss, who perfected tables showing the influence of the moon over the tides; and Germany encouraged Denis Papin, a Frenchman, whose invention of the steam boiler long before Watt was born went almost unnoticed, and who died in abject poverty. Pa-

pin's contributions to future domestic conveniences included also the air pump, in which he collaborated with Huygens. Papin died in 1712, so that the suction pump wherewith the man of the house clears a choked pipe goes back a long way. Papin invented also the condensing pump, the safety valve and the siphon; more, he constructed an engine to raise water from a river by pumps, operated by a water wheel. Without such devices we could not have modern heating and plumbing.

In colonial North America plumbing was in disrepute. Streams and ponds were considered good enough for anybody to bathe in. Virginia sought to discourage bathtubs by imposing a tax of thirty dollars — a large sum in those days — on each of them; but then the Old Dominion, which was to produce our most radical political thinkers during and after the Revolution, was a citadel of conservatism in its earlier days. Governor Berkeley thanked God in 1670 that "there are no free schools, nor printing, for learning has brought disobedience and heresy into the world, and printing has divulged them." Even a century ago learning and bathing were suspect in Cincinnati. When a rich man there had a tub built into his house the doctors and politicians, who read about it in the public prints through which such heresies were divulged, denounced the mogul and his tub. It was not until 1871 that a manufacturer in this country mustered up courage to turn out sanitary plumbing appliances.

Nor were our forefathers much more advanced in heating their houses, however their fireplaces may have roared. Abigail Adams wailed when she moved into

the unfinished White House in November, 1800, toward the close of the second president's only term: "There are twelve fires to keep. We have a cord and a half of wood, with none for sale, and the grates are not fixed for coal." The reason there was no wood for sale was that, although George Washington had recommended this site for the nation's new capital chiefly on account of its handsome wooded hills, the owners of the land had denuded it of all standing timber before passing title to the government.

"The house will require thirty servants," groaned the First Lady, "but there is not a single bell in the place." There was no fencing around it. "The great audience room I make a drying room for clothes."

During the War of 1812 the British burned that White House, still uncompleted.

Man has been even slower to learn about plumbing and pure water than about effective heating. During the London epidemic of 1854 a young medical graduate, John Snow, suspected that the germ of the disease was being carried in drinking water, and traced the infection to a Broad street pump. He tore the handle from the pump to prevent its further use, and the epidemic began to abate. Even so, it was a long time before we learned to take proper precautions against polluted drinking water, and even now we occasionally purify our reservoirs with chemicals which are injurious to the stomach. Science is provokingly slow sometimes.

London was quite as perverse about the use of gas for heating and lighting as about good drinking water. It was argued that gas would supplant whale oil and de-

stroy the whaling industry. Since Britain drew from whalers many of the sailors to man her fighting ships, how could she continue to rule the waves if she admitted gas?

Men, slow to protect their own health and provide for their own comfort, were even tardier in recognizing feminine rights and privileges in the home. It may be said with assurance that women have succeeded in being beforehand only in self-beautification. J. B. Priestley says they "must juggle with kitchen, coquetry and culture," and this was as true in the beginning as now; but only in the realm of coquetry have they been progressive from the first, often with unhappy results. "Jezebel . . . painted her face, and tired her head and looked out at the window," and was thrown to the jackals. Girls were painting their finger nails red before the dawn of history. The English Parliament sought to put its foot down in 1700 on seductive practices such as this. It enacted a law: "That all women of whatever age, rank, profession or degree, whether virgin, maid or widow, that shall from and after such Act impose upon, seduce and betray into matrimony any of His Majesty's subjects by means of scents, paints, cosmetic washes, artificial teeth, false hair, Spanish wool, iron stays, hoops, high-heeled shoes or bolstered hips, shall incur the penalty of the law now in force against witchcraft and like misdemeanors, and that the marriage shall upon conviction stand null and void."

For a century and a half after that law was passed, prejudice of the same sort persisted in our own New England. Ralph Waldo Emerson records that when Mrs.

Thoreau, wearing pink ribbons, called on his aunt, Miss Emerson closed her eyes against the giddy sight. Finally, her eyes still shut tight, she said sternly: "I don't like to see a person of your age guilty of such levity in her dress."

Red finger nails, iron stays, bolstered hips and pink ribbons are not so far removed from sanitary plumbing and good heating as one might suppose, nor is the shaving cream and pungent lotion dear to the man of the house. The relation of health and vitality to the good looks of both sexes is clear. The difference between the sexes has been that woman has traveled a rocky road with her cosmetics and light-minded beauty-aids; nor could she get a hearing, in "a man's world," for the more fundamental and important contributions to attractiveness. Not until the male began to realize their value to him did he come 'round.

With hot water, the man of the house need engage no longer in a tug of war during his morning shave, and if there is a shower in the bathroom he saves about half his time. The suburban commuter who boasts that he catches his morning train seventeen minutes after he jumps out of bed could never maintain that record without modernized plumbing and heating. That is the main reason why the homemaker has the promise of coming into her own. Those toilsome detours in dishwashing are, or should be, a thing of the past, and she may even brag that she lets things "pretty much take care of themselves." Our lares and penates do a merry-go-round with the ancient gods of sun and water.

CHAPTER IX

SLAVES IN THE GARAGE

Three-fourths of the automobiles in the United States are of the type known as "pleasure cars," and the most of them are in garages at home. "The automobile is so much a part of one's daily life," says a bulletin of Purdue University, commenting on the fact that to put the garage at the rear of the lot is a relic of horse and buggy days, "that it should be possible to reach it without going out of doors." It is so much a part of our daily life, indeed, that it has revolutionized our social and business set-up, and it has put at our disposal slaves by the billion.

Of the installed horsepower in this country, eighty-five per cent is in automobiles. More than a billion horsepower is under the hoods of cars at the disposal of the family. Let us translate this into terms of human muscular energy.

If the rear wheel of a bicycle is jacked up from the floor and geared to an electric generator, a husky man, pedaling steadily for eight hours, can generate forty watts of electricity. One thousand watts is about one and one-third horsepower. In one minute our man has created electric current which, at average rates, is worth the price of a paper match.

It should be said at once that the term horsepower, although it is accepted as the standard unit, has a blowhole in it. Watt and Boulton cooked it up to rate the

work of Watt's steam engine ; by watching the work of dray horses in London breweries, eight hours a day, they found that the average animal could pull continuously at the rate of 2200 pounds: that is, it exerted power enough to lift this weight one foot in one minute. One horsepower, we might suppose, is the energy required to lift a long ton one foot in one minute. But no, Watt and Boulton arbitrarily increased the figure by half, to 3300 pounds. Inasmuch as science depends largely on accurate measurements, it is astonishing that engineers have knuckled down for more than two centuries to that dogmatic decision. Why, Dr. Albert A. Michelson spent a great deal of money and some almost priceless time to correct an error of ten miles in the astronomical yard-stick, which is about eight times the diameter of the earth ; yet the wilful dictum of Boulton and Watt stands unchallenged.

Moreover, there are two ways of calculating horse-power. The taxable basis may be used, or the actual brake horsepower. The taxable basis is less than half as great. But, using that method, the horsepower output of American motor vehicles in the single year of 1935, during a nation-wide depression, was calculated at 130 billions, the equivalent of 97 billion kilowatt hours.

All the horsepower installed to run our factories, mills and railroads, light our homes, operate refrigerators and ranges and percolators and so on, plus the power installed in automobiles, is given by the General Motors Corporation as considerably more than a billion and a half. The horsepower of all motor vehicles, to present the precise figure in the table, is 1,424,980,000, and of "pleasure

cars" is 1,261,297,000. In comparison the installed power for steam railroads, manufactures, ships, mines and quarries, electric railroads and so on is surprisingly small. The figures are credited to Carroll R. Daugherty of the University of Pittsburgh.

To illustrate how many more slaves are at our command than in other countries: The Federal Power Commission has estimated that our electric output alone, on a per capita basis, gave us 678 kilowatt hours for each person, while Germany had 398, Great Britain 405, France 356, Japan 269, Russia 97, Italy 265. Canada alone outranks us. The Commission reports that we use our streams to generate more than seventeen million hydroelectric horsepower.

But let us see what this horsepower, overblown by Boulton and Watt, means in relation to human effort. The National Resources Committee, in its first report, says: "A mechanical horsepower, costing $20 to $50 per year, substitutes for ten to fifteen human slaves." Ten to fifteen slaves! Inquiries made in an effort to pin down that nebulous sentence led to my assertion that for a dollar a week we may command the efforts of eleven servants. Undoubtedly it is an understatement, and will get further from the exact truth as mechanical and electrical horsepower grow cheaper.

The billion horsepower in the family automobile, at any rate, is the equivalent of ten or fifteen billion slaves, many times the population of this globe.

A pound of automobile costs less than a pound of steak or butter. Of the thirty million cars registered, more

than seventy per cent are owned by families with incomes of $1500 a year or less. Many of them earn their steak and butter from this industry, which employs directly or indirectly one-eighth of our wage earners. No other prodigy of the Machine Age has graduated so quickly from the luxury class. Now a necessary, it has become the poor man's friend.

In this United States are more than two-thirds of the world's automobiles. Considerably more than half our families own at least one car, and even in the middle-income brackets it is regarded as proper to have a roadster for the eldest of the youngsters. Our car owners spend more than ten billion dollars a year on them, for the cars, the parts, materials and services to keep them in operation, and this takes no account of what they pay for drivers' and vehicle licenses; the tax bill runs well above a billion a year. In equity, all the taxes should go into more and better roads, but examination shows that about one-fourth of them are diverted to other purposes of no benefit to the motorist as such.

Four-fifths of the weight of this machine is metal. It consumes one-fifth of all the steel produced in this country. In its mills steel is rolled out, as one manufacturer puts it, "like pie crust." To make the one-piece turret top the most powerful presses in the world were built, and some of the tops are insulated with heavy corrugated felt; the flooring may be insulated with jute.

Engines are about the same size as they were in 1920, which is ages ago in the life of the automobile. When we think back to the horseless carriage with its whip-socket, and reflect that the first automobile show was

held at Madison Square Garden in 1900, with steam cars and electrics predominating among American makes, and all the exhibits, even the foreign gasoline cars, steered with something like mop handles, we realize the improvements and changes which have come about.

Tires at the first automobile show were an adaptation from the bicycle. They were easily punctured, and their lack of traction was such that they not only skidded but often wasted gasoline revolving without locomotion on a muddy spot. It was not until eight years later that we had the first all-rubber, non-skid tread, and demountable rims, to quicken tire changes. To strengthen the fabric, cords were introduced, but their flexing developed friction and heat. Presently the cotton fibers were soaked in liquid rubber, and now we have a rayon cord which maintains its strength even at high temperature.

By 1923 a low-pressure "balloon" tire was on the market, and punctures were well nigh a thing of the past. Despite superior traction, the careless driver on a wet road who applies his brakes suddenly is liable to skidding, perhaps fatal; but by and large it may be said that tires are the least of the cautious motorist's bothers.

Although, contrary to early expectations, it is possible to stop a car even on a frosty or icy street, the ability to stop is primary. Even with powerful four-wheel brakes, to bring an automobile up standing when it has been traveling fifty miles an hour takes about 140 feet, and engineers hardly expect to do better than this. If a car weighs 4000 pounds and is moving at 80 miles an hour, to stop it requires that the brakes must absorb, in heat, enough energy to run the entire car more than 200 feet.

Enough heat is generated in the engine itself to melt the metals of which it is made if there was not a cooling water jacket, which absorbs the heat and transmits it through the radiator. And that roar when the early engines were in operation has been eliminated, for the most part, by putting the exhaust gases through a muffler. Among those gases is 80 cubic feet of deadly carbon monoxide from a gallon of gasoline ; that is why the garage doors should be opened before the machine is started. If there is a leak from the exhaust pipe into a closed car, this gas may subtly deprive the driver of alertness and judgment. It may even kill him.

In the effort to obtain more power from his engine at less cost, the engineer set up a sort of indigestion, but in place of a belch he heard a knock. Therefore he undertook to find an anti-knock compound, and discovered that bromin was one of the elements he needed. In ten tons of sea water there is about a pound of bromin ; very well, a plant was built on the Atlantic coast to yield half a million pounds of bromin a month. This was the first time any chemical of value other than salt had been obtained in commercial quantities from sea water, and it was a new industry. The anti-knock compound enabled engineers to use higher compression and improve engine design somewhat ; so that the motorist got better acceleration and hill climbing, higher speed and more economy.

Better carburetors contributed also to better acceleration. They were devised to give a lean or rich mixture of gasoline and air as might be required, under various conditions of speed and power. They gave a quicker

pick-up, a faster getaway. This increased the mobility of the machine and reduction of steering effort eased its control. To increase comfort, it was made possible to heat closed cars in winter ; and to promote ease in riding, what is known graphically as knee action was introduced in 1934. Perhaps the back seat driver had some justification prior to that date, when we recall the pitching and jolting he had to undergo. The cause of this was not in the back seat nor in the rear springs ; it was all at the front of the car, where the wheels were rigidly attached to an axle. A bump in the road was transmitted to the other wheel, and if a front spring broke it threw the steering mechanism out of commission. The front springs, morever, because they had more work to do, were more rigid than the rear springs. Thanks to knee action, the front wheels are attached to the car in such a way that they move up or down independently of each other, and it is possible to use springs as resilient as in the rear.

Gears, or cogwheels, have presented to the motor engineer some of his more intricate mathematical problems. To make them smooth and quiet, which are qualities essential to efficiency, calculations in higher mathematics were required, and tooling to minute fractions of an inch. The crankshaft, with its clutches, flywheels, connecting rods and pistons, demanded care at least as expert. Valves and piston rods and cylinders, however accurately machined, were child's play in comparison.

Here is a new vocabulary. Millions speak now offhand of the clutch, transmission, drive shaft, axle gears and axle shaft, flywheel, carburetor, piston rods, spark

plugs, mufflers and manifold in the automobile, who at the turn of this century knew nothing of them. It has imposed, too, a new discipline. Gilbert Murray reminds us that a machine is a great moral educator. "If a horse or a donkey won't go," he says, "men lose their tempers and beat it ; if a machine won't go, there is no use in beating it. You have to think and try till you find out what is wrong. That is real education." He marvels at the care and conscientiousness of the millions of workmen who inspect the machines to which we entrust our lives, to see that there is nothing wrong with them, and at our faith that not one of them will have made a mistake.

Higher mathematics in the precision of the gear tooth, however, and an almost incredible resourcefulness in other improvements, have not yet given us an efficient motor. C. C. Furnas offers in *The Next Hundred Years* a table of "the swindle sheet for the average practice in automobile motors today," as follows :

	per cent
Energy of fuel going into cooling water	40
Transmission friction	2
Engine friction losses other than those appearing in cooling water	10
Incompletely burned fuel	20
Heat in gas	20
Useful work	8
Total	100

Mr. Furnas attributes his figures to General Motors Research Laboratory. Now, in a pamphlet issued in 1934 by the research division, called *Chemistry and*

Wheels, I find on Page 16 these statements: "Of the tremendous energy in a gallon of gasoline, only about ten per cent is usefully used to drive the car when it is running at thirty miles an hour. But this is more efficient than many other things. A steam locomotive utilizes only about eight per cent of the heat in coal when it is running most efficiently. . . Under the best conditions it is possible to obtain twenty-five to thirty per cent efficiency from gasoline engines."

In one field the motor manifests disheartening efficiency. It is deadlier than warfare. For years its toll of fatalities has run into tens of thousands annually, with perhaps a million maimed, many for life. For this the manufacturer is not to blame, unless he is held responsible for yielding to the persistent demand for higher speeds; he has tried to make his machine as nearly foolproof as might be, and has spent millions to that end, even to the point of shatter-proof glass. One of the shameful facts of the annual manslaughter is that men and women practice at the wheel of their automobiles deportment they would never tolerate at their dinner tables. Among motorists bad manners are the convention, and the road hog is a commonplace. A refusal to recognize that highways are constructed for the entire population, and a readiness to violate the common dictates of courtesy, are largely to blame for our costly list of the dead and crippled.

The list is costly not only in funerals, hospital bills, impaired usefulness and widespread grief, but in high insurance premiums. William Corbin has told in *The*

American Magazine of his surprise when he moved to New York and found that it cost him nearly $300 a year in premiums to get liability, property damage, collision, fire and theft insurance on a $600 car. "The rates," he found, "are made largely by the nation's motorists, who, in 1934, reaped a red harvest of 36,000 dead and 945,000 persons injured in 882,000 accidents. . . The greater the loss, the higher the rates." He surmised the rates might be a third lower if fraudulent and exaggerated claims had not swelled the cost; and he presented a dismaying case study of this form of racketeering, both by gangs and by fly-by-night insurance firms. Even reputable concerns include in their policies at times clauses which exempt them in circumstances which surprise the holder, if he has not read the document carefully.

Ernest Elmo Calkins, noting that incompetent and reckless drivers – he ignores downright impoliteness – are punished to little avail, has suggested a system of honors and cash awards for those who establish no-accident records of certain terms. These, he thinks, might be paid out of gasoline and other motor taxes. That a proposal so singular and so difficult to make effective should have a wide hearing is itself a reproach to the motorist. By most accounts it is the motorist and not his machine that is the mankiller.

Matthew Luckiesh, however, believes that bad lighting and faulty vision, rather than bad manners and recklessness, are chiefly responsible for our motor accidents, and no opinion of Dr. Luckiesh is to be taken lightly. It is true that the remedies for headlight glare, improperly illuminated roadways and bad vision rest largely

with the driving public. Undoubtedly seeing is a vital factor. When we quit the buggy we lost the help of the horse's eyes, and he saw a deal more of the road than the driver sees in a streamlined car.

Night driving is at least thrice as hazardous as daylight driving. For the most part the necessary light must come from the automobile, because it has been estimated that adequate illumination of all our roads would cost more than the annual expenditure for roads. These estimates, however, are based on electric light as we know it now. Charles F. Kettering has drawn attention to the fact that the present tungsten incandescent lamp is "about eight times as efficient as the original Edison carbon lamps," and that the "new sodium vapor lights are said to give nearly three times as much illumination as the best tungsten lamps." We must find new methods of producing light without the great heat losses now in evidence. "The firefly, deep-sea fish, and other of nature's means of producing light," says Dr. Kettering, "can teach us a whole new technique."

To obtain effective light without a glare which blinds the oncoming driver has been a major problem. A step at least toward its solution has been found in polarized light. Over the headlight is a screen which filters out the rays causing glare ; the windshield may have such a screen or polarizing agent, and the driver may wear goggles or glasses of like nature. Two inventors are in this field, one employing chemical crystals, the other with a polarizing screen which may be made in large areas. The difficulty is that they require, as at present developed, from four to five times the candle power of the

present systems, and the screens themselves are expensive.

It is possible to equip cars with headlights capable of producing either of two colors, and windshields which could be adjusted to screen the glare from either of these tints. If cars going one way were required to set their lights for one of the colors, and cars going in the other direction for the other colors, and the traffic each way were to regulate its windshield for protection against the other glare, a certain degree of relief would be afforded. But the efficiency of this system is not high, and the expense is by no means negligible.

It is always possible for drivers on roads where the contrary stream of vehicles is not constant to dim their lights as a courtesy to an approaching driver. It is possible, indeed, to dim all lights where there are two streams. Anyone who will take the trouble to note how seldom this expedient, which involves but trifling effort, is put into use for the welfare of the other fellow and indeed for the welfare of all on the road, will realize that strictures on the bad manners of most motorists can hardly be so severe as to be extravagant.

Physicians have tested a drug which, they find, reduces eyestrain and improves the worst conditions of night driving. They tried this first with industrial employees, and concluded that it improved their work in color-matching by seventy-five per cent, and then proceeded to the motorist, with results which they described in the *Ohio Medical Journal* as encouraging.

It is not true, as many suppose, that high speeds are mainly responsible for automobile accidents. Studies show that most of them happen at rates of less than fifty

miles an hour ; and although motor advertising in recent years has laid emphasis on the high speeds attainable, a thorough inquiry into the preferences of car owners showed that they put dependability first as the quality they desired, operating economy second, safety third, and so on down to speed as the tenth qualification.

Nevertheless there has been a persistent outcry for automatic governors on all automobiles, limiting their speed, say, to less than fifty miles an hour. Such devices would be of little value in city streets, where speed is seldom attained, and could not prevent a large percentage of accidents on country highways. They might cause accidents, to the contrary, by making it impossible to get past a grade crossing rapidly or to move around a car ahead and get quickly back into line. A governor may be devised to meet these objections.

Fashion fluctuates in automobiles almost as rapidly as in feminine headgear. The innovations may have a certain importance, as when the gear-shifting lever is mounted conveniently on the steering post, or is made semi-automatic. But for the most part they have nothing to do with fundamental improvements, or the relative position of parts. They affect design, contours and finish. Often they are but novelties which, while they proclaim to the Joneses for a season that this is a brand-new car, will proclaim as loudly a little later that it is passé. Automotive engineers are hopeful usually that new models will increase the number of purchasers, and advertising campaigns are built upon these hopes.

Style and showiness have depended in part upon the

finish of the machine, its lacquer, enamel and chromium, and its coloring. Thomas Wilfred, who undertakes to play tone poems upon his color organ, the clavilux, says: "Victims of melancholia are often stimulated almost to normalcy when subjected to a strong and even ribald use of color." Ribaldry is a strong word for most modern automobiles, but perhaps is not unjustified as applied to some of the most ostentatious. Henry Ford built an immense fortune by producing a car in sober black, seldom dignified in colloquial terms by calling it a car; but his fortune was based, not on the color but on the fact that he established a monopoly for years in the cheap machine. When that monopoly-without-patent was invaded he was forced to abandon his famous T-model, still endeared to some elderly hearts, and to compete with the others in streamlining and pastels or violent pigments, as the case might be.

Occasionally innovators who go beyond mere styles propose new fuels for the engine. Rural legislators, with a view to the use of farm products in the manufacture of alcohol, have asserted that it could be produced at seven or eight cents a gallon; for these statements there seems no present justification, as alcohol is a good deal costlier than gasoline, and gives less driving power to the gallon. But the technologist may surmount these handicaps.

It seems likely that before the technologist makes alcohol practicable as a motor fuel the oil-burning Diesel engine will be installed in "pleasure" cars. This engine has attracted widespread attention of late in streamlined trains; on a record run from Denver to Chicago the

"Zephyr" averaged nearly seventy-eight miles an hour for more than a thousand miles and burned less than four hundred gallons of fuel. The ninety-five-ton train carried eighty-four passengers. Speeds of 120 miles an hour and even greater fuel economies were ahead, for the Diesel engine was far more efficient than the most highly developed gasoline motors.

Although general public attention has been drawn to the engine by spectacular exploits such as the Burlington run, it was forty years old as a successful invention in 1937. Rudolph Diesel, while a student at the Munich Technical College, learned how low was the efficiency of the steam engine, and declared that he would devise something better. His first engine exploded in 1892 and came near killing him, but by 1897 he had a successful model in operation. Its first regular commercial operation was in St. Louis, Missouri, in the following year. This was a two-cylinder unit of sixty horsepower.

The Diesel is an internal combustion engine like the gasoline motor, but requires no electric spark to ignite the fuel, mixed with air to make it explosive. Air is compressed in the Diesel piston at such high pressures that its heat sets off the fuel. The engines are utilized in general industry, privately owned public utilities, municipal power plants, for marine purposes and locomotives, in tractors, buses and trucks.

Railroads have managed great savings in operating and fuel costs and for the upkeep in the roundhouse. They have managed faster schedules than their executives had supposed to be possible. They use but a small fraction of total Diesel horsepower, but their successes with it

have attracted more attention than in the more pedestrian fields.

Since the Diesel engine saves about half in the fuel costs, its coming as a workable power for the family automobile may well be awaited with eagerness in a country which has consumed twenty-two billion gallons of gasoline in a single year. It costs more to make a Diesel engine than a gasoline motor, partly because of the expensive fuel-injecting system, but this difference would soon be offset by economies elsewhere. The difficulty which has confronted engineers was that they could not reduce the Diesel to automobile cylinder sizes. For trucks and buses engines large enough to be practicable were soon possible ; for small passenger cars they were difficult to build.

Even more revolutionary in its implications than the Diesel engine is the automobile trailer, already an accomplished fact. One economist has asserted that within fifteen or twenty years half the population of this country will be living, so to speak, on the road. The National Resources Committee sets this down as one of the six inventions which will most profoundly affect the American way of living during the next two score years, and adds :

"A highly mobile population of problematical size may be created, in which the traditional home, which has its roots in a single locality and is controlled by neighborhood mores, may be abandoned. . . Whether trailers come under the head of housing or transportation is debatable. That this is a rapidly growing industry of

large possibilities and wide social implications, however, is beyond argument."

Those who are most prone to fancy that we may become a nation of nomads dwell on our restless pioneer tradition, the way our forefathers had of pulling up stakes and moving along. There are more solid foundations for the fancy: The congestion of our cities, their unsightly and unsanitary housing, their restrictions and monotony. Several millions now live in trailers, and the demand for them far outstrips the supply. This is an infant industry, which has doubled itself annually during its youth. We now have mobile residences which can be expanded into several rooms, complete with shower bath and cocktail bar.

That we may develop a working population housed in these movable homes is highly probable. Wage earners could then move from place to place as working conditions and seasonal demands altered. If they rented small plots on the outskirts of industrial areas, they could raise their own food, or a part of it, enjoy fresh air and sunlight, and use the automobile for transportation to and from their work. They would be free of the encumbrance of stationary property and the bugaboo of costly mortgages. About four-fifths of the trailers sold have been purchased by working men who intended to use them as permanent homes.

Not all of the remaining trailers were sold to persons who wished only to take a vacation and avoid either tourist camps or hotels. Many of them were fitted out as display rooms for commercial products. "This is a feature," says the National Resources Committee, "that

may even touch the operation of large department stores and mail-order houses." To have on hand a handsome show window for the retail merchant gratifies many a salesman. Even now their displays range from prenatal medicines to burial caskets. They have the advantage of displaying a full line and of making possible deliveries on the spot.

Enjoying more and more leisure, and with the predilection of business men to retire earlier from active pursuits, the trailer offers a haven to those who want to quit with a modest income. It raises difficult questions, to be sure, in regard to community life and the schooling of children and taxation. H. T. Webster, who is the most gifted among our cartoonists in reflective satire, has devoted a series of "tintypes" to these matters. There are problems of water supply and sanitation, overnight parking facilities, tracts for traveling salesmen, for tourists and vacationists, for those who wish to settle down more or less permanently ; police and fire protection must be provided. Some communities began early to levy taxes on owners and operators of trailer camps, a few of them direct taxes on the trailer inhabitants. Roads and bridges must be widened if, as seems probable, the trailer is here to stay.

That it is here to stay nearly any observer is likely to concede. That we are to become a nation of nomads appears much less probable. Dorothy Dunbar Bromley puts the pro and con aptly when she says : "Trailers will undoubtedly have their charms for apartment dwellers who yearn for the open road, even if it must be fouled with gasoline fumes. Trailers will invite you to dis-

cover America and its various people. But life aboard a trailer will seem less alluring if it's the only life that's open to you.

"Home may pall, but there's nothing like one to go back to when you are sick of perpetual motion. To be a man or a family without a home would seem to me as tragic as to be a man or family without a country."

Steel and rubber are the principal constituents of this machine which is transforming American life; its motive power in the future may be oil and now is derived from oil. There is good ground for believing that oil was mixed with clay to make mortar for the walls of Babylon, and that the ancients used it for embalming the dead. From immemorial times it has been known in China, Persia, Burmah and Galicia. At Baku on the Caspian there was a fire temple which has been described by travelers from the time of Marco Polo. Herodotus told of the springs of Zacynthus, Pliny of the oil of Agrigentum, which was used in lamps.

A Franciscan missionary who visited this country wrote in 1629 about our oil, and springs of the liquid were described in a letter to General Montcalm from the commander at Fort Duquesne. Other springs were found in western Pennsylvania, Ohio, West Virginia and Kentucky. In 1819 a well was bored for brine in Wayne County, Kentucky, which yielded so much petroleum that it was abandoned in disgust; and ten years later another, in Cumberland County, gushed so freely that in thirty years it was estimated to have given off 50,000 barrels, most of which went to waste.

Whether from springs and wells, or floating on the surface of ponds and lakes, the oil was used, if at all, for medical purposes. It was supposed to be a fine liniment for rheumatism, and in the Allegheny Valley it was prescribed by wiseacre doctors as a remedy for tuberculosis ; later, it was thought to be a specific for bronchitis. Its real medical value, if any, has been found in vaselines and ointments.

As to the origin of oil there is still some speculation. Coal, which is associated with it, has an organic structure, but petroleum is only in part organic. It is a fluid bitumen, and when burned in its natural state gives off so much black smoke that it was abandoned at first for lighting ; not until kerosene was distilled from it did we learn that in lamps it was far better than tallow candles or whale oil. Not until 1859 was a well drilled near Titusville, Pennsylvania, for the special purpose of obtaining oil. In its first year the output was some two thousand barrels. Presently we had gushers, and fabulous fortunes began to pile up, so that petroleum came to be regarded as liquid gold. But not all the money which went into this new industry multiplied miraculously ; "everybody has seen the picture of a gusher," says Benjamin T. Brooks, a consulting chemist, "but nobody has ever seen the picture of a dry well."

Here was a liquid which the earth had harbored for millions of years, and which was used for lighting, lubrication and still for medication until near the close of the last century. It awaited its real usefulness until the invention of the internal combustion engine. Iron is as old, but primitive man began to utilize it as soon as he

found that he could beat it into tools and weapons. Probably he got it first from meteorites ; at any rate, he called it the metal from heaven, and early Egyptians thought the firmament was of iron. It is about one-twentieth of the earth's crust, and is found sometimes almost pure. Its use goes back perhaps six thousand years. It is present in all natural waters, and is vitally necessary to the human physical constitution ; the body contains more than a quarter of an ounce of it ; but this, with all the other metals and chemicals so vital to our life, could be bought at a drugstore for less than a dollar. It is thinking which lends man a certain importance. Aristotle, whose theory is espoused to this day by eminent psychologists, declared man thought not merely with some gray matter under the skull pan but with the whole body : "Thought is to the man," he said, "as chips to the woodman's axe." Without an admixture of iron in the body, thinking goes gravely askew.

Iron goes into the automobile in the form of steel, or an alloy. In early days, the processes of making steel were slow and costly. The celebrated Damascus blades of the Middle Ages were forged from steel imported from India. It was the middle of the last century before a cheap commercial method was found, and credit for this goes as a matter of custom to Henry Bessemer, born of French parents in England. His method was to force currents of air or steam through molten iron and burn out impurities ; but a month before he took out his patent, in 1855, Gilbert Martien of Newark, New Jersey, obtained an English patent for purifying cast iron by passing streams of air or steam "through and amongst the

melted metal as it flows from the blast furnace." The unsung hero of this discovery, however, was William Kelly of Eddyville, Kentucky, whose acquaintances were too conservative to have much patience with his new-fangled material. After Bessemer obtained a patent in this country, in 1856, Kelly was able to establish his priority in the field, and an American company was formed finally to exploit his method. This was merged with the company holding the English patent, and Kelly realized a comfortable fortune ; but Bessemer, acclaimed far and wide, was knighted and piled up a fortune estimated at ten million dollars, an enormous sum in those days. Neither the Bessemer nor the Kelly method is now in general use, however ; they have been supplanted by the Siemens-Martin open hearth process. More than forty alloys of steel are used now in automobiles.

In some schools motoring is now taught. The course includes instruction in parking, putting water in the battery, changing the oil regularly, signaling and street signs, the vagaries of speedometers, the care of the car at home and so on. It is not unreasonable to suppose that such instruction will spread, and that, since the family automobile is an integral part of home life, it may even be included in schools of domestic science. Since the turn of this century no branch of education, probably, has advanced so rapidly as domestic science in the United States. (In Europe it is not a separate field of study.) It has its distinctive place in the curriculum, and is found at every academic level, from elementary school to university. Home economics is so nearly all embracing

that no definition has been devised for it, and the curriculum tends to change rapidly. Its main objectives are the manual skills required in the home, the economics of food, clothing and shelter, and executive capacity. We had cooking schools as early as the seventies of the last century, but not until this century was the household regarded as a subject for scientific study and research; and with thousands of public schools, normal and technical schools, academies and universities offering a diversity of courses, ranging from a few months to the full-fledged four-year course with its bachelor degree, it seems not impossible that the care of the automobile in the garage at least may be taught.

It is heartening to note that in the high school at Freeport, Long Island, the class in "Highway Safety" scorns the road hog as much as the students in Latin detest Cataline and the students of English distrust Iago and Shylock. Whether or not this kind of teaching inculcates a proper contempt of the road hog, it is the more necessary because the tests imposed on applicants for a driver's license often are insufficient. In many localities they amount to little more than a gesture. There is no proper precaution in such places as to the prospective driver's knowledge of fundamental rules of the road, to say nothing of careful visual examination and other finer points which have an acute bearing on fitness for motoring. The automobile has been improved far more rapidly and earnestly than our governmental processes in dealing with its drivers.

CHAPTER X

HOMEMADE CLIMATE

A manufacturer of mechanical refrigerators, who had equipped an apartment house throughout, was disquieted to find that some of the appliances caused higher operating costs than he had promised. He directed an expert to test the machines, but there was nothing wrong with them. A talkative housemaid gave the clue to the mystery. She had passed along to some of her friends in the building the happy thought that to leave the refrigerator door open and sit nearby was pleasant, in hot weather, while peeling the potatoes for dinner. Thus in half a dozen kitchens there was an impromptu form of air conditioning.

That incident was not the origin of a revolutionary modern convenience, but it happened when the new industry's total orders in a year were but $8,000,000. As the automobile came by its inches in the 1907 depression, and the radio in the sharp panic of 1920–21, air conditioning was a baby of the years after the 1929 crash. Even in 1936 its sales were but $43,500,000; but during the first half of the next year they mounted more than 150 per cent, with the assurance of a volume during the twelve-month of more than $100,000,000. Applications for rights on air-conditioning devices were flowing into the United States Patent Office at the rate of 300 a day. Technical schools were offering special courses in the field. Even the baby panda in the Brookfield Zoo at

Chicago, a prize much admired by visitors, enjoyed during hot weather, when not on display, an atmosphere artificially cooled and dried. A Himalayan bearcat to that extent supplanted the lion as the king of beasts.

About the time Mrs. Calvin Coolidge let a contract for an air-conditioned home to cost $25,000, at Northampton, Massachusetts, Supreme Court Justice Hugo L. Black leased a house on Seminary Hill, overlooking Alexandria, Virginia, which was also air conditioned, but with a difference; for this one-acre tract was a part of the site of Fort Harrison, and on it there was a cave which had been used as an ammunition storehouse during the Civil War; a huge fan in the cave blew cool air during the hot summers through the house. This was an intermediate step in an advance which began, in fact, when prehistoric man struck fire from flint and began to explore the possibilities of heat; it was continued when he made fans of palm leaves.

Normally the human body generates, when inactive, 100,000 calories an hour. If the weather were always mildly cool these furnaces we carry about with us would not inconvenience us, but for at least four thousand years man has sought comfort with fans, and he began even earlier to try to mitigate the severity of winter. Even the Peking Man knew, 750,000 years ago, about fire, and human culture dates from that discovery. Civilization has kept fairly accurate step with the multiplication of its uses. The first public servants were those who tended the tribal fires, in those days regarded as gods, and they

became in time the administrators of the law and the state. There is a credible theory that architecture had its origin in the construction of sheds to shelter fire, and the hearth has always been the center of the family. We speak of life as a flame.

Like fire, the fan has had its religious meaning, and still has in certain rituals, notably in Rome. In the British Museum is a treasured bas-relief showing Sennacherib attended by women with fans of feathers; even in the tomb of Amen Hotep, an Egyptian king of the seventeenth century before the Christian era, a fan handle was found. In those days the luxury was a prerogative of royalty, like parasols and fly swatters. Three thousand years later Queen Elizabeth inventoried with pride twenty-seven fans. The things have been made of silk and ivory, adorned with point lace and jewels, perfumed, painted by Watteau and other famous artists. In comparison, the businesslike electric fan loses in romance; but the householder with the blower, the refrigerant and the heater of a complete air-conditioning outfit may smile in derision at these predecessors, for he enjoys at small cost the equivalent of a Riviera resort plus a fur overcoat.

Our bodies would reduce us to cinders if we could not get rid of the heat they produce. This heat is the continuous equivalent of two sixty-watt incandescent lights. Expressed in British thermal units, it reaches 400 when we are sitting idle, 600 when using a typewriter, 850 when playing badminton, 1300 at tennis or heavy

labor. We burn fuel at a great rate. We eat on an average three or four pounds of food a day, drink three pints of water, breathe thirty-four pounds of air.

Yet we know surprisingly little about how to adjust our physical heat-making selves to our surroundings. Until the coming of air conditioning we knew not much more than Amen Hotep with his fire and fan. We left to a mechanism of endocrine glands, tissues, muscles and nerves the task of balancing heat production with its disposal, so as to maintain the normal body temperature of 98.6 degrees. We still do not know much about the inner operation of this machinery, but we are better informed about the effect of exterior conditions.

Thus it is agreed that the mechanism operates satisfactorily at a temperature of seventy degrees, but this figure may be changed if the air is moist or in fair circulation. And we have found that we need drier air in summer, damper in winter. These facts are the bases of an innovation; and in outfitting homes with it the discovery has been made that on hot August days a room may have the benefit of 1300 pounds of ice, so far as cooling the atmosphere is concerned, at an outlay of three cents an hour.

In the factory, the mill, the shop or the restaurant an air-conditioning plant pays for itself right speedily, but in the home it must come in part out of the domestic budget, because it pays for itself partly in intangibles. If a new home is being constructed it can be financed as part of the mortgage, and lenders willingly advance funds on it because it enhances the value of the property for rental or for future sale. On that basis the additional

cost need be but a few dollars a month, and a year-round system need not exceed the expense of automatic heating in winter.

Air conditioning begins best with the furnace. On this point there is general agreement, but not even the engineers who are making the improvement popular are agreed among themselves about all it should be and should do. The National Board of Fire Underwriters reports that such a plant should control the temperature at all seasons, clean the air and move it around, and regulate the amount of moisture in it. Systems are now on the market which accomplish all these functions. But what of unpleasant odors? They can be removed by filtering the air through chemicals like those used in gas masks. And why shouldn't pleasant odors be substituted, say the smell of new-mown hay? And what about the invisible health-giving rays of the sun, the ultra-violet and infra-red, which do not penetrate our window panes? Until questions such as these are answered, we cannot be said to have reached our goal.

Whether hot air or hot water or steam rises from the furnace in the basement, it is necessary first, in air conditioning, that this pass through a filter, usually of spun glass or steel wool or some fibrous material, coated with a viscous substance such as vaseline. The filter acts as the mucous membrane of the system; it catches impurities and holds them, just as they are waylaid in our respiratory tracts. The next step is to moisten the air, if it is hot, by passing it through a spray or introducing steam to dampen it as it leaves the radiator. In summer it must be cooled and dried.

There is a distinction between ventilation and the circulation of air. In any conditioning plant there must be circulation, which may vary from five to fifty feet a minute ; some of them change the air of the room completely every quarter of an hour. For winter five feet is accepted as the minimum, for summer fifty feet is the maximum. Ventilation means the introduction of fresh air from outside the house, and most systems provide for such an inlet.

Once the fan, filter and moistening process are provided for winter air conditioning, either in a new house or one already in use, the units for summer cooling can be added at comparatively little expense. Two steps need to be taken : the temperature of the atmosphere must be lowered and as a rule its moisture must be substantially reduced. Since the automatic refrigerator is in effect an air-conditioned chamber, engineers have utilized the lessons they learned there. Dissatisfied with the obvious expedients of blowing air over ice or cold water, or using fans to suck in cool air at night for use during the day, or even with the circulation of cold air through steam pipes, they introduced an amplified refrigerator.

That apparatus consists of a liquid refrigerant, usually odorless and harmless to health, which extracts heat from its area by evaporating at a low temperature ; a compressor to return the evaporated gas to its liquid form so that it need not be replaced ; and a condenser to cool and dry the air, which is forced over coils cooled either mechanically or chemically or with water. Vapor from the air collects on the coils, just as it collects on the window

panes of overheated rooms in winter, and the air is made less humid. Sometimes a material called silica gel is used in the condensers, but more often water is employed.

If the time comes when thirty-odd million homes in the United States begin the manufacture of their own climate, the use of water for washing air and cooling it will pose a new problem. Our water supply must be doubled at least, perhaps quadrupled. All forward-looking municipalities and communities, it may be taken for granted, own their reservoirs and water plants, but this is not invariably true. Lexington, Kentucky, a city of fifty thousand which puts on a deal of side, tolerates a private corporation. Flatbush, a section of Brooklyn and therefore a part of Greater New York, buys its water from a commercial concern, which may be one reason why the very name of this section has been the butt for generations of vaudeville comedians. Greenwich, Connecticut, one of the two richest residential communities in the world – the other is Newport – is an instance of that sort of backwardness. The ancient Romans knew better, and built marvelous aqueducts.

Whatever their social pretensions or wealth, modern centers will be hard put to it when they must buy from grasping private corporations an immensely expanded supply of this necessity. More enlightened communities will foresee the situation and enlarge their plants. As a fact, domestic air conditioning has reached a point already where some engineers have begun to devise ways to meet the new demand. Domestic, commercial and industrial air plants consumed even back in 1935 water at the rate of 120,000 gallons a minute. On the basis of

that warning, it was proposed that cities and towns be zoned, with a central air-conditioning plant in each district to take care of all the homes which desire to pay the additional tax, or, as an alternative, supplying the service arbitrarily as a health measure, and imposing the tax. A survey was made of Knoxville, Tennessee, which lies beside a river and is close to cheap power from the Tennessee Valley Authority ; the plan was to cool the river water to 50 degrees in summer and heat it to 140 degrees in winter, pump it from a central station through insulated pipes to 1000 homes and install the necessary conditioning machinery. By doing this, Knoxville would save one-half of its water consumption, but still would use 150,000 gallons a minute.

"Invention is a great disturber," says the National Resources Committee in its report on technological trends. The disturbance of our water supply by the invention of air-conditioning plants is one of the matters an alert population must meet and overcome.

It is a frequent complaint of air-conditioned railway cars, restaurants, theaters and so on, that one has a sense of "chilliness" on entering them. Some, to be sure, maintain a temperature much lower than that outside, and the effect cannot but be disagreeable, both when entering them and when returning to the street. With experience the theater may find that it profits by providing for a change of but ten degrees, say, before the performance, lowering it slightly as the evening goes on and increasing it before the audience exits. In the home the entrance halls and the rooms could be of graduated

coolness, with little added cost. It has been estimated that to adjust ourselves to a considerable and sudden change in temperature – that is, to acclimatize ourselves – requires about three hours ; and since one of the hurdles this invention has got to clear on its way to general use is psychological, there would be sound sense in avoiding changes which are too precipitate.

Even so, the psychological hazard would remain. Some of us are "fresh air fiends," and cannot be comfortable with the windows closed, as is necessary in air conditioning. We cannot be at ease even though we know that the air we get is purer and better than if the windows were open. This has got to be lived down. When first a unit was devised to air condition a bed, there was objection because the canopy overhead was opaque – whether because of claustrophobia was not determined – and a translucent covering was substituted. There is a third psychological difficulty, applying to this as to all departures, described by one man as "psychic inertia ;" this is not the same as physical indolence, but is merely an ingrained preference for the familiar. Often people will go to a deal of trouble to avoid trying out the new.

It is not necessary to air condition an entire home, both winter and summer. A unit can be procured at modest cost for conditioning a single room. On a soggy summer day about nine pints of water can be extracted from a single chamber, for when air is warm it is susceptible of much higher saturation than when cold ; at seventy-two degrees it will suspend eight times as much vapor as at twenty degrees.

As for the unit built to air condition a bed, it can be operated by plugging into a light socket for two cents over an eight-hour sleep. It stands about as high as the footboard, and provides circulation of the air beneath the canopy without causing a draft, a prerequisite of all such devices, whatever their size. Apparently this idea originated with Powel Crosley, Jr., when he was sleeping in an old-fashioned four-poster. It is attractive to sufferers from asthma and hay fever.

Self-contained conditioners for rooms large or small are on the market, available in a multitude of models to meet various climatic and installation requirements. Apparently there is the right style and capacity, whether the building is old or new, piped for gas or wired for electricity or isolated, owned or rented, in Alabama or Maine. Mass production and precision in manufacture, spurred by competition and expert laboratory research, have brought down costs and will bring them still further down.

Compare the present plants with the earlier ones. In place of tanks, ungainly rows of iron piping and heavy pumps, when ammonia was the refrigerant, we now see light tubes of copper or aluminum, occupying little space, highly efficient and actually decorative in general effect. We have compressors of the automotive type and others burning gas, which have no moving parts. We have condensers especially calculated to economize in the use of water, where the supply is inadequate or expensive. We have attractive portable sets, too, which circulate every minute 300 cubic feet of fresh, clean air of the right moisture, and in some cases deodorize it.

We have a choice of units which can be installed in existing heating plants.

South of the Mason and Dixon Line temperatures on the lower floors of a dwelling are likely to be 100 degrees, and in the attic 130 degrees, when only 95 degrees outside. Long ago householders there learned to bring in cool air at night and imprison it during the day by closing windows and drawing down the shades. This was improved in time by the installation of fans in the attics, which sucked the air through grilles from the lower rooms and blew it through vents under the eaves. To operate such a fan cost from one to two cents an hour, depending on the utility rate.

North and south of the Line it was understood fairly well that to insulate the walls, floors and ceilings helped keep out cold in winter and heat in summer. Everywhere there was a tendency to avoid "drafty" houses, with leaky doors and windows, as wasteful of fuel and dangerous to health. Insulation and well-caulked windows are a part of good air conditioning.

Long before the white man ventured into the southwestern United States, the Indians there had learned that adobe, sun-baked bricks of clay and straw, was a protection against heat and cold. Adobe serves in construction somewhat as wool works in clothes ; it provides numerous air cells which deter the transfer of heat. In one case the heat of the household fire, in the other the heat of the body, is retained. All construction material, whether wood, stone, brick, concrete, stucco, tile or roofing, acts somewhat as an insulator, but none of these

so well as adobe. The wooden lathing to hold plastering has little such value, and nowadays we substitute for it, in some instances, a rigid board which serves both as a finished wall surface and as a protection against heat losses. There are flexible blankets, loose fibrous mats, rock and glass wool, cellulose crêpe and asbestos, nearly all non-combustible, which improve insulation and often pay for themselves by economies in fuel, and by lower insurance rates because they afford protection against fire.

Although proper insulation is essential to successful air conditioning, it is an economy in any circumstance. The saving it effects in fuel was determined in a seven-month test at St. Joseph, Missouri, with an average outside temperature of 40 degrees and an average within the steam-heated house of 70 degrees. Coal, oil and gas were used at different periods, and the saving, when the walls and roof — but not the floor — were satisfactorily insulated, was at the rate of more than six tons of coal a year, more than 200,000 cubic feet of gas, more than 900 gallons of oil. In annual fuel costs the saving was a bit more than two-fifths. This was somewhat better even than most manufacturers of insulating material advertise ; they promise a saving, as a rule, of one-fourth on fuel and think the house should be some ten degrees cooler in summer.

Although complete year-round air conditioning is not beyond the purse of those who can finance a $5000 home, those who cannot afford this do well if they are tenants to persuade the landlord that insulation alone im-

proves the investment because it affords a genuine economy.

The American Society of Heating and Ventilating Engineers helped the School of Public Health at Harvard to chart a "comfort zone" for us. When the temperature is between 72 and 85 degrees, they found, the relative humidity, or presence of moisture in the air, should be 30 per cent; when between 68 and 78, close to 70 per cent. Relative humidity is a phrase based upon 100 per cent as the saturation point, but as a rule we are content to speak merely of humidity.

Specifically, we are comfortable in winter with a temperature of 70 and a humidity around 40 per cent, and that is the condition prescribed in daytime for nurseries all through the year; babies prefer cooler air at night and a bit more moisture. In summer the standard for the general household is 76 degrees and a relative humidity of 55 per cent. The United States Weather Bureau tells us we can count on ideal climatic conditions only about 15 days a year.

Human energy, our most precious asset, depends largely upon the air we breathe, whatever the season. Obviously we have been singularly remiss in studying it. We have undertaken until recently to cope with cold weather by wearing more clothes out of doors and providing more heat indoors; in summer we have worn lighter and fewer clothes and perhaps have installed fans, but the fans were to cool us, only casually to circulate the atmosphere. For three centuries we did practically

nothing in this country to moisten the household air in winter.

Now, aside from its effect on human energy, hot, dry air has a deleterious effect on the skin and hair of human beings. For a century at least the women of the United States have heard visitors from abroad and travelers returning thence comment in disparagement on American complexions, as compared with the beauties of women in Stockholm and London. One might suppose that in a matter so close to the feminine heart something would have been done about it, but the "beauty parlor," which deals with symptoms rather than causes, appeared to be the only recourse. In 1937 American women spent more than $400,000,000 in these havens, even the "permanent" having lost by then its worst terrors. Part of that sum went to manicures, of course, and not all of the money spent on the hair or skin was in payment for bad air in the home. But the major part of it might have been spent much more intelligently and to better effect on air conditioning.

A pan of water, set on the floor of many of our overheated homes in winter, would evaporate almost as rapidly as on Sahara's sands. The dry atmosphere absorbs moisture from our skins and from the mucous membrane of our respiratory tracts ; we become uncomfortable and worse, more susceptible to colds, sore throat, influenza, tuberculosis, diphtheria. We can contract infections and contagions in only three ways : through solid foods, liquids, or the air we breathe ; and the diseases we get through the throat appear to be more lethal than the others. The person who sneezes overtly in a room

of that sort may be guilty of involuntary homicide.

"It is now beginning to be recognized," says Professor C. P. Yaglou of the Harvard School of Public Health, "that our present heating methods are crude and less healthful than nature's method. There seems to be a great difference between the sensations of warmth, comfort and well-being produced by solar radiation falling upon the body on a pleasant cool day, and those which arise in rooms heated by the usual convection methods. The assertion is often made that the common cold and other more serious respiratory diseases begin with the heating season, and there is good reason to suspect that the effect may be due, at least in part, to the source and nature of radiation employed in modern heating systems."

It is *beginning* to be recognized : this is a commentary, indeed, upon our vaunted technological achievements. Consider, for a moment, the amount of soot to be found in the air of some of our urban centers. Baltimore precipitates 1530 tons per square mile every month ; Chicago, 1430 tons ; Cincinnati, 500 tons ; Cleveland, 700 tons ; St. Louis, 600 tons. That was the situation according to measurements made in 1937.

As for dust, a laboratory count in Room 807, Biltmore Hotel, Oklahoma City – not during a western dust storm – revealed during twenty-four hours, in a single cubic meter of air, 4300 particles of dust on a slide in the open window. Oklahoma City, with some 175,000 population, has a good reputation for general cleanliness, and surely is not worse than most of our cities.

Not only soot and dust but pollen, gases from automo-

biles and germs infest the air indoors and out. Hay fever takes its tribute from those whose systems are allergic to pollen ; and the housewife who sweeps the living room, or shakes out an automatic cleaner after using it there, may well pause to ponder the fact that a thimbleful of dust may harbor five million germs.

Only now are we beginning to abandon the ancient bogey that air which has been breathed is extremely harmful. One of the valuable bulletins on *Better Homes in America,* issued by Purdue University, helps to discredit that superstition. "Science has demonstrated," it says, "that the change is too small to be of any significance to health or comfort. Discomfort once attributed to this change in the chemical composition of the air [from having been breathed] has been traced to the more or less offensive odor given off by the upper respiratory tract, skin and clothing. This apparently is of more aesthetic than practical importance."

Back in 1857, a little more than a quarter of a century after the Baltimore and Ohio Railroad began operating the first steam-drawn train in this country, attempts were made to improve air conditions in railway coaches. At first this was merely an effort to make use of mechanical motion to promote ventilation. It was not until the turn of this century that industry began to cool air by blowing it into factories and mills over ice or through water. Candy factories, which had been compelled to close in hot weather because their materials could not be made to stay put, lithographing shops which found their inks refractory because paper absorbed moisture from the air,

textile mills where the workers became bunglesome and caused accidents, tobacco plants impregnated with irritating dust, where the material itself became difficult to handle, tried air conditioning some thirty years ago. In the early stages ammonia, although corrosive, suffocating and sometimes explosive, was the cooling fluid. Not until the early twenties, however, did the public become conscious of these steps; this was when motion picture exhibitors announced in neon lights that the temperature within their "palaces" was fifteen degrees, say, below the street temperature. One effect of this was to fix in our minds the notion that air conditioning meant merely cooling off the place.

Many persons who would not have seen the picture otherwise dodged out of the street heat into the "movie" house – and thus helped pay for the innovation – because they knew they were below par physically and mentally. Extreme heat causes us to lose essential chlorides through perspiration, increases the temperatures of the skin and deep tissues, accelerates the respiration and heart action, deprives the brain and digestive organs of normal blood supply, lowers our energies, causes heart strain, nausea and sometimes prostration. It is possible that the motion pictures saved some lives in those days.

Not that other businesses were neglectful of the new processes. They were as forward-looking as the films but not so loud-spoken. A survey of forty restaurants which had installed air-conditioning systems showed an increase of one-third in patronage, of one-fifth in the amount expended. The proprietors reported that their waiters were more alert and efficient. Fur stores, ap-

parel shops, funeral "homes," barbers and beauticians, dentists and doctors, meat markets and soda fountains, department stores and millinery shops, Pullman sleepers and hospitals, found gradually that clean air at the proper temperature and satisfactorily moistened contributed to personal comfort, efficiency and health. Even automobiles in time were air conditioned. The "summer slump" in business ceased to be a bugaboo, and loss of time from work, owing to respiratory troubles, declined in some cases by nearly half.

Efficiency? Why, the owners of one of the two deepest mine shafts in the world made the world's largest installation, up to that time, in the conviction that air conditioning would improve the efficiency of their workers underground and enable them to delve the more deeply. This was near Johannesburg, South Africa, in the Robinson Deep Mine, and the motive was to get more gold. There are economists of the "classical" school who have said hopefully that if gold mining could be extended thus to greater depths, formerly prohibitive because of the heat and humidity, production might be increased so that countries which had been forced off the gold standard could return to it. The gold standard is "an accident of history," Dr. Lionel Edie has observed; but greater production and therefore cheapening of the metal by this means would be not an accident but the application to mining of a process intended for industry and the home.

Let Willis R. Gregg, Chief of the United States Weather Bureau, say the last word about the increased efficiency we may enjoy through air conditioning. "The

energetic, hard-hitting tactics of the northerner," he reminds us, "who works hard and plays hard because the climate in which he lives inspires and invigorates him to greater activity, has had much to do with the development in our northern states of giant industries and other activities, with a resultant centralization of buying power.

"Is it too much to predict that air conditioning of the working and living quarters of other residents of the more humid areas may cause more activity in those parts that will open up to use natural resources beyond our imagination?

"Or that the developments made possible by enabling men to work in strength-sapping climes will take up the employment slack and open up new channels of buying power?"

Chief Gregg is a meteorologist, and his job is to forecast the weather, not the development of natural resources or buying power. But he qualifies as an expert in the field of homemade climate, and his suggestions are provocative. Few observers of the possibilities of air conditioning would be disposed to dispute his prophecies.

CHAPTER XI

OUT OF THE AIR

In the United States the radio audience is estimated at ninety million persons. Empowered with ubiquity and addressing the infant mind as well as the adult intelligence, the ignorant as well as the literate, radio is our most pervasive and most significant agency of entertainment and information. It bears an onus of social responsibility greater than any other institution, not excepting government itself. It is still an adolescent industry, with certain Eulenspiegel qualities of the clown, the prankster and the adventurer, but with possibilities also of establishing itself in the national life as a Savonarola or a Luther, a Jefferson or a Hamilton, an Esculapius, Newton or Edison, or a combination of them. It is our most powerful single influence. It has ranged from Gracie Allen to Harry Emerson Fosdick, from tom-tom "swing" to grand opera.

During the morning and the mid-afternoon hours, women constitute some three-fourths of the radio audience, at other times nearly two-thirds. At all times the majority of the listeners are doing something else, working, reading or playing. Housewives can listen, as men cannot, while they go about their duties. If the programs fall below the standards they prefer, they have themselves chiefly to blame, for the executives of radio chains are sensitive to their opinion. But it should be said, by way of qualification, that in many instances the

selection of programs is in the hands of a small clique, which controls even the matter of auditions, and which is so arbitrary that it must be held in part accountable.

Posing as a friend of the whole family, radio should be an invisible enemy of the "regular habit of the luxury of woe." That phrase was dropped by William James into a letter to his homesick thirteen-year-old daughter ; it would have been a help to his beloved "Peg" if there had been wireless in those days. To the lonely in strange hotels and on isolated farms, to invalids and other shut-ins, to fireside groups and congenial gatherings, its astonishing melody or message or blare may be a benison. But first of all its programs are dedicated to mother and the children.

Nearly anywhere one may hear during a week day, excepting Saturdays, at least two hours of talks about fashions, deportment, cooking, beauty, home decoration, gardening and marketing. Women commentators discuss events from the feminine angle, often with penetration and wit. Almost as much time is given to the youngsters. Stories to the themes of Cinderella, Sleeping Beauty and Robinson Crusoe, King Arthur and Robin Hood, talks on adventure and hobbies and animals, even a deal of educational material, are addressed to the younger generation. It is in this field that the programs are most open to question.

"Radio broadcasting," Franklin D. Roosevelt has said, "is an essential service to the American home." Roy S. Durstine, a successful advertising man, is dubious whether the service is all it should be, and so is George Henry

Payne, who voiced severe criticisms as a member of the Federal Communications Commission. Mr. Durstine noted that "extremely vocal groups have come into existence to protest against offensiveness and horror and cheapness on the radio." He offered fifteen suggestions for its improvement, directed mostly at advertising practices, but he added : "Remove from the air all the horror programs which send children to bed frightened." This was the core also of Mr. Payne's complaint. Paragraphers and comic strip artists have expressed it. There is a story of a script for a children's program that contained the phrase, "He has a heart of stone," which was changed to "He's a yellow rat," on the theory that the kiddies would like it better. In one studio, during such a program, a ripe cantaloupe was crushed to give the sound of bashing in a man's head. Berton Braley has written a jingle, "The Children's Hour" – too long to quote in full – in which he says :

And they listen in awesome silence
To the talk of some mobster group,
As they're opening up a bank vault
With nitroglycerin "soup" ;

Oh, sweet is the noise of battle
To children's listening ears,
As the guns of detectives answer
The guns of the racketeers ;

And these educational programs
Will make the youngsters cower,
And the night will be filled with nightmares
Induced by the Children's Hour !

In imitation of the motion picture, the radio has substituted stories glorifying the G-man for those heroizing the gangster. If an end is put to this it will come almost certainly, not from the masculine protests which I have recorded but from an organized feminine outcry. One woman at least has thrown out something more than a hint over the microphone itself. Adela Rogers St. John, an observant commentator, said that programs might teach children self-discipline as well as self-expression. "I believe in expression of personality for children," she observed, "but not too darned much of it. Some of our children are allowed to express themselves right into reformatories and jails."

Occasionally there has been a warning note in the pages of a magazine addressed to women, but as yet there has not been the organized and widespread outcry which seems necessary if the dictators of radio programs are to mend their ways.

How different was the form of self-expression encouraged by Walter Damrosch when he undertook in 1928 the "Music Appreciation Hour" for children. In all probability Dr. Damrosch is our most generally beloved American. The Women's National Radio Committee, representing organizations with a membership of ten millions, gave him what was called a super-award for having "done more for good music than any other man in this country," and congratulated him on his "foresightedness nine years ago in grasping the possibilities of radio for the dissemination of musical culture." He would have been more pleased, doubtless, if the committee had

told him he had done more than anybody else to interest children in music, as he had. Many millions now listen eagerly to his programs. Notebooks for them and manuals for their instructors are distributed at cost, with explanatory notes, thematic illustrations, tests and biographical material about composers. The eagerness of the listeners was shown by the demand for these booklets.

No one need pay exorbitant sums now to hear the work of great composers interpreted adequately. Isolated villages may listen to *Il Trovatore* or *Aïda* as though in a parquet seat of the Metropolitan Opera House. The great popularity of Wagner in this country is due primarily to broadcasts of his operas and selections from them. Sunday concerts and symphonies have lifted the musical taste of the public, and a thorough survey has revealed that more than half of the audience prefers distinctly good music.

That survey, which embraced farmers, clerks, bus drivers, Negroes, traveling salesmen, grocers, manicures, school teachers, millionaires, and ran from New York's Park Avenue to Sauk Center's Main Street, disclosed surprisingly that more than one-fourth of them knew who Toscanini was and what he did. When Toscanini was giving concerts on Saturday evenings, in a studio seating about 1200 persons, the broadcasting chain received an average of more than 50,000 requests for seats at each performance.

Music, which speaks an international tongue, has been democratized by the radio. The most familiar definition of culture, "to know the best that has been said and thought in the world," now has been broadened to in-

clude an acquaintance with the best music that has been written and played. The average listener, who finds most scientists, philosophers and distinguished men of letters beyond his ken, does not feel that Beethoven or Chopin is out of reach, and it is he who has forced the change. The province of music is not limited to a group of specialists but is a continent as broad and as varied as North America.

When the superliner *Queen Mary*, on her maiden voyage from Southampton to New York, broadcast a program from off the coast of Ireland to a marveling world, it was not an operatic aria nor a symphonic selection, but a thumping torch song. To this extent at least the judgment of program tsars, who devote a lot of ethereal and muscular energy to blues and the like, found a confirmation of their judgment. The owners of the majestic ship thought as the program pooh-bahs thought about the public taste. Well, ocean transportation is in the hands of private industry, just as the radio is, and just as transportation by air is. When it became possible to fly from New York to Los Angeles the promoters did not advertise nor emphasize California sunsets nor a bird's-eye view of the Rockies, but the fact that it was possible to break one's fast, first on one coast and then on the other. The appeal was to the carnal inner man rather than to the esthetic, and that is the major appeal of the radio, in spite of the facts established by surveys.

In the field of current events the transmitter gives but little better account of itself than in the field of music. With the exception of a few women who reserve the

right to speak their minds, the commentators on news are as biased certainly as newspaper columnists, and betray much more frequently the influence of the advertiser. Some of them have won large followings either by simulated excitement, an air of "inside" information, a lively sense of humor or a racily attractive manner, but they do not distribute the truth, the whole truth and nothing but the truth.

In regard to controversial issues we are served somewhat better. A weekly forum at the Town Hall Club in New York City was put on the air in 1929 and caught on so conspicuously that hundreds of smaller chains took the cue. Speakers representing divergent viewpoints give the pro and con of the issue, in a fashion soundly democratic, and are heckled thereafter, as a rule, by persons in the immediate audience. This leveling and spreading of social, political and economic argument is more effective than the unmistakable democratization of music because radio executives have recognized it as good business, whereas they appear still to put their faith in Tin Pan Alley rather than the classics.

Mrs. Franklin D. Roosevelt, Mrs. Mary Beard, Inez Haynes Irwin and Alice Roosevelt Longworth have been among the women commentators who spoke their minds, both on news and on controversial issues. Dorothy Thompson was the first woman ever to help report by air the proceedings of national political conventions, from the floors of both major parties. The first Chinese woman to make her voice heard on the other side of the world was Madame Chiang Kai-shek, wife of a generalissimo and political leader, who discussed, in fault-

less English, the "New Life" movement in her country. Signorina Liso Sergio, sometimes called "the golden voice of Rome," was heard on the air before any woman in the United States.

In this country women had their first important place in radio programs in 1934, and one of the major chains would not admit them until two years later. Executives supposed their voices were not suited to the medium. When they made room timorously for the newcomers they were pleasantly surprised to find not only that the message carried well but that the listeners were responsive. Broadcasts by officials of women's organizations are now a commonplace. Geraldine Farrar and Marcia Davenport have dealt discerningly with musical programs. Mary Margaret McBride, newspaper columnist and magazine contributor, has a name somewhat too unwieldy for radio programs so she is known to uncounted admirers as Martha Deane. Kathryn Cravens was headed for the stage when she heard a news broadcast which altered her ambition, so that she began discussing "News Through a Woman's Eyes." Anne Hard, who became a Fellow in Greek while at college, has traveled widely and is not dreaded anywhere because her broadcasts are highbrow. The array is too extensive to be set down here in detail ; but it may be said with safety that by and large women do somewhat better than men at the microphone. They have a primary advantage, to be sure ; they are on the inside track with the majority of the audience. They know what interests that feminine majority, and they speak its language.

A comparison of woman's steady march to the ballot

box with her slow entrance into radio suggests that perhaps politicians are wider awake than broadcasting officials.

Whether the radio is supplanting the daily press as a medium of news, and may oust it from that field when it can send a paper visually into the home, is a debatable question. A survey, somewhat too sketchy to be quite satisfactory, indicated that twice as many persons depended on newspapers; but President Robert Maynard Hutchins of Chicago University estimates that one-third of our population suffers congenital difficulty in acquiring information from print. The New York Association of Teachers of English has reported that radio, with its "crooning, swing music, gags, super-plus melodramatics and juvenile junk liberally interlarded with advertising" is nothing short of a "menace."

It was the "juvenile junk," evidently, which prompted George Henry Payne to say that radio might make us "a nation of grown-up children," to declare that it was "stopping the growth of the American mind" and to call for a house-cleaning or an accounting of the broadcaster's stewardship. Not long thereafter the Federal Communications Commission announced that it would investigate the "monopolistic tendencies" and other economic and social aspects of the industry. The commission reported to Congress that it was powerless to curb misleading and objectionable medical or other advertising, and reported also that it had received many complaints about stock-selling schemes and commercial fortune-telling on the air.

We spend annually much more than a billion dollars on amusement, and nearly one-fourth of it goes for radio sets, running in number between nine and ten millions. New receivers sometimes have push-button automatic tuning and dials to simplify finding overseas stations; our air is crowded with broadcasts from all parts of the world, some of them unblushing propaganda. The words of Mussolini and Hitler come to us actually before they reach the ears of persons in the rear of halls where they are speaking, and we may learn of events in Bangkok before they have happened there according to the clock or calendar.

In *A Midsummer Night's Dream*, Puck put a girdle around the earth in forty minutes. Radio girdles the earth in the fraction of a minute. Whether we shall close our air channels to alien broadcasts, if possible, by "jamming" them with stronger stations; whether we shall censor and restrict our own stations, and thus limit the freedom of the air far more severely than the freedom of the press has been transgressed by governmental authority, are questions still awaiting solution. It is probable that no hard-and-fast, clear-cut answer will be found to them. But a Yes or No should be found for the inquiry whether our communication through the air shall continue as an enterprise governed by the profit motive, or shall be taken over by the government and operated as the British Broadcasting Company is managed.

Two stations, KDKA in Pittsburgh and WWJ in Detroit, lay claim to primacy in radio transmission, in

August 1920. We saw our first motion picture in 1895, heard our first wireless a quarter of a century later. But it was in 1875 that Clerk-Maxwell demonstrated, mathematically at least, that light waves were electromagnetic, and suggested that there must be other similar waves to which our eyes were blind. Two years later Heinrich Hertz gave a practical demonstration that the suggestion was sound ; he generated what he called "wireless waves," focused, reflected and polarized them.

"I am here to support the assertion," said the father of the Hertzian wave, "that light of every kind is itself an electrical phenomenon – the light of the sun, the light of the candle, the light of the glowworm. Take away from the world electricity, and light disappears ; remove from the world the luminiferous ether, and electric and magnetic effects can no longer be produced in space."

Sir William Crookes, chemist, noting that Hertzian waves were not obscured by fog and could pierce mountains, suggested that they might be utilized for signaling through space. Marconi, seizing that idea, was first to devise an instrument for signaling, but when he was asked in 1897 how far such messages might travel, he hazarded, "Twenty miles."

At any rate, here was something better than the signal flares in ancient Greece, warning Clytemnestra that her victorious husband was returning from the wars and that she would better quit her philandering. Sir Oliver Lodge received the first signals transmitted from ship to shore. At first it was supposed that the principal value of wireless would be at sea, and especially in warfare. Back in 1897 the Italian Navy was equipped with it.

Two years later the British Admiralty established it at shore stations and on thirty-two fighting craft; even a French gunboat was so supplied. Nationalist pride and competition played a large part in developing the discovery. At one point the United States Navy interfered with certain negotiations for fear Great Britain would set up a world monopoly of radio communication. Long before Japan made informal war in China, the United States, Britain and Japan fell into a sharp dispute about radio control in that "backward" country. The Germans were first to realize that this necromancer might be useful for trade, and opened the initial commercial station.

A subsidiary of the British Marconi Company was formed in the United States in 1899. Lee De Forest's patents on the three-element tube provoked litigation thereafter, while inventive talent was atiptoe and companies were multiplying to exploit the novelty. It was not until 1919 that the General Electric Company instigated the formation of the Radio Corporation of America, in an attempt to stabilize the industry; and during the next year the sale of receiving sets amounted to $2,000,000, which was rated as remarkable. In that year, 1920, the Westinghouse Company put into operation the first permanent radio-broadcasting station in this country. Then began the periods of boom and bust which seem to characterize our new industries, quite apart from our periodic rises and recessions; the childhood measles and mumps of radio appeared to have been cured when the National Broadcasting Company was formed in 1926 and the Columbia two years later. In

1929 the sale of receiving sets reached $800,000,000.

If a Pittsburgh factory had not begun turning out crystal receiving sets for the United Fruit Company, what is known as the sustaining program would have been later aborning. Commercial programs, sponsored by an advertiser, take about one-third of the time on the air, and they average four-fifths entertainment, the balance of the time being devoted to sales talk or propaganda. Sustaining programs, consisting at first of music from gramophone records, were devised as a means of selling the crystal sets, whose purchasers wanted to hear something more than "Are you there?"

To meet that demand, the Westinghouse Company looked about its shop at Newark, in search of a program manager. There was a belief that he must be college bred, and Charles B. Popenoe was chosen on the basis of his sheepskin. The studio was the women's cloakroom at the factory, because it had been observed that the wraps deadened sounds from outside. This observation developed into acoustics so elaborate that some studios are now swung in space, to provide air walls around them.

At that time there was no notion that persons or firms with things to sell might utilize the radio. It was still too innocent to be commercial. Not until after Miss Amy Lowell and Robert Service had made plain that the human voice could be transmitted as well as a gramophone record, by reading their verses, did a New York department store and other advertisers begin to take advantage of the medium. Now "sponsors" may pay as much as $15,000 an hour.

Fancy any newspaper, or the Association of Newspaper Publishers, organizing a bureau to single out for reprobation or reproval advertisers who violated a general policy of decency, sound business ethics and good taste! Large broadcasting chains do this, and one of them reported sadly that 158 advertisers of cosmetics, 146 advertisers of foods and beverages, 128 advertisers of medicines, mostly patent medicines, had transgressed. Yet in spite of these precautions, there was widespread complaint of the nature of the ballyhoo that went over the air.

Essentially the difference between marketing a magazine and marketing a radio program is the difference between appealing to the literate and to the mass. The publication can wait to be read and to establish itself, moreover, whereas the broadcast must succeed at once or it is lost. Most of the diatribes against radio arise from the fact that it is addressed in the main to what the editor recognizes as subcirculation. This is not true of the programs on WQXR, a station in New York City, which finds sponsors for some of its excellent programs; and grand opera was broadcast first to advertise a dentifrice, then a cigarette.

When hard-headed business men, concerned only with profitable returns on their investments, find that symphonic, classical and operatic programs pay their way it is the more surprising that the bulk of the radio's time is given to crooning, slapstick humor and general nonsense. George Henry Payne seems justified in describing these as "moronic." He retorted to a complaint by David Sarnoff of the Radio Corporation of America,

who said that the Federal Communications Commission "leaves the door open for indirect and insidious government censorship," that he might well have expected "a milder tone from the head of the company that was responsible for the Mae West broadcast." The St. Louis *Globe-Democrat* asserts with a show of reason that "the listening public will not always be satisfied to have its mental age reckoned at 'below ten' by those who concoct the programs."

In many homes there is a separate radio set in the kitchen, in others there are sets in the children's playroom and in bedrooms. Even when there is but one receiver its upkeep in good order may prove an item in the budget. Few laymen can learn how to remedy faults in their instruments, but if difficulty arises from an outworn tube this is not impossible to discover; the tube can be unscrewed, if it does not light when the current is on, and can be replaced at a nearby shop. If the trouble is more obscure, an expert must be summoned; there are service stations which provide all repairs and a complete check of the instrument at $1.50 a month, and clean the cabinet to boot.

As in all expanding industries, prices are likely to decline. Whatever the price, it appears justified. There is good reason to believe that radio is like to supply to the public, as time goes on, more and more of its amusement, factual material and education. Already it is a factor in our social, cultural and political life. It is a possibility that the art of reading may be limited presently to a small class, and that most of the population

will depend on the ear and on wireless pictures for its knowledge. Already a deal is being done in the field of education, and pupils may get from the air, sometimes, better instruction than they could expect from their teachers.

Motion pictures are becoming almost as pervasive as the radio. Outlying villages and farm houses, too distant from "picture palaces" to make practicable enjoyment of this diversion, enjoy it nevertheless in their homes. Commercial films have been at their disposal for years.

The Rev. Dr. Fosdick's complaint that we "create the cinema and degrade morals with it," cannot apply to the product manufactured for household display. Bedroom and bathroom scenes, the exaggeration of the trivial and the glorification of gangsters or their pursuers do not find a ready market with this audience. Yet the range of offerings is nearly as great as in the commercial house. It embraces drama and comedy, scenics and travel, adventure and the thriller. Sometimes an early favorite, such as *The Covered Wagon*, or a Charlie Chaplin hit, or *The Hunchback of Notre Dame* is done over in the sixteen-millimeter film dispensed to the domestic market.

To some extent the exhibitors in the home are organized. The Amateur Cinema League has a membership of thousands, embracing bank presidents, Pullman porters, business executives, barbers and a former king of Siam. Sixteen countries are represented on its rolls. Galli-Curci was an early and enthusiastic subscriber,

when Hiram Percy Maxim was president of the organization, and Rudy Vallee became a "fan" later. One member asked sadly that his dues be suspended : he was at a disadvantage because he had been sent to a penitentiary. About one-tenth of the members are physicians, dentists and other professional folk.

Some families boast their own cameras. These are employed for the most part to make moving pictures of the children at play or on the bathing beach, of sportive dogs and cats, even of weddings. But the large trade, from the industrial standpoint, is in the manufacture of projectors for home use, and of films for them. Those who can afford it may have expensive projectors which give technicolor pictures with sound ; they may hear musical novelties in the living room. As a rule the films are rented rather than sold outright ; but when there is a newsreel of a disaster such as the destruction of the dirigible *Hindenburg*, for example, ardent collectors are eager to own them for their "libraries."

Sometimes these smaller reels are made of local events for exhibition at a neighborhood commercial house. A parade or an Elks' picnic may swell the boxoffice receipts enough to justify the outlay, and no special skill is needed in "shooting" such scenes. Manufacturers occasionally send along a commentator with a reel for exhibition in an outlying town ; he can pack into his automobile even the equipment for a sound-and-color picture.

In the industrial field these films play an important rôle. Some of the larger corporations make pictures of exceptional interest, in which the promotional factor is

unobtrusive, and distribute them without charge. Their value may lie only in what the advertising man terms "attention-calling," but the better the film the longer it is likely to linger in memory. A motion picture, for example, of the construction in its higher reaches of the Empire State Building in New York City, distributed by a firm whose machinery aided in the work, found a wide and appreciative audience. Industrial processes and research afford many fascinating spots for such pictures, which could not be presented in commercial houses, owing to the fear of causing resentment, but which are accepted eagerly for home presentation.

In the educational sphere the sixteen-millimeter film occupies a place even more important. The student of surgery, for example, can get from a motion picture of an operation a much more precise idea of what the surgeon is doing than would be possible from a seat in the chamber. History, biology and chemistry are being taught in this way, largely to those who expect in turn to teach them in the classroom.

At the New York headquarters of the Amateur Cinema League beginners are advised on technical matters, and get help in other directions. Whether they are engaged in making a picture in praise of fascism or communism or an industry does not matter, so long as the subject has not behind it a purpose obviously fraudulent. In the Amateur Cinema League there is freedom of expression. The first amendment to the Constitution has full sway there. Large distributors, who still oppose the household picture for obvious reasons, complain that the threat of Federal censorship hangs over them, but

there appears to be no such danger for the sixteen-millimeter. Since it is seldom if ever used in interstate displays, there is good reason to doubt whether Uncle Sam could interfere even if he were so disposed.

Not only the commercial motion picture exhibitor but the sponsor of radio programs has his competitor. Excellent programs, usually of string music, are now distributed by telephone wires rather than the ether. They have the advantage of being free of strident announcers and of advertising. Installation and service are by no means exorbitant, and this new industry has made rapid gains. It is a twenty-four-hour service in most places, and has been taken for the most part by restaurants, clubs and bars; but already householders who resent the character of the advertising they hear from their radio sets, or the nature of the programs, have begun to take advantage of the novelty.

With motion pictures, programs by telephone or by air, and a multitude of time-saving, muscle-saving and care-saving devices available for the house, we are likely to take too much for granted the fact that at the table we have defeated the seasons. Even a generation ago an orange at the toe of the Christmas stocking was the occasion of applause and delight. Now tropic fruits and vegetables are on the market stands the year 'round, and all the nations of the earth contribute to the refreshment of the American palate. If they are not bought from the open stands they can be obtained in packages, and if they have been subjected to quick freezing the household equipment comes into play, for an automatic

refrigerator is needed. To enjoy a variety of diet with fresh vegetables and fruits in frozen climes contributes undoubtedly to health. Louis I. Dublin, matter-of-fact insurance statistician, warns us that we shall die sooner if we don't get married ; "the home environment is more healthy," he says.

CHAPTER XII

BROTHER TO THE OX?

Farming is one of the most backward of our major industries. It is subject to more hazards than others: flood and drouth, storm and insect pests; but it lags also because in rural areas there is less disposition to take advantage of the multiple mechanical devices meant to lighten the labor and reduce the costs of operation.

Insofar as the household conveniences and comforts common to the urban home are concerned, the farm, even when isolated, does not differ greatly from the city, for gas and electric and steam power can be provided there as well as in populous districts; so there is no need to discuss here the appliances for the laundry and for lighting, refrigeration, cleaning and so on. It is in the use of mechanical improvements especially invented for agriculture that this industry is backward.

It is a major industry because its cash income from marketings runs now around ten billions, as compared with less than four and one-half billions in 1932. Nearly one-third of our people live on farms, and it is estimated that about one-sixth of all our acreage, aside from forests and woodlands, pasturage and non-agricultural tracts, is required to feed and clothe the people. It is a major industry because it is of primary importance to the national life, either in peace or war.

As in any other major industry, mechanization involves efficiency, volume of output, prices, costs, in-

come and net gain or loss. The sales manager of one corporation has declared that there is a five-billion-dollar outlet on the farm for electrical goods alone, aside from the use of gas and steam. It has been reported by *Business Week* that farms were being electrified at the rate of thirty-two per cent a year, but that is a somewhat nebulous statement, for mere electric lighting may bring a house into this status. Another good authority finds that of more than six and one-half million farms having occupied dwellings, only a little more than one and one-third millions enjoy electric service.

This is not to say that the farmer and his wife are totally indifferent to the advantages of machinery. When the Rural Electrification Administration began coddling the man with the hoe under the New Deal, one woman bought a vacuum cleaner immediately her home had been wired. As there wasn't a rug in the house, this was puzzling; but she explained that as soon as the apple crop was sold she meant to buy a rug, and then could put the cleaner to use. On another farm there was a bill for current averaging fifteen dollars a month, but there was no electrical contrivance save a refrigerator; it was explained that the door was being left open day and night in hot weather, to cool the house, and that the improvement seemed well worth the price. Another wrote gratefully that he had saved the lives of four new-born calves by carrying them from the barn into the house and reviving them with the bathroom heater. Still another reported that, although he was accustomed to lose at least one pig in every litter, he had reared six litters without a loss, because he had put electric lights

in the farrowing shed, so that the piggies could see and did not trample the weaklings to death in the rush for dinner.

To the contrary, a fairly recent survey revealed that farm houses boasting bathtubs ranged from sixty-eight per cent in California rapidly down to three per cent in Alabama; that those having a kitchen sink and drain ran from ninety-eight per cent in Maine down to three per cent in South Carolina, Georgia and Alabama; that those having central heat ran from a bit more than half in New Jersey to less than one-fifth of one per cent in Arizona; that refrigeration varied from eighty-five per cent in Rhode Island to twelve in Louisiana; power washing machines from eighty-three per cent in Utah to less than one per cent in Georgia and some other states; and that although ninety-five per cent of the dwellings in Massachusetts had a water supply in the house, many other states, including Oklahoma and South Dakota, were woefully deficient.

Changes from human power to the use of the lower animals and thence to mechanical power have been more rapid in the United States than elsewhere in the world, but nevertheless have been slow. The high cost of manual labor and the unreliability of transients seem to have been potent factors in causing the changes. During the last generation the number of man-hours in the production of crops had been reduced in some localities by half; yet at the beginning of 1938 there were still more than eleven million horses in use on our farms, and nearly four and one-half million mules. In 1830 more

than half the plowing and sowing of wheat was done by hand, nearly all the reaping, binding and shocking, threshing and stacking the straw, and two-thirds of the winnowing. A century later the manual labor – including the operation of machines – was less than one per cent. With the sickle and flail, about forty-seven man-hours were required to produce twenty bushels of wheat; with machinery this was reduced to two man hours. Similar conditions prevail in regard to corn, cotton and other crops.

With the development of urban industry, more and more workers were drawn away from the farms; in 1820, eighty-three per cent of all who worked for pay were in agriculture; in 1930, less than twenty-two per cent were so engaged. Before the Civil War, the average farm worker cared for about fifteen acres; now he tends some thirty-six acres. At the end of that war the value of power and machinery to each worker was one hundred and forty-four dollars, whereas in 1930 it was four hundred and forty-four dollars, with automobiles accounting for one-fifth of the increase. To put it in another way, the average worker had at his command prior to the war one and one-half horsepower, where now he has seven.

By 1930 our farms were utilizing two billion gallons of petroleum fuels and ninety-odd million gallons of lubricating oils. Not until 1920 did the use of machines on the farm encroach greatly on the number of work animals, and we have seen that they still number some sixteen millions. It is an odd coincidence that a twelve-hundred-pound horse exercises a power equivalent to

eight one-hundred-and-fifty-pound men. The use of oxen has been decreasing steadily since 1860, and few can be seen nowadays.

In some parts of the United States steam engines and windmills came into use soon after the Civil War. In plowing and the threshing of grains steam plows were employed, but animals still did the bulk of work. In those regions which tended to be dry the windmill found its greatest popularity, and was used for pumping. Steam began to fade from the picture as the effectiveness of the gas tractor and the motor truck were more widely realized, but there was little change in the number of windmills.

Not until we were nearing the close of the last century did the stationary gas engine begin to be utilized, and not until after the turn of the century the automobile, and gas-driven tractor and truck. Since 1918 we have witnessed the greatest increase of mechanical power on the farm, with growing use of the electric motor. Despite the profound depression which began toward the end of 1929, the use of electricity and gas in agriculture increased steadily. In 1929 our farmers paid nearly fifty million dollars for electricity alone, a large part of it for irrigation pumping. For years the value of automatic energy in labor saving equipment for the major operations was almost ignored, while the gadgets which make urban households more comfortable and housekeeping there the easier spread more rapidly to rural regions. The flatiron, percolator, milking machine, toaster, cream separator, radio and vacuum cleaner, which required but

little power, were in use far more hours every year than the machines for grinding feed, threshing grain and doing other heavy chores.

A good deal may be said on behalf of four-footed power as against machines driven by gas, electricity or steam. Both horses and mules provide reserve power against temporary overload and in emergencies; their feed can be produced on the farm, and they can be hitched in units of flexible size. They are adapted to practically all draft work, can pull over loose or wet ground, and incidentally they assist in fertilizing the soil. But they are below par in hot weather, they must rest frequently under heavy loads, and they cannot work a twenty-four-hour day, if need be, as the automatic machine can. They require more care when not in use and must be fed even when in harness. And in the sordid matter of dollars and cents the machine gets the better of them.

Pumps, for example, can be operated best by water or wind, gasoline, electricity or steam. With hydropneumatic tanks nearby, water can be stored to supply pressure for the household system, the barn and the dairy. It has been observed that when water at the proper temperature is supplied to the cow's drinking cup to drink when she pleases she produces more butter fat. Milk goes nowadays from teat to consumer, at less cost and of better quality, thanks to machines. There are devices for milking the cow, separating the cream, churning it, packaging the butter and sending it on its way; for pas-

teurizing and bottling whole milk or skimmed milk or buttermilk. And radio plays its part in encouraging the contented bossy.

Some ten years ago a learned German wrote a thesis on the influence of music on the yield of milk, and the idea was sponsored by the University of Halle. Now the *Deutsche Allgemeine Zeitung* of Berlin has a slogan: "Farmers, install loudspeakers in your cowsheds! Your cows will give more milk!" Several dependable pamphlets and books have appeared on the subject. If no radio is available, gramophone records will do as well. Cows prefer slow, heavy melodies, and those which were most susceptible had the best characteristics otherwise. One doted above everything on a Caruso record, and another gave the most milk when listening to "Tonight or Never."

In this country, according to *Electrical Merchandising*, dairy farms on the Pacific Coast were first to install radios. One western farmer at least has installed an annunciator to call the pigs, "without leaving the comfort of his rocking chair."

Agnes Repplier tells us in her essay on *The Masterful Puritan* that for four years after the Pilgrims landed at Plymouth Rock they had no cow. "We should better understand," she says, "what life was like in that harsh wilderness, where children who could not get along without milk had but one alternative – to die."

Contrast, if you will, the pitiful plight of New England colonists with our farmers today, owners of some twenty-six million cows. The problem today is not how to get milk, but how to put the supply on hand to

the most profitable use. Shall it be sent to a creamery, or churned at home? A Wisconsin farmer, owner of a fine herd, with condenseries and cheese factories all around him, decided first that he would separate the cream for himself, because he wanted the skim milk, fresh, sweet and warm, for a flock of calves. He knew that a creamery would pay him for cream on the basis of its butter fat content about the same as the prevailing market price for an equivalent of butter, and so he decided to do his own churning.

Customers aplenty were waiting for that man's butter and for his buttermilk, which he bottled and sold at eight cents a quart. When he had more skim milk than he needed, he made it into cottage cheese. A one-half-horsepower engine churned sixty pounds of butter in a batch from some twenty gallons of cream, and he profited handsomely.

The fact is that cream yields about one-fifth more butter than it contains of butter fat. The difference is called the overrun, and is due to salt and moisture. The creamery, paying for butter fat the market price for that weight of butter, pays for its packaging, advertising and marketing out of the overrun, and has a margin of profit beside.

Dairy farmers find, too, that artificial ice saves them a deal of money. They know that after a mild winter their supply of ice in storage is inadequate or totally lacking; and that even after a severe winter they must supplement it by purchases. A farmer near Washington, D. C., spent an average of $14.40 a month in this way, and in summer sometimes as much as $20.00, before he

began making his own ice. Now his milk containers are automatically cooled, and he uses machines for milking, grinding feed, pumping his water, cooking, warming a brooder, and lighting his poultry house as well as his home. Five horsepower does the work, and his bill for all the power is seldom more than $25.00 a month.

Hens have submitted no less meekly than cows to efficiency. From test tube to the morning skillet the egg may well follow a mechanized route. Long an individualist is regard to diet and rest and in domestic matters, the hen is no longer permitted always to choose her mate. No, chickens are hatched by modern methods from eggs fertilized by artificial semination, and their mothers are regimented like factory workers in separate cells, while their fathers may be hundreds of miles away. The practicability of this process has been demonstrated on a mass scale. Yes, it is possible even to vary the color of the egg yolk by special feeding of the hen. Yolks of red and green have been produced, although what their virtue may be, aside from décor, is difficult to determine.

No longer may her ladyship of the barnyard take her sunbath as she pleases, quarrel with her companions over the possession of a worm, lay an egg when she feels like it and cackle her triumph to an admiring world. She occupies one of some thousands of metal cells, the atmosphere is air conditioned and her hours of work are artificially regulated even more rigorously than if she were a member of the C. I. O. When she betrays a predilection for loafing and becomes lax in her duties she is "culled." These "battery systems" have sprung up

rapidly about this country during the last few years. In the United States there are nearly three-quarters of a billion hens, and about one-tenth of them have been regimented as this is written.

One economy effected in this way is that when the hen no longer runs at large not so much land is required. Space requirements pushed poultry farms further and further from the cities, the cackle further and further from the sizzle of the morning skillet. The new system enabled the poultryman to put a five-acre farm into a single building on the outskirts of the city ; there are three such egg factories in Chicago's Loop, and hotel managers are experimenting with plants on the roof.

Those who have groaned at the task of picking freshly killed chickens need groan no longer, for a machine is on the market which plucks the fowl in forty seconds. Its major parts are a speedy suction fan and revolving plucker-plates, turning two hundred and fifty times a second ; the fan blows up the feathers and the plates nip them out, dry and clean, then the current of air carries them to a bag attached to the machine. In most markets there is a premium on birds plucked in this way, because the bird has fuller flavor and takes a better brown in the roaster.

It is even proposed that chickens be laundered, at least before they are to be exhibited at fairs. A specialist at North Carolina State College avers that the chicken should be doused in water at about one hundred degrees Fahrenheit, lathered thoroughly, and left to soak out its dirt without scrubbing, after which it should be rinsed in second and third tubs and then dipped in water con-

taining a bit of bluing. As farms use more washing machines than cities, the process may attain greater popularity than seems likely at first blush.

Almost all the machinery utilized for the dairy and poultry yard or poultry system is in small units. In preparing and seeding the soil, in fertilizing and cultivating, in harvesting and binding or stacking the crop and in moving it, larger pieces are required. They are available in abundance, they are efficient and economical.

As mechanical power was developed, plows were constantly improved and enlarged, until as many as fourteen disks were used. To make easier the raising and lowering of the disks, an automatic lift was invented. Disks are more likely to be at an angle than vertical, and this has come about through an interesting incident of the earlier days, when the disks were attached to wooden frames. Under pressure the wood was inclined to wear, so that the disk slipped out of alinement, and tilted. The farmer, to remedy this, drove wooden wedges into the framework, but in one instance the disk still stood at an angle, and this led to the discovery that the slope threw the earth to one side and so facilitated the work. Presently the plow and harrow were united, in an implement usually called a combine ; and since this mixes trash and wheat stubble with the soil, it tends to retain the snow and conserve moisture, in addition to preventing the blowing of soil in what has come to be known as the Midwestern Dust Bowl. But combines of this sort have been sold in large numbers only since 1927.

After the steam engine was introduced on the rail-

roads, efforts were made to adapt it to the farm, and particularly to plowing. These were first successful in England, where cables were stretched across the field, and wound by steam from one drum to another as they drew the plow across. The first recorded steam plow in this country appears to have been used by J. W. Fawkes in Pennsylvania, who is said to have constructed, in 1858, a drag capable of pulling "eight plows at the rate of three miles per hour over original prairie sod." (The suggestion of prairies in Pennsylvania is interesting.) From 1875 to the close of the century the development of steam tractors was rapid; but, although the steam engine is a century and a half old, successful steam plowing is a creation for the most part of the Twentieth Century.

W. E. Taylor says, in *Soil Culture and Modern Farm Methods*, that "the plow has blazed the way from the Garden of Eden to the magnificent farms of North America."

Seeders and corn planters are a comparatively recent development. Four rows of corn can be planted simultaneously with some machines, and fertilizer distributed at the same time; but mineral fertilizers are likely to injure the grain, and are utilized separately. With tractor corn planters, soil working attachments are available, and some have floating units to plant the grain accurately on uneven or terraced land. There are many types and sizes of these machines and of seeders, suited for nearly all conditions.

Fertilizer distributors are attached, too, to seeders, or grain drills. It was not until 1893 that a double-disk furrow opener was put on the market, and it was soon im-

proved so that the seed reached the bottom of the furrow before the soil fell back to cover it. This was the lightest machine of the sort developed to that time, and it made the hoe type obsolescent. Pressure-feed oiling, anti-friction bearings and high carbon-steel parts assured as much durability, strength and accuracy as are to be found in industrial machines. The equipment ranged in size from one-horse machines to huge power-lift tractor-drawn drills. And cultivators, which represent a development from the hoe, are myriad; they will tend growing plants in two, three or four rows.

Tractor-drawn machinery, sometimes rubber-tired, is more extensively used by rice growers than by any other group of farmers. It is employed largely in preparing the seed bed and quite generally for harvesting. As a rule an acre of rice, yielding fifty bushels, takes but five days of labor through the whole process of planting, growing, harvesting and threshing. In China, where small machinery is operated by animal power, and where the crop is harvested with a sickle and threshed by hand, fifty days of labor are required for the same processes.

With the invention of the cotton gin at the end of the eighteenth century, woolens ceased to be cheaper than cotton fabrics and were no longer made in imitation of them. Prior to this, the seed and lint had been separated by hand. Between 1921 and 1923 depredations of the boll weevil so reduced the crop that the prices of cotton increased, and the growing belt was extended into Texas and Oklahoma, where, for one thing, weeds were few, and where huge cattle ranches were converted into cotton farms. It was there that the trac-

tor for general farm purposes first became popular. Cultivators and listers to take care of two rows at once became common in a short while. Handstripping has been superseded to a great extent by the sled, or stripping machine. A family in this new southwestern area often grows from one hundred to two hundred acres of cotton, and employs outside labor only in harvesting.

During this century the gasoline motor has been the most important addition to agricultural machinery. Tractors were common at first only in the wheat areas, but have been developed for light draft operations and have multiplied since 1925. Tobacco, sugar-beet and truck farmers, as well as fruit growers, often use smaller units of machinery. Fruit growers sometimes spray their trees with ethylene, which is odorless and is not poisonous, to speed the ripening process and give a sounder, more flavorful product.

Indeed, gas for cooking, heating, lighting and power on the farm is supplied by a compact generator which burns nearly anything handy, such as corncobs, leaves, straw, paper and refuse. It has been estimated that two tons will yield gas for three months in an average family.

Sometimes garbage is used also for feed or fertilizer.

Ingenious farmers have circumvented bulls and steers which break their fences by running along the rails, waisthigh, an electric wire, and charging it from a battery if other current is not available. If there are hogs to be kept in their place, another wire is strung low. Even the most ferocious bull will turn back at a touch of electric shock, and the cost of the current is far less than the expense of repairing a fence.

To cope with the pests which destroy vegetables, grains and fruits, lighted traps are gradually supplanting insecticides. Grape-leaf hoppers, artichoke plume moths and cigarette beetles have been caught and destroyed wholesale in this fashion ; a single trap has been known to kill a million beetles in four days. In Illinois a homemade contraption called a "hopperdozer" has harvested grasshoppers at the rate of a bushel an hour, and it is estimated that there are two hundred thousand insects to the bushel. The machine, twelve feet wide, was attached to the front of a truck, driven through the fields to disturb the grasshoppers, which, when they rose, struck a backstop and fell into a tank of poisoned water.

In the United States there are almost as many rats as human beings, and only about one-fourth of them are in towns of ten thousand or more. The others are in villages and on farms. As foraging is easy in the rural areas, there are few rat-free farms. In one Texas county with a population of some thirty-five thousand, a rat-killing campaign brought out more than one hundred and fifty thousand tails in six weeks. Both the brown and black rats are importations from Europe, and were introduced to this country from the first ships to cross the Atlantic. They are holding their own tenaciously in agricultural districts, in spite of vigorous organized attempts to exterminate them. They are a crafty, hardy and destructive breed.

It seems probable that hunger spurred the ingenuity of primitive man more actively than the need for shelter and clothes. No inventive twist was required to take

advantage of a cave or to dry out the skin of an animal for protection against cold; but the gathering of wild berries, fruits and grains was seasonal and precarious, so that he began presently to cast about for means of growing them. No writer has accounted satisfactorily for the beginnings of the plow, at first a crooked stick, which was developed to a certain efficiency in ancient Egypt and thence reached Greece. It was operated by man power, and in the South by slaves on many plantations, almost up to the Civil War.

After the discovery of metals, the wooden parts which furrowed the ground were plated; Virgil says that the old Roman plow was made of two pieces of wood meeting at a sharp angle and covered with iron. The Dutch are said to have been the first people to improve on this. In this country our early statesmen were not above devoting attention to such matters. Thomas Jefferson was one of the first to tell how the wooden moldings could be made uniform, so that the village smithy could make uniform metal plates; and in 1836 or '37 Daniel Webster invented a plow, duly described by the New York State Agricultural Society as "having been twelve feet long from the bridle to the tip of the handles; the landslide is four feet long; the bar and share are forged together; the moldboard is of wood plated with iron." Webster was impatient because the plows he saw could not turn a furrow more than six inches deep; his implement dug from twelve to fourteen inches. He specialized in fine cattle, particularly oxen, and reported with gratification: "When I have hold of the handles of my big plow in such a field as this – a brush-covered pasture – with four

yokes of oxen to pull it through, and hear the roots crack and see the stumps all go under the furrow out of sight, and observe the clean, mellowed surface of the plowed land, I feel more enthusiasm over my achievement than comes from my encounters in public life in Washington."

Once man had learned to turn the soil with facility, he began devising means of planting grain and seed. Pliny says that the early Romans sowed their corn with as much care as they raised their armies. Columbus found that the natives of the West Indies ate bread made of maize; and Captain John Smith, when he visited Jamestown, Virginia, in 1609, two years after the London Company founded the settlement and more than a decade before the Pilgrims touched Plymouth Rock, noted of the Indians that "the greatest labor they take is in planting corn." Governor John Winthrop, Jr., of Connecticut, observed that some of the Indians, in planting, "took the time of the coming up of a fish, called Aloofes, into the rivers; others of the budding of some trees. . . Where the ground is bad or worn out, the Indians used to put two or three of the aforementioned fishes under or adjacent to each corn-hill, whereby they had many times a crop double to what the ground would otherwise have produced. . . The English settlers in Connecticut before 1678 had introduced the plow in cultivating maize." The corn was dropped by hand in those days from a bucket or pouch, and wheat was broadcast. The mechanical planter was an American invention; patents were issued as early as 1799. The Commissioner of Agriculture reported in 1869: "Fifteen years ago

there were but four patented hand planters ; today there are over a hundred." The first patent was granted to Eliakin Spooner of Vermont for a corn planter ; the first for a cotton planter to Christopher Ford of Virginia, in 1825.

Resourceful settlers soon began casting around for a way to improve on the hoe. The first patent for a cultivator was registered in 1819, and for cast-steel cultivators in 1827. At the beginning of that century Pittsburgh began making scythes, sickles, shovels and other farm hardware. But as late as the middle of the Nineteenth Century, in the South, the hoe was still the principal instrument of husbandry. England preceded us in this as in other agricultural advances.

Crude grain drills date back to the dawn of history. W. L. Braley, in an article for *Farm Implement News*, "Some 4730 Years of Grain Drill History," says that these devices are recorded "simultaneously with the history of man from the primitive stage." In ancient Egypt seed were scattered by hand on the mud left by the receding Nile, and the broadcaster was followed by a flock of sheep or goats, which trod the seed into the soil. In China, Japan and Arabia farmers have drilled their seed into the ground from time immemorial ; and Braley says that the first use of grain drills "occurs in Chinese history about 2800 B.C." In India their use preceded any written record.

Marked progress in machines for agriculture did not come until the Nineteenth Century, but the giant strides have been taken during this century, some of them since 1925. That the farmer has been slow to take advan-

tage of them may be due in a measure to their novelty, and to that fundamental aversion to innovations which is common to the race. It seems certain that this generation will witness immense improvements in the equipment and practices of our rural areas. When Stephen Phillips sang of raising "out of the tomb to glory the pale wheat, serene ascension by the rain prepared," he took no account of an automatic Aladdin on the farm.

CHAPTER XIII

PATHFINDERS

Whistler's impertinence in saying that the true function of art was to improve on nature cannot compare with the hardihood of the technologist, who undertakes not merely to improve on nature but actually outdoes her ; he rearranges her molecules and produces substances beyond her ken. Light-heartedly he transmutes our food, our clothes, our shelter and our environment. He has done more to democratize the American scene than radio has done to democratize music.

Press-agented as the mainstay of industry, the research laboratory has continued without fanfare to change and improve the home. Furniture which looks as though it were upholstered with leather but is not, the paint upon it, cosmetics, toiletware, garments which are not what they seem, fountain pens, household cement, shoe heels, the automobile coat, steering wheel, dashboard and buttons, the roof shingled with a fireproof composition instead of wood, are laboratory products. We have servants which appear to exercise the human senses ; they can see, hear, feel, smell and taste, to all intents, and they volunteer cheerfully to do the drudgery of the world.

Every once in so often, however, nature puts man in his place. She did this when he attempted to emulate and excel one of her humblest creatures, a worm some three inches long. This worm, when ready for another form of existence, squirts from a tiny orifice in its under

lip a viscous matter which hardens in the air and forms a thread, five hundred yards long or more, in which it winds itself as a protection against enemies and inclement weather. Man, unwinding this cocoon at great expense of time and toil, was envious and jealous of the silkworm. Any alert chemist, he thought, should do as well as that, for the process appeared simple. It was obvious that the worm, on its diet of mulberry leaves, was converting cellulose into a liquid which had the property of becoming tough and shiny in the air. René Réaumur wrote two centuries ago that someone ought to take this good business away from the underworld and turn it over to competent chemists.

What was needed was just the right solvent for cellulose. A solvent of a sort was found, and rayon was introduced to the world at the Paris International Exhibition of 1889. Dismissed airily as "a passing fad," it caught on amazingly after a time. We now have rayon suits even for men, and they are said to be satisfactorily durable. So popular was this synthetic fabric that Waldemar Kaempffert asserted, in the *New York Times* that it "precipitated a crisis among Chinese and Japanese silk growers." The fact was that we bought silk even when rayon was skyrocketing. While rayon was climbing from nothing to a sale of 143,000,000 pounds in this country, 1.15 pounds per person, we more than doubled our consumption of silk, from 52,000,000 pounds to .84 pounds per capita.

That was because man, two centuries after Réaumur had thrown out his fertile suggestion, still had not found a good, going solvent for cellulose. This is one field

in which our technologist is still an "almoster." After mixing wood pulp or bleached-cotton linters with a copper compound he can dissolve them in concentrated ammonia, clean the liquid and force it through tiny orifices into a solution where the cellulose is deposited as a thread. But it is not pure cellulose, and it is a long way from the output of the humble silkworm.

Rayon is a cousin of the cellophane in which loaves of bread, packages of cigarettes and so on are wrapped. Both have been subjected to derisive jests, rayon presumably because it attempts to imitate a superior, cellophane perhaps because it causes a deal of irritation.

In your garage is a car varnished, in all probability, with a lacquer cooked up by the technologist. The most up-to-date automobile in 1913 required twenty-one coats of paints and varnishes, and even seven years later the painting job took eleven days. Three years later, thanks to nitrocellulose lacquers, the time was cut to two days ; but now the body is made of metal and coated in a single day with any color the whimsical public may desire. The coating requires but two hours.

A research chemist in Utica, New York, has perfected and patented a process for making such lacquers out of the casein and lactose of surplus milk, after treating them with a weak acid. The dairy is not likely to lack a market for its skimmed milk. The casein can be converted, for one thing, into a fairly good artificial wool. And the farm will profit likewise. Corncobs, oat hulls and the wastes from cotton are being put to use. And the soy bean, indigenous to China and India, has been trans-

planted profitably to American farms, for sauces, forage and as a raw material which goes along with milk into your automobile.

A meal obtained from soy beans, after being subjected to high pressure and treated synthetically with chemicals, emerges as motor parts. The meal of this herb and its oil go into plastics from which come radio cabinets, table tops, tiling for floors, brackets, spools, shuttles and buttons. Nature provided us with resins, but not with plastics as we know them now, and they are among the triumphs which enable the technologist to smile at his defeat by the silkworm.

Adolph Baeyer, a German chemist, began in 1872 to heat carbolic acid and formaldehyde together, in an effort to get a commercial resin from them. Others followed his example, but without notable results for two generations. Science often moves with laggard steps. Not until 1909 did Leo Hendrik Baekland, an American chemist born in Belgium, concoct a plastic called bakelite, which he himself described as "a chemical synthesis from phenol and formaldehyde, replacing hard rubber and amber for uses in electricity and industrial arts where former plastics are unsuited." Nearly all electric fixtures which require insulation find some use for it. Umbrella handles, push buttons, jewelry and cigarette cases are made of it, and it goes impartially into trays for the dining room, into mines beneath the earth and airplanes above the earth ; it can be molded easily at low temperature, resists rust and nicking, and is pleasing to look upon. Already there are more than twelve hundred synthetic resins and plastics on the market, competing with it.

They may utilize petroleum, natural gas, glycerin, corncobs, oat hulls or rubber in gathering their raw materials. Yet even now there is no plastic which meets all the demands, especially in the price range.

Laboratories of the oil producers, not satisfied with plastics from petroleum, have promised to produce billions of gallons of a synthetic gasoline for your automobile or airplane — if you have one — with a quicker take-off, higher power and lower consumption. The technologist himself is restless and hopes everyone else will be. Charles F. Kettering, research director for General Motors, speaks for them thus:

"I sometimes say that my job is to keep the public reasonably dissatisfied with what they have. Some people object to that, saying that a satisfied customer is the best advertisement. A satisfied customer may be a good advertisement, but he's an awfully poor buyer."

We are expected to be skeptical, then, about the brilliant lacquers with which automobiles are finished, and well we may be. They are by no means impervious to the elements. Until the machine gets a coat of many colors which is "durable against the daily dust of life," invulnerable to sun and wind and wet, and still beautiful, we have a right to demand improvement.

Those who rhapsodize about the technologist as a magician and a miracle man seem to take no account of the fact that he has failed even more signally in his attempts to synthesize food than in his competition with the silkworm. He can make sugar from sawdust, but we can get it more cheaply from certain types of beet

and cane. He has told us a great deal about the deleterious elements in some natural foods, and has helped us get rid of them with no impairment of nutriment. He has made us uncomfortable by telling us that we spend, as a rule, twelve dollars a pound for the calcium we get in milk, when we could buy it for eight cents in a drug-store; the nigger in this woodpile is that we cannot assimilate the druggist's calcium phosphate.

Thus the rosy dream of Pierre Berthelot, that man would presently carry around his food in his vest pocket — a tiny tablet of nitrogenous matter, another of starch or sugar, a bit of fatty matter and perhaps a little aromatic spice — proves but a dream. M. Berthelot did not arrange for certain minerals which we need in our make-up and which as yet we can eat only after the vegetable world has put them through secret chemical reactions. He made no allowance for vitamins, nor for the fact that the human body requires volume and roughage, that it is a complicated organism subject to allergies and other whimsies, and that its mysteries are obstinately guarded.

No entry on the technologist's agenda offers larger returns than food. We spend almost one-third of our dollar on the table. In less than two months the average grown-up eats his weight in edibles, including the water in them. Most of our dietitians are fond of thinking of nourishment in terms of energy. They tell us how many calories we get in this food or that, and have made the very word a bane to the man or woman who wishes to reduce. On an average we take in some 3500 calories daily, but if energy were all we needed we could live on the technologist's synthetic sugar. We must have

iodin and iron and copper, phosphorus, sulphur and chlorin, to say nothing of vitamins, a Twentieth Century discovery. The technologist is proud of having devised a substance which can be substituted for cod-liver oil in supplying Vitamin D, and an acid substance which gives us Vitamin C, and the first of them is as palatable, perhaps, as the oil it replaces. But as a rule his well meant approaches are not tempting. They are not pleasing to the tongue, the nose and the eye. They are synthetic but not esthetic.

One man who graduated from the ranks of medicine into the United States Senate has observed that we can live on two-thirds of what we eat; our doctors live on the other third. This may be a sounder contribution to gastronomy than anything the technologist has offered.

Not until 1906 did we begin to suspect that fats, proteins, carbohydrates and minerals were not the be-all and the end-all of diet, and not until 1912 did an investigator cook up the word "vitamine," from which the *e* was soon dropped. After that the cookbook and the kitchen no longer had a monopoly of nutrition; the subject entered the textbook and the laboratory. There it was found that vitamins, although they are as vital to our well-being as their discoverer supposed, nevertheless contribute little to our upkeep, but are protective and gustatory. One of them helps humbly to guard the eyes from infection, another helps the nervous system escape certain diseases, and some promote appetite, two are believed to prevent scurvy and rickets, one to be needed for reproduction; but about all of them we are a good deal in the dark.

All forms of life, so far as we know, and nearly all substances in the world we see around us, depend on chemical reactions. The work of the technologist strikes to the roots of life and of inanimate matter. If sometimes he gets a setback and is rebuked by nature his task nevertheless is not to be disparaged. Let us remember that in the Middle Ages a great ado was made over a new technique of applying horsepower and that inventions to make this possible were hailed as revolutionary, although they did not introduce fundamental new methods of production. In the laboratory today there are such fundamental changes. Dr. Charles A. Beard, who championed an economic interpretation of history, has been followed by some who go a step further, and propose a technological conception; they can hardly make this stand up, but there is no denying the influence of technology on our social and economic life, even upon our political fortunes.

Not yet "chemically civilized," we have utilized in a single year the yield of 100,000 acres of cotton to make artificial leather, and cotton linters from more than 2,000,000 acres to make commodities ranging from lamp shades to films for the candid camera and the screen. We have used the product of nearly 1,500,000 acres of corn to make solvents for lacquers, and other acres to make "dry ice" and glycerine. The vexatious cotton seed, a bane of the southern Negro's perspiring life, has accounted for an item of $200,000,000 in black ink in industry's ledger. During the Civil War, when sugar was scarce in the South, molasses was used in coffee and was known as "long sweetenin';" many millions of gal-

lons are distilled now to make industrial and "rubbing" alcohol. A mixture of coal dust and air forms an explosive almost as violent as T N T, but we can deal more conveniently with cornstalks and are on the eve of utilizing petroleum for this purpose. We have uses for the refuse of slaughter houses, why not for rotting peaches and pears ?

Dame Fortune takes a hand every once in so often in these advances. We believe that bronze, an important part of many domestic utensils, was an accidental discovery early in man's tinkering with metals ; and nearly three thousand years later the photo-electric eye, which plays its part in the household, was the outcome of a fortuity. But the tires on automobiles are the result of two happy accidents in a row.

A friend of Charles Goodyear told him he had dreamed that sulphur would harden rubber. Apparently Goodyear believed in dreams, for he began experimenting with the mixture, and spent years, but not continuously, in that inquiry. Quite by chance he dropped the mixture on a hot stove, and he had vulcanized rubber. He did not know what happened at that moment, and no one has found out since then. We treat rubber on a vast scale with heat and sulphur to get a product which is harder and tougher and stronger than rubber, and which is of prime importance to industry, commerce and daily life, but we do not know as yet precisely what is happening in the process.

Years later a veterinarian whose son rode a bicycle to school over cobblestone streets wanted to improve the soft-rubber tires because the boy complained about them.

The father made a wooden wheel, fashioned a canvas loop and tacked it around the rim, inflated a rubber tube with a football pump and inserted it in the canvas container. Thus the first pneumatic tire was not a scientific invention, but it was research in the same sense that the cave man was doing research when he lengthened his arm to knock fruit from a tree with a stick. It came out of an effort to improve the *status quo*, a belief that things as they were could be improved.

The fruit of a small boy's wheedling, however, did not meet immediate approval. "Engineers," Charles F. Kettering tells us, "had many learned discussions as to the whys and wherefores of it; why it wouldn't work, and why it would work." Then, after an obscure bicycle racer, using the new tires, beat the champion, everybody agreed there must be something to it. But not until the twenties of this century was the pneumatic tire made generously durable by running cords through the rubber. It was years before the manufacturer combined the veterinarian's canvas fabric with the main material.

As for kitchen utensils, the majority of them are made of aluminum, which is more abundant than iron. In earlier days the process of reducing bauxite was so difficult that the price of aluminum was prohibitive. Charles M. Hall spent all he had developing a better process and defending his patents; then, when he was at the end of his rope, he got financial help from the Mellons of Pittsburgh, who bought up the bauxite fields and established a monopoly. A fortune usually reckoned at a billion dollars was garnered largely from the pennies of the

homemaker. There is aluminum aplenty in beds other than bauxite, but the technologist has not learned how to separate it economically.

The housewife who pays monopoly prices for her aluminum pots and pans may reflect that her aluminum cabbage slicer, with its blade of tempered steel, is a lot better than the wooden contraption her grandmother used. Instead of the metal bedwarmer, in which live coals were placed, she can have a vulcanized-rubber hot-water bottle or an electric pad. Her shining stainless cutlery is a commentary on the scythe broken in the harvest field and reluctantly adapted to kitchen uses. But the man who fashioned the "butcher knife" wore the skins of wild animals and so did his wife, whereas both of them now may wear cotton or wool or silk or rayon. Wood and coal are no longer the accepted fuels in the kitchen ; the technologist has other uses for both of them. He may make paper out of the wood, and he may distil the coal, to obtain from it a multitude of dyes and drugs after segregating the gas.

After glass, probably man's first success in synthesis, he had a long row to hoe before he could make the kind of paper on which these words are printed. At first he made parchments and then fine vellums from the skins of goats, lambs and calves, scraping them laboriously and then polishing them with pumice stone. A coarser writing material was obtained from wolf and goat skins. But long before the Christian era there were glimmerings of a better way, for there are fragments of Homer and Euripides written on a material made from papyrus leaves.

In this field, as in many others, the "backward" Chinese, doubtless the most civilized people in the world even now, led the way. More than two thousand years ago they were making paper from the inner bark of certain mulberry trees, and presently they taught the art to the Arabians. Lecky says the Mahommedans were using paper made of cotton as early as 1009; but it was not until the Fifteenth Century that paper replaced vellum and parchment in Europe.

Although some fine paper is still handmade in this country from linen and other rags, the bulk of our printing is done on cellulose fibers from wood pulp, closely woven. We use 12,000,000 tons of lumber a year to make paper, most of which we get at high prices from Canada; yet there are forest growths in the South which could be put to this use at a great saving to publishers, according to competent chemists, and although paper could be made from cornstalks and straw, which are a part of the 1,000,000,000 tons going to waste every year on the farms.

Paper, ranging from tissue to cardboard, has a multitude of uses other than for printing; packed into steel shells under high pressure, it gives us wheels which do not vibrate and rumble so unpleasantly as those of solid metals. In the kitchen it may serve for cups, hand towels, napkins, plates, as an envelope to conserve the juices of vegetables and meats; it may clean dirty stoves and soiled ash trays or line pantry shelves in some instances.

It is possible to grow vegetables in a city flat. Chemical farming, which eliminates at a single stroke plowing,

spading, and hoeing weeds, makes it possible to grow peas, beans, corn, potatoes and so on without the aid of soil. State agricultural stations have experimented successfully with shallow tanks in which the chemicals necessary for the growth are placed. Over the tanks a wire netting was placed, and the vegetables – or flowers, if preferred – were "planted" in excelsior and shavings, so that the roots struck down into the artificially fertilized water beneath. At night the tanks were covered, during the day exposed to sunlight; and semimonthly they were drained to introduce new chemicals and fresh water. Fourteen chemicals have been used; but the average householder would need to consult experts in order to know what chemicals were needed for certain growths and when to introduce them. The apartment garden is not likely to flourish at a great rate, nor generally, for the present; but it is an illustration of the influence of the technologist on the domestic scene.

That influence is manifested even in the uncanny performances of the photo-electric cell, commonly called the electric eye. Industry has employed it to count, classify and grade commodities; to act as a robot attendant upon automatic machines, and give notice when they are falling down on their jobs; to throw aside defective output, select materials and finished products on the basis of color or texture, and maintain lubrication or temperature. They stop elevators even with the floor and have even been used to keep tab on highway speeders. These are the functions of which we have heard most, but there are others which touch the housewife's interests. In irradiating milk with ultra-violet rays, for

example, so as to make it richer in the Vitamin D which is believed to prevent rickets, an electric eye takes care of the uniformity of the product. In the schoolroom an electric eye, like a conscientious janitor, may turn on more light when it is needed and avert eyestrain for the pupils. At home a beam across a passageway may cause a door to open when the beam is interrupted by the passage of the maid; the electric eye may lower or raise awnings, close windows or open the garage doors. It is the electric eye which justifies the statement that we now have devices which can see, hear, feel, smell and taste; to say this puts a slight pressure on the words, for actually the services have no sensation and merely appear to exercise these functions. But they appear also to remember, to think and to judge, so that the terms are not far-fetched in reality.

That we may perceive push buttons and other articles in the dark, if we find it needful, we owe to the accidental discovery by Antoine Becquerel, a French electrochemist, that uranium salts exercised an energy which affected photographic plates even through wood or cloth. A sample of pitchblende was even more active. He suggested to Madame Sklodowska Curie that she look further into this peculiarity, and toward the turn of the last century she and her husband succeeded in isolating radium. Thereupon it became necessary to revise all the public-school textbooks which taught as a law of physics that matter was inert. A happy accident upset ultimately our whole conception of the unseen world. The "pure" physicist began to treat matter as fundamentally insubstantial.

It is not improbable that while the Curies were reducing tons of metals other scientists were toying with the same idea. It is remarkable how often individuals or groups widely separated and without intercommunication hit upon the same line of research, and this fact is a body blow to our boastfulness that we are the most inventive people in the world, with most of the innovations to our credit. We credit Robert Fulton with being first to build a steamboat, but actually he trailed in that field. In England William Symington was nearly a quarter of a century ahead of him and Symington was not an innovator. The automobile and its four-wheel brakes are of English, not of American origin, and Leonardo da Vinci invented an airplane centuries ago. The telegraph and the telephone are not our achievements, and an Englishman ran neck-and-neck with Edison in devising the incandescent lamp. Two men, widely separated, invented electromagnetic clocks in the same year ; three, the microscope in 1610 ; three, centrifugal pumps in 1850 ; three, the phonograph in 1877. Men in three different countries discovered sun spots in 1611.

This does not mean, we may be sure, that the world made prompt use of the discoveries. It was nearly a century before we made telegraphy a servant, seventy years before we built an airplane which would stay off the ground, and on an average thirty years before we utilized other advantages.

Often those in the vanguard of scientific progress are embarrassed by their own successes. Thus when scientists began to get caustic soda from common salt by electrolysis they had chlorin on their hands as a by-product,

with little demand for it; then they found that chlorin was good for bleaching cotton sheets and other fabrics which went into the house, as well as for bleaching in industry; and then they discovered that it could be employed to sterilize water for domestic consumption, so that presently they began to be sorry they had so much caustic soda on their hands. Then it was found that the caustic was valuable in producing rayon, which took up some of the slack.

In the opening chapter of *Technological Trends and National Policy*, a report by the National Resources Committee, it is said: "If the legislators, Governors and Presidents since the beginning of the century could have foreseen the development of six industries – all but one touching the family – based on the telephone, the automobile, the airplane, the motion picture, rayon and the radio, and could have anticipated their influence on society and the changes they precipitated, they would have been in a much better position for directing the policies of the State."

Here was a direct light upon the relation of technology to politics. While the Founding Fathers were framing the Constitution in Philadelphia some of them went down to the river for a look at Fulton's steamboat, but they got no glimmer from it of the industrial revolution then aborning, nor of its power in democratizing their progeny. If they had realized this they would have been uncomfortable, for they feared the "passions of the populace," thought almost without exception of govern-

ment by the people as "government of the worst," and did not draw a democratic document; it remained for amendments to that able pronouncement to point the way to organized self-control. As a people we have met political and scientific emergencies after they arose, not by anticipation.

To a great extent the technologist does anticipate, plan and design for the future. He is disposed to rate our culture by the extent to which we depart from nature, just as the hydroelectric engineer would like to measure by horsepower; but his planning does not always provide for a rational balance between inventions and the conditions of the world to which they are offered. Inventions are disturbing, as the Founding Fathers should have known; they cause technological disemployment and sometimes upset customs. Professor Charles E. Merriam of the University of Chicago, a member of the National Resources Committee whose work I have quoted, thinks that more power to our elbows should not cause greater insecurity.

"Science cannot smugly wave aside its responsibility," Professor Merriam warns. "The older gods of power are melting in the fierce heat of modern social forces, and men look to see what is to take their place in the reorganization of associated life, in ideologies, in symbolism. Government, industry, morality, art and science are alike involved in the emerging scheme of things social."

This outpost upon the frontier of knowledge, the technologist, this pioneer in new regions of chemistry, phys-

ics, engineering and power, may not treat his obligations lightly nor is he to be lightly treated. He should be regarded, not as a necromancer but as an economic, social and political pathfinder.

CHAPTER XIV

TOMORROW

If we only had some sort of an outline of what we don't know, it would be of greater benefit than anything I can think of. I sometimes picture the situation something like this : There is a great cliff of knowledge stretching up into the sky, and about a hundred years ago a large chunk of fundamental scientific information was broken off and fell down here into a level place. It is out of this piece of basic material that the engineer has been fabricating most of the so-called modern developments in all the scientific and engineering subjects. The building of railroads, the making of new industries, the extension of electric power and communication – all these we have been getting out of that piece of rock blasted from the cliff a hundred years ago. We have become so interested in the fabrication of that fundamental information into usable products that sometimes we forget maybe it was an accident that the piece of rock fell when it did. We have been breaking it up into smaller and smaller pieces and have neglected to get a new piece of rock. . .

— *Charles F. Kettering.*

Roger Bacon, twice imprisoned for his heretical views of man and the world around him, wrote nearly five centuries ago :

"Machines for navigating are possible without rowers, so that great ships suited to river or ocean, guided by one man, may be borne with greater speed than if they were full of men. Likewise cars may be made – so that without a draught animal they may be moved

with inestimable speed . . . and flying machines are possible. . ."

Even when this continent was discovered, man could move no faster over the water than the wind could drive his ships, and no faster over land than speedy animals could run ; cars to move "with inestimable speed" were centuries in the future, and to talk of flying was still a heresy. How different Bacon's prevision from the attitude of the first United States Commissioner of Labor, who said in 1886 : "The nations of the world have overstocked themselves with machinery and manufacturing plants far in excess of the wants of production. . . The day of large profits is probably past." The next fifty years, he declared in a flatulent outgiving, could not possibly show such progress as the half century preceding. Merely to glance at the fifty years since that utterance, during which Bacon's ships and cars and flying machines have become actualities, is to marvel at the other man's ineptitude. His bugaboo of overproduction and his lament for the passing of large profits are no less notable than his lack of foresight.

Foresight tells us that things are sure to be altered. Change is the only certitude. To sit back and say that the next half century cannot produce innovations as remarkable as the last is to thumb one's nose at history. To attempt to map the paths progress will take is precarious. Any attempt to lead an excursion into the future is fraught with danger, but we can at least collect the opinions of pathfinders, and by examining the defects of the things we have we can make a guess at what those things will look like in the future.

What, for example, may we surmise about the city of the future? Most of those who have meditated about this think we shall have ribbon cities along our main routes of travel, with widenings of the ribbon here and there for larger centers of population and activity, where will be concentrated the transportation centers, the costlier public facilities, big financial institutions, libraries and museums. It seems unlikely that the big cities will be used for residential purposes; when transportation is sufficiently improved, all of us will prefer to live at a distance from our work, where we can have more sunlight, air, space and quiet. This seems likely to be the first step in urban decentralization. Our great cities, as a fact, are a by-product of our facility with steel, concrete and refrigeration. They are monstrosities in more ways than one, and few of them are fit to live in, unless one can afford a home in the outskirts.

We may be sure that the dirt and noise will be abated, perhaps eliminated, even in the cities. The winter smoke pall over our congested cities is as disgraceful as their slums, and almost as unhealthful. Smoke is depressing and costly. Sulphur dioxid from coal smoke is destructive to the exteriors of buildings, and we pay a huge bill annually for cleaning soot away. C. C. Furnas says that in the Chicago district alone "about 2500 tons of sulphurous acid on the average comes down upon the population every day, that acid having been derived from the sulphur in the coal." He notes that it rots garments and carpets, dulls the finish on automobiles and spoils the paint on houses. An engineer has estimated that smoke costs the people of that city fifty millions a year.

The effect everywhere of smoke on human health is expensive, aside from the intangibles involved.

Already we have smokeless fuels. Their general use in the furnace is a probability, almost a certainty. And with the elimination of smoke will go a decrease in the dust and other dirt which characterize urban surroundings. Cleanly cities are likely to be seen during our own lifetime. Campaigns to abate noise are already under way, with perceptible effect.

One of the most obvious disadvantages of city life is congestion of the streets. Largely this is due to the roadside squatter. Motorists and shopkeepers alike seem to think that cities must provide parking space. If that notion is to prevail, clearly it would be cheaper for the city to condemn cheap property and provide parking lots, perhaps double-decked or triple-decked, than to permit the use of streets which have been acquired and paved at great expense. Some theaters and shops now provide space for automobiles, but it is likely that in the future these will be mostly underground.

One way of dealing with the roadside squatter is to use the parking meter. Scores of cities have tried this expedient, and although some have abandoned it on account of court decisions that the device was illegal, none has found that it was not effective. Its chief value is that it makes parking at the curb expensive and so discourages the practice.

In some cities, including Chicago and Pittsburgh, huge parking machines not unlike Ferris wheels have been set up; automobiles are driven onto a platform and hoisted into the air until the drivers want to use them

again. This appears to be a more cumbersome and expensive remedy than some others. One town has a belt of municipal parking lots, others supply them in congested areas, and a suburb of New York City was first to enact an ordinance requiring the builder or owner of every apartment house to provide a place off the street for at least one car to every family it housed. In some places shops are being constructed but two stories high, with ramps leading to parking areas on the top.

Devices and plans such as these must be developed by a method of trial and error until we have found a satisfactory way of dealing with our preposterous urban street congestion. Charles F. Kettering has estimated that by 1960 we shall have a registration of thirty-seven million passenger cars and six million trucks. Perhaps by that time we will have found a sensible way of parking them. Dr. Kettering says that the second twenty-five years of any industry – and the motor industry is in that period – shows much greater progress than the first quarter century, but we can hardly expect of our municipalities such progressiveness as industries manifest.

"You won't have to wait for traffic lights to change when you want to cross Main Street in 1960," says Norman Bel Geddes. "Conveniently located underpasses will take you right across without a stop. Traffic going ten blocks or more will speed along fifty-mile-an-hour express streets connected by ramps with a network of local streets. These local streets will also be free from interference – from building line to building line. Open areas beneath buildings will provide parking space . . . loading platforms for trucks. Pedestrians will use ele-

vated sidewalks – shop and cross streets at the second-story level."

We may be certain that along with the changes in traffic conditions and in buildings will go great changes in automobiles. These machines are short-lived and inefficient. Mr. Furnas says they are but eight per cent efficient, by which he means that they get but eight per cent of driving power from the gasoline they burn. Automobile manufacturers dismiss this as an overstatement, but do not deny the general charge. Dr. Kettering thinks that if the elegant streamlined car of today were sealed against dust and deterioration, in ten or twenty years nobody but the junkman would consider buying it. There is much discussion pro and con of putting the engine in the rear ; there is almost as much talk about the weight of the machine, which even to a layman must appear excessive. These facts may indicate, possibly, the changes which are ahead of us.

Vastly more automobiles, with a vastly increased population and much more free time for driving, must be taken into account. If we were to employ to the full the devices now at hand, we could reduce the average working day by one-half. The homemaker, even without a maid, need spend even today but a fraction of her time in the kitchen and at her other household duties if she had all the domestic devices available, and these are sure to multiply.

Already the kitchen and the rest of the house is being prefabricated. Against this there is a natural prejudice, akin to the objection some men have to "hand-me-down" clothes. They pay twice or thrice as much to have their

garments tailored to their taste, but they are in the minority, whereas those who insist that their homes shall be made to order greatly predominate. The future of the ready-made house may be estimated, however, from the fact that a single concern in an upstate New York city, which turns out steel houses, found itself six months behind its orders soon after it began business. And there seems no reason why there should not be as great a variety in prefabricated houses as in men's ready-made garments.

Television, already established commercially in England, is so fully assured for the United States that not a great deal of space need be accorded to it here. It is interesting to reflect, however, that we may be able at home to watch the arrival of celebrities at a metropolitan first night, and see the performance of a play at its opening without paying an extortionate ticket speculator; and that the opening of grand opera will be as easily available to all of us. And it is quite within the range of possibility that we may witness great news happenings, even those which are unplanned and unforeseen. News-reel camera men have revealed an almost uncanny talent for being on the spot at crucial moments; that their cameras should be equipped for sound and visual projection is not impossible.

The United States, with less than one-fifteenth of the world's population, has three-fifths of its telephone and telegraph facilities. We have nearly half of the world's monetary gold and two-thirds of its banking resources. It is entirely reasonable to suppose that once we close the

gap in television we shall forge rapidly ahead; and we shall have time aplenty to see and listen.

We shall have an abundance of time free from labor, but we shall have "an entirely new conception of things that can be done," if Dr. Kettering's dream is realized. He has endowed an investigation into the process by which plants take energy from sunlight, and so provide us with food and fuel. The heat and power in the coal, wood, oil, and gas which we burn are stored from the sun's rays. On a clear summer noontide one horsepower of sunlight falls upon a comparatively small patch of the roof. The energy and sustenance we obtain from the table derives from the same source.

Dr. Kettering, who dug telephone post-holes to work his way through college, invented the automobile self-starter, and has taught physicians how to treat arthritis, asthma and venereal diseases by creating an artificial fever, is not the man to rest on his oars. He wants to know how vegetable life, which is chemically inefficient, transmutes the sun's rays for us. Therefore he has established the C. F. Kettering Foundation at Antioch College, and has contributed also a great deal of his spare time and inquiring scientific acumen. He persuaded Dr. L. O. Inman, Dean of Antioch and a biologist, to take charge of the group of scientists trying to solve the riddle.

Now, the green stuff in plants which does the transmuting of the sun's energy is chlorophyl, and already one part of this complicated molecule, which breaks down the raw materials of air and earth and water and impreg-

nates them with sunlight, has been synthesized by Dr. Paul Rothemund of the Antioch group. He has reconstructed it in the laboratory. The other part, which combines elements into food, is yet to be recreated. If this is accomplished, and man is enabled to do with test tubes and retorts what Dame Nature has been doing for eons behind a mystic veil, the possibilities of the future seem well-nigh limitless. We shall have pried another chunk of knowledge loose from Dr. Kettering's cliff.

When the routine tasks of life are done mostly by machines and instruments, both in the factory and the house, our population must adjust itself to an abundance of leisure. Mr. Furnas, who foresees a four-hour working day — a workday maybe as short as two or three hours — believes we may achieve a leisure without lethargy, and thinks that sports, travel and hobbies may fill a large part of the gap, to our profit. Leisure he regards as an important commodity, and so it is, if used to advantage. When spent at the bridge table, in reading mystery stories or tabloid picture papers and in working crossword puzzles, it does not return high dividends. We are an extremely literate people, but this is no guaranty that our free time will be spent in good reading. At present the average family spends more on motion pictures than on books, and but a small per cent of the books are worth the price paid for them. If Thomas Jefferson, in his immortal Declaration, had set down life, liberty and *leisure* as our inalienable rights, he would have posed a problem which is at the heart of the pursuit of happiness. It will grow in importance as time passes.

In the "nuisance impurities" of petroleum, mostly nitrogen compounds, chemists are now finding substances which open new horizons "as broad as those opened by the discovery of coal tar." They even go so far as to say that all the needs of civilized society may be satisfied in the future from the products of petroleum. Fats derived from the oil may serve as food, from other ingredients textiles and plastics can be made, and there is the prospect of brand-new industries. Dean Frank C. Whitmore of Pennsylvania State College blames the automobile for our tardiness in making these discoveries; the fuel value of petroleum and gasoline contented us, so that we did not strive to learn their true nature. But the supply is by no means inexhaustible.

We may look forward to synthetic materials all the way from our underwear to wall paneling, building blocks and roof; from kitchen to food and drink; to safety and economy as well as speed in transportation; to an independence of heat, rain and drouth in obtaining our materials from the land; to the manufacture as a matter of course of hormones, vitamins and enzymes, and in these fields we should expect to outdo nature, which is an inefficient chemist.

What was for a long time a mere suspicion is deepening into conviction, that many of our social inadequacies and maladjustments can be remedied by the technologist. We have a fair knowledge, or at least the good beginnings of a knowledge, about the disastrous effects of malnutrition; good nutrition is a matter of chemistry of food and the chemistry of the human body. Psychopathic cases which are still on the sunny side of lunacy,

and actual instances of insanity, may be traced to the lack of certain chemicals or hormones. Domestic quarrels, fatigue and irritability have been the result of eyestrain.

Overgrown corporate structures, patent pools and the innate conservatism which regards inventions as things which make securities insecure will retard our progress somewhat, but it may be said with certainty that industry is alert. Almost invariably it welcomes departures when they hold forth promise of public betterment, for in the long run this betterment means profits. The General Electric Company spent during fifteen years ten million dollars on research and educational projects, and could not see that it got back a penny of its outgo. It seemed like pouring money into a sieve. But during the next seven years all those dollar-pigeons came home to roost. Other big corporations are as eager for general benefits, on the sound theory that when they contribute to the nation's welfare they not only create good will but generate dividends.

Most of us think of the industrial revolution – which made it possible, for one thing, that a single corporation might invest ten millions in research and educational projects – as having begun with the first steam locomotive, something more than a century ago. This may have been what Dr. Kettering had in mind when he spoke of that "large chunk of fundamental scientific information" which was broken off the limitless cliff of knowledge. It is somewhat cavalier treatment to accord to Copernicus; to Christian Huygens, inventor of the pendulum clock, who developed also the wave theory of

light ; to Descartes and Laplace and Newton and Keppler, all of whom preceded the Machine Age by many years. It may be supposed, however, to embrace John Dalton, whose studies of the structure of matter led him to advance the atomic theory ; Malthus, Schwann, Darwin and Faraday ; and presumably it is meant to include James Watt, who died in 1819.

The real beginning of the industrial revolution, in the opinion of Miriam Beard, came in the north of England. Francis Egerton, third Duke of Bridgewater, was a man of wealth, great curiosity and tremendous energy. He cheapened coal for his market by building canals to move it from his mines ; but we learn in *A History of the Business Man* that as the shafts were sunk more deeply there were new difficulties in pumping and ventilation. "The quaint and cumbersome steam-pump of the inventor, James Watt, was at length installed by the Duke, and the Industrial Revolution had begun." The Duke died in 1803.

It cannot be said that the steam engine did anything to lighten the labors of the homemaker, other than providing her with running water in some cases. Not until gas and electricity were applied to domestic machinery was her drudgery much decreased. Before that happened Louis H. Gibson wrote a book called *Convenient Houses,* which was devoted to better planning. "The life of the woman who keeps house," he said, "is one of extremest drudgery and hardship. The Indian's home is often preferable, for the squaws have time for much else than the absolute duties of camp life." He compared the

pioneer cabin to more spacious later houses to their disadvantage.

"The woman's troubles began," he said, "when her husband, by dint of hard work and close economy, found himself in a position to gratify his pride by building a new house. There is more sweeping and washing to do. There is more of everything to do. She came into the new house expecting to find things easier than they were before. Even if she keeps a girl she has infinitely more to do than in the old house. She cannot understand it. She has a new house and a girl and yet she is always tired."

When we contrast a modernized house, even with no servant, with that house of a little more than half a century ago, we need not suppose that we have reached the saturation point in mechanical labor-saving and comfort-creating devices, for man's ingenuity is invincible. How can we be sure that during the next half century even the living places of the very poor will not be so equipped that virtually nothing remains to be done by muscle power? For the present, to be sure, we can be grateful if the economies and comforts of the myriad devices on hand are more widely spread, more widely enjoyed. The general public may be grateful as that process goes on; but the discontented technologist and director of research will still be trying to blast another chunk from the cliff of knowledge, and new inventions will arrive. Matthew Luckiesh, Director of Research for General Electric, says that man's most valuable assets are the things he doesn't know. He is one of that devoted

group whose job would vanish, as Dr. Kettering once laughingly observed, if there were no prospect of improving what we have. Each of them has a mind richly stored, but it is an inquiring mind, never cocksure but eager to assert its own ignorance. It is a mind atiptoe, which scorns the easy chair. It is a Sherlock Holmes of the mental realm, following clues invisible and intangible to mortal sense, enacting the leading rôle in mysteries not always neatly solved. It is most at home on the brink of the unknown.

It need not surprise us that the words of Dr. Kettering and Dr. Luckiesh have in them a touch of the transcendental. Mr. Furnas comments on this aspect of research when he says: "Today the pure physicist seems to be reverting to metaphysics. He is always dabbling on the border land of the unknowable and inconceivable. His idea of the atom is something that cannot be pictured. It is expressible as formulae but it is something which our minds cannot visualize because it is not the kind of thing that can be visualized. Physicists have space that bends back on itself and universes that in some way expand without end. Energy sometimes acts like matter and matter sometimes is like energy. Matter *is* energy."

In this expanding universe what may not lie ahead of us?

CASUAL DON'TS

Electricity

Don't be cheap when your family's safety is involved ; buy improved equipment and have it inspected regularly.
Don't fail to throw out broken plugs and cords when insulation is worn.
Don't touch faucets or metallic objects and electrical fixtures at the same time.
Don't touch electrically charged wires with wet hands.
Don't handle appliances or water faucets while using the telephone.
Don't leave the electric iron connected when the ironing has been completed.
Don't disconnect insulated cord by jerking ; clasp the button and pull the cord gently out.
Don't let amateurs install electric stoves or other devices.
Don't place things on the stove when it is not in use.
Don't use lamp cord for any other appliance.
Don't attach alternating current wires with direct current outlets.
Don't use wrong voltage in appliances.
Don't bend, twist or wet electric cords.
Don't put cords under rugs.
Don't force plug from the outlet with a tool of any sort.
Don't put percolators, waffle irons and the like into water to clean.
Don't try to repair an electric refrigerator yourself.
Don't try to chip frost from the refrigerator.
Don't touch the evaporator with an implement.
Don't fail to have extra electric bulbs and plugs on hand.

Gas and Electric Machines

Don't neglect to keep on hand an extra belt for machines which require a belt.

Don't put too much oil nor too little in motors.

Don't suppose that saving one minute is highly important; the house runs the highway a close second in fatalities because of hurry.

Enamelware

Don't keep enameled pans and small utensils when they have been chipped; throw them away.

Don't strike an enameled surface a hard blow, nor permit heavy things to drop on it.

Don't subject the ware to severe heat or cold.

Don't place soiled spoons or other used articles on surface.

Don't wash enamel when very hot for fear of cracking.

Don't use inflammable blacking on stove.

Miscellaneous

Don't walk up and down stairways in the dark; keep them lighted.

Don't be careless when walking on polished floors and loose rugs.

Don't use boxes or chairs in place of a strong stepladder.

Don't allow cleaning utensils to lie around.

Don't use any but safety matches; Henry Wadsworth Longfellow's wife was burned to death after she threw an unextinguished match on the floor.

Don't neglect lighted cigarettes, pipes and cigars, which are the most frequent cause of fires.

Don't use candles to thaw frozen pipes; an electric heating pad, or heat from a toaster, hot wet cloths or bags of hot salt are better.

Don't run the auto motor with garage door closed.

Don't take medicine from a cabinet in the dark; turn on the light to be sure you have the right bottle or box.

Don't allow thermos bottles to stand without an occasional washing in cold water with a small amount of baking soda; let them stand an hour.

Don't leave scissors or needles loose in the sewing basket; keep a cork to stick them in.

Don't fail to wash knives in cold water after peeling onions.

Don't allow water or grease to stand on the linoleum floor; it may cause a fall.

Don't leave milk, butter or cream in an open container in the refrigerator.

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comparing unfavorably with work on the land.

Do You Know

That at an outlay of a dollar a week the average family can now command the equivalent of eleven servants?

That more slaves in the guise of gas and electricity are created in this country than all history has ever seen in human form?

That our modern equipments make possible a new freedom for the housewife, her husband and her children?

That mechanical inventions offer better food, better health, greater comfort and and real savings in the budget?

That they mean savings in our most precious asset—human energy?

That the light we read and work by is a most important factor in our health?

That under severe eyestrain we may exert more physical effort than a ditchdigger?

That our automatic furnace, our modern range and washing-machine, and other devices pay for themselves in cold cash?

We Americans boast of our high standard of living, yet only two-thirds of our homes are equipped to cook with gas or electricity, one-fourth have no tub or shower.

Tireless technologists are changing our whole environment; they are spending millions to bring about a better way of life.

This is the story of their strange and familiar inventions that make life easier and more profitable. There are *Slaves by the Billion* at the command of American homemakers. Silas Bent tells us how to make the most of them.

SLAVES BY THE BILLION

THE STORY OF MECHANICAL PROGRESS IN THE HOME

With an Introduction by Katharine Fisher,
Director of Good Housekeeping Institute

by SILAS BENT