

***FREDERICK
IRVING
ANDERSON***



***ELECTRICITY
FOR THE FARM***

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FOR THE FARM***

Frederick Irving Anderson

Electricity for the farm

**Light, heat and power by inexpensive methods from
the water wheel or farm engine**

EAN 8596547130581

DigiCat, 2022

Contact: DigiCat@okpublishing.info



TABLE OF CONTENTS

[PREFACE](#)

[ILLUSTRATIONS](#)

[INTRODUCTION](#)

[PART I](#)

[ELECTRICITY FOR THE FARM](#)

[CHAPTER I](#)

[CHAPTER II](#)

[CHAPTER III](#)

[CHAPTER IV](#)

[PART II](#)

[CHAPTER V](#)

[CHAPTER VI](#)

[CHAPTER VII](#)

[CHAPTER VIII](#)

[CHAPTER IX](#)

[PART III](#)

[CHAPTER X](#)

[CHAPTER XI](#)

[CHAPTER XII](#)

PREFACE

[Table of Contents](#)

This book is designed primarily to give the farmer a practical working knowledge of electricity for use as light, heat, and power on the farm. The electric generator, the dynamo, is explained in detail; and there are chapters on electric transmission and house-wiring, by which the farm mechanic is enabled to install his own plant without the aid and expense of an expert.

With modern appliances, within the means of the average farmer, the generation of electricity, with its unique conveniences, becomes automatic, provided some dependable source of power is to be had—such as a water wheel, gasoline (or other form of internal combustion) engine, or the ordinary windmill. The water wheel is the ideal prime mover for the dynamo in isolated plants. Since water-power is running to waste on tens of thousands of our farms throughout the country, several chapters are devoted to this phase of the subject: these include descriptions and working diagrams of weirs and other simple devices for measuring the flow of streams; there are tables and formulas by which any one, with a knowledge of simple arithmetic, may determine the power to be had from falling water under given conditions; and in addition, there are diagrams showing in general the method of construction of dams, bulkheads, races, flumes, etc., from materials usually to be found on a farm. The tiny unconsidered brook that waters the farm pasture frequently possesses power enough to supply the farmstead with clean, cool, safe light in place

of the dangerous, inconvenient oil lamp; a small stream capable of developing from twenty-five to fifty horsepower will supply a farmer (at practically no expense beyond the original cost of installation) not only with light, but with power for even the heavier farm operations, as threshing; and in addition will do the washing, ironing, and cooking, and at the same time keep the house warm in the coldest weather. Less than one horsepower of energy will light the farmstead; less than five horsepower of energy will provide light and small power, and take the drudgery out of the kitchen.

For those not fortunate enough to possess water-power which can be developed, there are chapters on the use of the farm gasoline engine and windmill, in connection with the modern storage battery, as sources of electric current.

It is desired to make acknowledgment for illustrations and assistance in gathering material for the book, to the editors of *The Country Gentleman*, Philadelphia, Pa.; The Crocker-Wheeler Company, Ampere, N. J.; The General Electric Company, Schenectady, N. Y.; the Weston Electrical Instrument Company, of Newark, N. J.; The Chase Turbine Manufacturing Company, Orange, Mass.; the C. P. Bradway Machine Works, West Stafford, Conn.; The Pelton Water Wheel Company, San Francisco and New York; the Ward Leonard Manufacturing Company, Bronxville, N. Y.; The Fairbanks, Morse Company, Chicago; and the Fitz Water Wheel Company, Hanover, Pa.

ILLUSTRATIONS

Table of Contents

Even the tiny trout brook becomes a thing of utility as well as of joy

Farm labor and materials built this crib and stone dam

Measuring a small stream with a weir

Efficient modern adaptations of the archaic undershot and overshot water wheels

A direct-current dynamo or motor, showing details of construction

Details of voltmeter or ammeter

Instantaneous photograph of high-pressure water jet being quenched by buckets of a tangential wheel

A tangential wheel, and a dynamo keyed to the same shaft—the ideal method for generating electricity

A rough-and-ready farm electric plant, supplying two farms with light, heat and power; and a Ward Leonard-type circuit breaker for charging storage batteries

INTRODUCTION

Table of Contents

The sight of a dozen or so fat young horses and mares feeding and frolicking on the wild range of the Southwest would probably inspire the average farmer as an awful example of horsepower running to waste. If, by some miracle, he came on such a sight in his own pastures, he would probably consume much time practising the impossible art of "creasing" the wild creatures with a rifle bullet—after the style of Kit Carson and other free rovers of the old prairies when they were in need of a new mount. He would probably spend uncounted hours behind the barn learning to throw a lariat; and one fine day he would sally forth to capture a horsepower or two—and, once captured, he would use strength and strategy breaking the wild beast to harness. A single horsepower—animal—will do the work of lifting 23,000 pounds one foot in one minute, providing the animal is young, and sound, and is fed 12 quarts of oats and 10 or 15 pounds of hay a day, and is given a chance to rest 16 hours out of 24—providing also it has a dentist to take care of its teeth occasionally, and a blacksmith chiropodist to keep it in shoes. On the hoof, this horsepower is worth about \$200—unless the farmer is looking for something fancy in the way of drafters, when he will have to go as high as \$400 for a big fellow. And after 10 or 15 years, the farmer would look around for another horse, because an animal grows old.

This animal horsepower isn't a very efficient horsepower. In fact, it is less than three-fourths of an actual horsepower, as engineers use the term. A real horsepower will do the work of lifting 33,000 pounds one foot in one minute—or 550 pounds one foot in one second. Burn a pint of gasoline,

with 14 pounds of air, in a gasoline engine, and the engine will supply one 33,000-pound horsepower for an hour. The gasoline will cost about 2 cents, and the air is supplied free. If it was the air that cost two cents a pound, instead of the gasoline, the automobile industry would undoubtedly stop where it began some fifteen years ago. It is human nature, however, to grumble over this two cents.

Yet the average farmer who would get excited if sound young chunks and drafters were running wild across his pastures, is not inspired by any similar desire of possession and mastery by the sight of a brook, or a rivulet that waters his meadows. This brook or river is flowing down hill to the sea. Every 4,000 gallons that falls one foot in one minute; every 400 gallons that falls 10 feet in one minute; or every 40 gallons that falls 100 feet in one minute, means the power of one horse going to waste—not the \$200 flesh-and-blood kind that can lift only 23,000 pounds a foot a minute—but the 33,000 foot-pound kind. Thousands of farms have small streams in their very dooryard, capable of developing five, ten, twenty, fifty horsepower twenty-four hours a day, for the greater part of the year. Within a quarter of a mile of the great majority of farms (outside of the dry lands themselves) there are such streams. Only a small fraction of one per cent of them have been put to work, made to pay their passage from the hills to the sea.

The United States government geological survey engineers recently made an estimate of the waterfalls capable of developing 1,000 horsepower and over, that are running to waste, unused, in this country. They estimated that there is available, every second of the day and night,

some 30,000,000 horsepower, in dry weather—and twice this during the eight wet months of the year. The waterfall capable of giving up 1,000 horsepower in energy is not the subject of these chapters. It is the small streams—the brooks, the creeks, the rivulets—which feed the 1,000 horsepower torrents, make them possible, that are of interest to the farmer. These small streams thread every township, every county, seeking the easiest way to the main valleys where they come together in great rivers.

What profitable crop on your farm removes the least plant food? A bee-farmer enters his honey for the prize in this contest. Another farmer maintains that his ice-crop is the winner. But electricity generated from falling water of a brook meandering across one's acres, comes nearer to the correct answer of how to make something out of nothing. It merely utilizes the wasted energy of water rolling down hill—the weight of water, the pulling power of gravity. Water is still water, after it has run through a turbine wheel to turn an electric generator. It is still wet; it is there for watering the stock; and a few rods further down stream, where it drops five or ten feet again, it can be made to do the same work over again—and over and over again as long as it continues to fall, on its journey to the sea. The city of Los Angeles has a municipal water plant, generating 200,000 horsepower of electricity, in which the water is used three times in its fall of 6,000 feet; and in the end, where it runs out of the race in the valley, it is sold for irrigation.

One water-horsepower will furnish light for the average farm; five water-horsepower will furnish light and power, and do the ironing and baking. The cost of installing a plant

of five water-horsepower should not exceed the cost of one sound young horse, the \$200 kind—under conditions which are to be found on thousands of farms and farm communities in the East, the Central West, and the Pacific States. This electrical horsepower will work 24 hours a day, winter and summer, and the farmer would not have to grow oats and hay for it on land that might better be used in growing food for human beings. It would not become "aged" at the end of ten or fifteen years, and the expense of maintenance would be practically nothing after the first cost of installation. It would require only water as food—waste water. Two hundred and fifty cubic feet of water a minute, falling ten feet, will supply the average farm with all the conveniences of electricity. This is a very modest creek—the kind of brook or creek that is ignored by the man who would think time well spent in putting in a week capturing a wild horse, if a miracle should send such a beast within reach. And the task of harnessing and breaking this water-horsepower is much more simple and less dangerous than the task of breaking a colt to harness.

PART I

[Table of Contents](#)

WATER-POWER

ELECTRICITY FOR THE FARM

CHAPTER I

Table of Contents

A WORKING PLANT

The "agriculturist"—An old chair factory—A neighbor's home-coming—The idle wheel in commission again—Light, heat and power for nothing—Advantages of electricity.

Let us take an actual instance of one man who did go ahead and find out by experience just how intricate and just how simple a thing electricity from farm water-power is. This man's name was Perkins, or, we will call him that, in relating this story.

Perkins was what some people call, not a farmer, but an "agriculturist,"—that is, he was a back-to-the-land man. He had been born and raised on a farm. He knew that you must harness a horse on the left side, milk a cow on the right, that wagon nuts tighten the way the wheel rims, and that a fresh egg will not float.

He had a farm that would grow enough clover to fill the average dairy if he fed it lime; he had a boy coming to school age; and both he and his wife wanted to get back to the country. They had their little savings, and they wanted, first of all, to take a vacation, getting acquainted with their farm. They hadn't taken a vacation in fifteen years.

He moved in, late in the summer, and started out to get acquainted with his neighbors, as well as his land. This was in the New England hills. Water courses cut through everywhere. In regard to its bountiful water supply, the

neighborhood had much in common with all the states east of the Mississippi, along the Atlantic seaboard, in the lake region of the central west, and in the Pacific States. With this difference; the water courses in his neighborhood had once been of economic importance.

A mountain river flowed down his valley. Up and down the valley one met ramshackle mills, fallen into decay. Many years ago before railroads came, before it was easy to haul coal from place to place to make steam, these little mills were centers of thriving industries, which depended on the power of falling water to make turned articles, spin cotton, and so forth. Then the railroads came, and it was easy to haul coal to make steam. And the same railroads that hauled the coal to make steam, were there to haul away the articles manufactured by steam power. So in time the little manufacturing plants on the river back in the hills quit business and moved to railroad stations. Then New England, from being a manufacturing community made up of many small isolated water plants, came to be a community made up of huge arteries and laterals of smoke stacks that fringed the railroads. Where the railroad happened to follow a river course—as the Connecticut River—the water-power plants remained; but the little plants back in the hills were wiped off the map—because steam power with railroads at the front door proved cheaper than water-power with railroads ten miles away.

One night Perkins came in late from a long drive with his next-door neighbor. He had learned the first rule of courtesy in the country, which is to unhitch his own side of the horse and help back the buggy into the shed. They stumbled

around in the barn putting up the horse, and getting down hay and grain for it, by the light of an oil lantern, which was set on the floor in a place convenient to be kicked over. He went inside and took supper by the light of a smoky smelly oil lamp, that filled the room full of dark corners; and when supper was over, the farmwife groped about in the cellar putting things away by the light of a candle.

The next day his neighbor was grinding cider at his ramshackle water mill—one of the operations for which a week must be set aside every fall. Perkins sat on a log and listened to the crunch-crunch of the apples in the chute, and the drip of the frothy yellow liquid that fell into waiting buckets.

"How much power have you got here?" he asked.

"Thirty or forty horsepower, I guess."

"What do you do with it, besides grinding cider to pickle your neighbors' digestion with?"

"Nothing much. I've got a planer and a moulding machine in there, to work up jags of lumber occasionally. That's all. This mill was a chair-factory in my grandfather's day, back in 1830."

"Do you use it thirty days in a year?"

"No; not half that."

"What are you going to do with it this winter?"

"Nothing; I keep the gate open and the wheel turning, so it won't freeze, but nothing else. I am going to take the family to Texas to visit my wife's folks for three months. We've worked hard enough to take a vacation."

"Will you rent me the mill while you are gone?"

"Go ahead; you can have it for nothing, if you will watch the ice."

"All right; let me know when you come back and I'll drive to town and bring you home."

Three months went by, and one day in February the city man, in response to a letter, hitched up and drove to town to bring his neighbor back home. It was four o'clock in the afternoon when they started out, and it was six—dark—when they turned the bend in the road to the farm house. They helped the wife and children out, with their baggage, and as Perkins opened the door of the house, he reached up on the wall and turned something that clicked sharply.

Instantly light sprang from everywhere. In the barn-yard a street lamp with an 18-inch reflector illuminated all under it for a space of 100 feet with bright white rays of light. Another street lamp hung over the watering trough. The barn doors and windows burst forth in light. There was not a dark corner to be found anywhere. In the house it was the same. Perkins led the amazed procession from room to room of the house they had shut up for the winter. On the wall in the hall outside of every room was a button which he pushed, and the room became as light as day before they entered. The cellar door, in opening, automatically lighted a lamp illuminating that cavern as it had never been lighted before since the day a house was built over it.

Needless to say, the farmer and his family were reduced to a state of speechlessness.

"How the deuce did you do it?" finally articulated the farmer.

"I put your idle water wheel to work," said Perkins; and then, satisfied with this exhibition, he put them back in the sleigh and drove to his home, where his wife had supper waiting.

While the men were putting up the team in the electric lighted barn, the farmwife went into the kitchen. Her hostess was cooking supper on an electric stove. It looked like a city gas range and it cooked all their meals, and did the baking besides. A hot-water tank stood against the wall, not connected to anything hot, apparently. But it was scalding hot, by virtue of a little electric water heater the size of a quart tin can, connected at the bottom. Twenty-four hours a day the water wheel pumped electricity into that "can," so that hot water was to be had at any hour simply by turning a faucet. In the laundry there was an electric pump that kept the tank in the attic filled automatically. When the level of water in this tank fell to a certain point, a float operated a switch that started the pump; and when the water level reached a certain height, the same float stopped the pump. A small motor, the size of a medium Hubbard squash operated a washing machine and wringer on wash days. This same motor was a man-of-all-work for this house, for, when called on, it turned the separator, ground and polished knives and silverware, spun the sewing machine, and worked the vacuum cleaner.

Over the dining room table hung the same hanging shade of old days, but the oil lamp itself was gone. In its place was a 100-watt tungsten lamp whose rays made the white table cloth fairly glisten. The wires carrying electricity to this lamp were threaded through the chains reaching to

the ceiling, and one had to look twice to see where the current came from. In the sitting room, a cluster of electric bulbs glowed from a fancy wicker work basket that hung from the ceiling. The housewife had made use of what she had throughout the house. Old-fashioned candle-shades sat like cocked hats astride electric bulbs. There is little heat to an electric bulb for the reason that the white-hot wire that gives the light is made to burn in high vacuum, which transmits heat very slowly. The housewife had taken advantage of this fact and from every corner gleamed lights dressed in fancy designs of tissue paper and silk.

"Now we will talk business," said Perkins when supper was over and they had lighted their pipes.

The returned native looked dubious. His New England training had warned him long ago that one cannot expect to get something for nothing, and he felt sure there was a joker in this affair.

"How much do I owe you?" he asked.

"Nothing," said Perkins. "You furnish the water-power with your idle wheel, and I furnish the electric installation. This is only a small plant I have put in, but it gives us enough electricity to go around, with a margin for emergencies. I have taken the liberty of wiring your house and your horse-barn and cow-barn and your barn-yard. Altogether, I suppose you have 30 lights about the place, and during these long winter days you will keep most of them going from 3 to 5 hours a night and 2 or 3 hours in the early morning. If you were in town, those lights would cost you about 12 cents an hour, at the commercial rate of electricity. Say 60 cents a day—eighteen dollars a month. That isn't a

very big electric light bill for some people I know in town—and they consider themselves lucky to have the privilege of buying electricity at that rate. Your wheel is running all winter to prevent ice from forming and smashing it. It might just as well be spinning the dynamo.

"If you think it worth while," continued Perkins,— "this \$18 worth of light you have on tap night and morning, or any hour of the day,—we will say the account is settled. That is, of course, if you will give me the use of half the electricity that your idle wheel is grinding out with my second-hand dynamo. We have about eight electrical horsepower on our wires, without overloading the machine. Next spring I am going to stock up this place; and I think about the first thing I do, when my dairy is running, will be to put in a milking machine and let electricity do the milking for me. It will also fill my silo, grind my mowing-machine knives, saw my wood, and keep water running in my barn. You will probably want to do the same.

"But what it does for us men in the barn and barn-yard, isn't to be compared to what it does for the women in the house. When my wife wants a hot oven she presses a button. When she wants to put the 'fire' out, she presses another. That's all there is to it. No heat, no smoke, no ashes. The same with ironing—and washing. No oil lamps to fill, no wicks to trim, no chimneys to wash, no kerosene to kick over and start a fire."

"You say the current you have put in my house would cost me about \$18 a month, in town."

"Yes, about that. Making electricity from coal costs money."

"What does it cost here?"

"Practically nothing. Your river, that has been running to waste ever since your grandfather gave up making chairs, does the work. There is nothing about a dynamo to wear out, except the bearings, and these can be replaced once every five or ten years for a trifle. The machine needs to be oiled and cared for—fill the oil cups about once in three days. Your water wheel needs the same attention. That's all there is to it. You can figure the cost of your current yourself—just about the cost of the lubricating oil you use—and the cost of the time you give it—about the same time you give to any piece of good machinery, from a sulky plow to a cream separator."

This is a true story. This electric plant, where Perkins furnishes the electric end, and his neighbor the water-power, has been running now for two years, grinding out electricity for the two places twenty-four hours a day. Perkins was not an electrical engineer. He was just a plain intelligent American citizen who found sufficient knowledge in books to enable him to install and operate this plant. Frequently he is away for long periods, but his neighbor (who has lost his original terror of electricity) takes care of the plant. In fact, this farmer has given a lot of study to the thing, through curiosity, until he knows fully as much about it now as his city neighbor.

He had the usual idea, at the start, that a current strong enough to light a 100 candlepower lamp would kick like a mule if a man happened to get behind it. He watched the city man handle bare wires and finally he plucked up courage to do it himself.