MAKING ROADS BY MACHINERY.

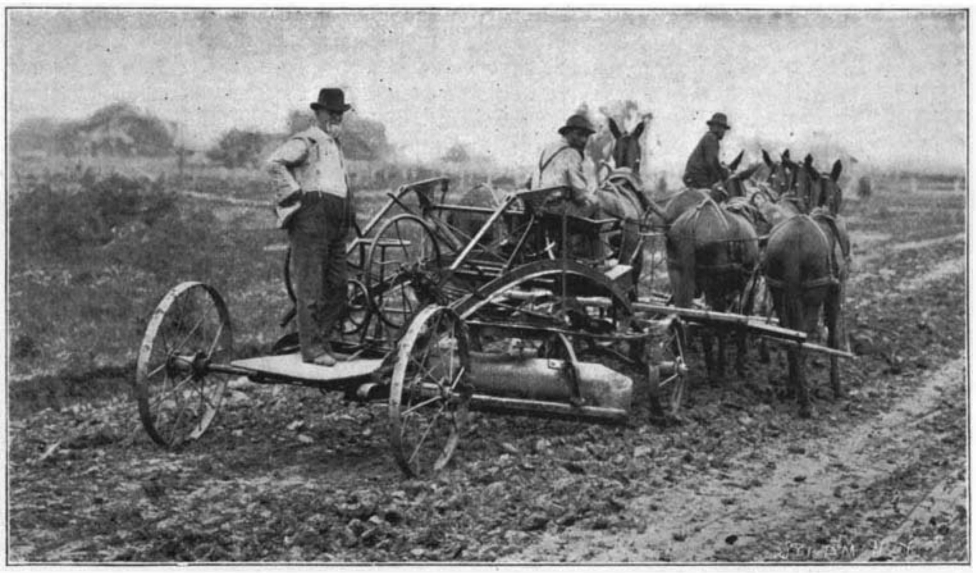
BY WALDON FAWCETT.

The immense number of crude and frequently impassable roads to be found in all parts of the United States and the serious extent to which they have handicapped the marketing of farm products in various sections of the country lend especial significance to the crusade in favor of good roads which is being conducted by the Office of Road Inquiry, a division of the Department of Agriculture. As yet there have not been secured appropriations of sufficient size to enable the government to undertake on its own account the provision of better highways, but this will come in time, and meanwhile highly important results are being accomplished solely by the presentation of forceful object lessons.

The investigations of the Office of Road Inquiry are mainly directed in seven general fields, namely: to ascertain as nearly as practicable the actual cost of bad roads and the benefit of good roads; to demonstrate the interest of cities and towns and the owners of property of all kinds wherever situated, in the improvement of country roads; to develop the methods whereby all of these interests may co-operate with the farmers in the work of road improvement; to discover what actual and systematic road improvement is being carried on in any part of the United States, and how the same or modified methods may be applied to other sections; to discover road materials in various sections of the country; to discuss new plans for road construction and encourage experiment in this direction and, finally, to actually construct sample roads.

The governmental experts have incidentally devoted much attention to the subject of wide tires; have investigated the use of convict labor in road construction, and encouraged the organization of State and local road associations. In this connection many important experiments have been made to test the power required in hauling over various kinds of roads. The government has learned, too, by consultation with many thousands of the most intelligent farmers of the country that the expense of moving farm products and supplies averages on all the American country roads 25 cents per ton mile, whereas the charge in the good roads districts of this and other countries is less than one-third that amount. This extra expense amounts in the aggregate to more than the entire expenditures of the national government, and taking into account all of the hauling done on the public roads the loss is equal to one-fourth of the home value of all the farm products of the United States.

Probably the most interesting phase of the work has been found, however, in the construction of specimen roads of various kinds in different parts of the country. Ordinarily three styles of road have been represented in this experimental work—a modern macadam, a sand and a dirt road. Of these three the macadam highway is the most interesting from the point of construction. After a uniform grade has been secured by the use of wheeled scrapers, drag scrapers and plows, and possibly road graders as well, there are placed upon this foundation three separate layers of the best quality of stone that is procurable in the vicinity. The foundation course, which is about five inches in thickness and made up of two and one-half inch stone, is thoroughly rolled before the second course, composed of one and one-half inch stone, is put on, and this layer in turn is sprinkled and rolled before the surface layer or "binder," as it is commonly called, consisting of three-quarter inch stone and dust, is put in place.



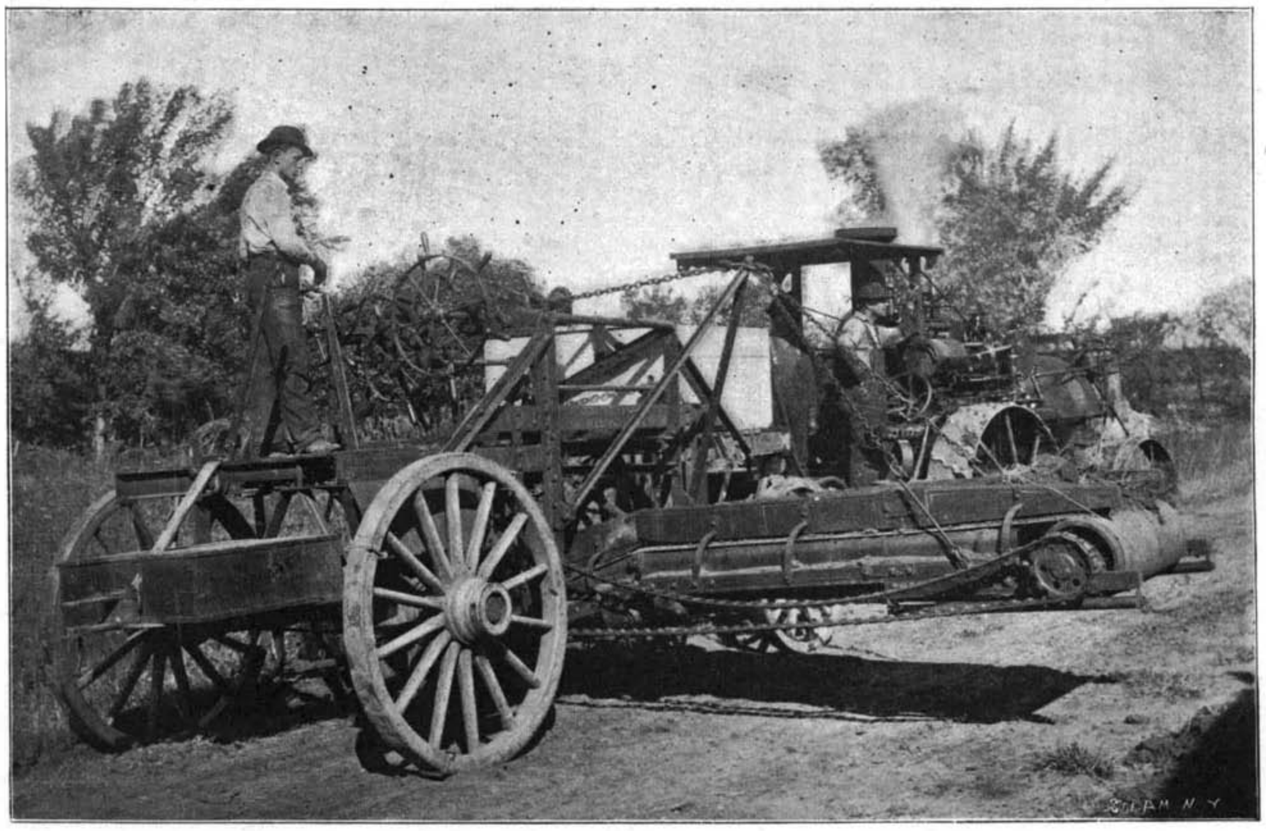
Road Scraper at Work.

The sand road is formed by placing six inches of river sand on a bed of natural clay, neither the bed nor the surface of the road being rolled. The dirt road is made by grading in the usual manner. As a rule neither of these latter classes of highways is constructed save to demonstrate the superiority of the macadam road. Considerable attention has been given to the construction of steel-track wagon roads—decidedly the most novel type of highway yet introduced in any country. The steel road might be compared to a street car track of modified design, and the plan for its utilization was doubtless suggested by the well-known tendency of teamsters to make use of urban and inter-urban trolley and cable lines on highways where locomotion would otherwise be difficult.

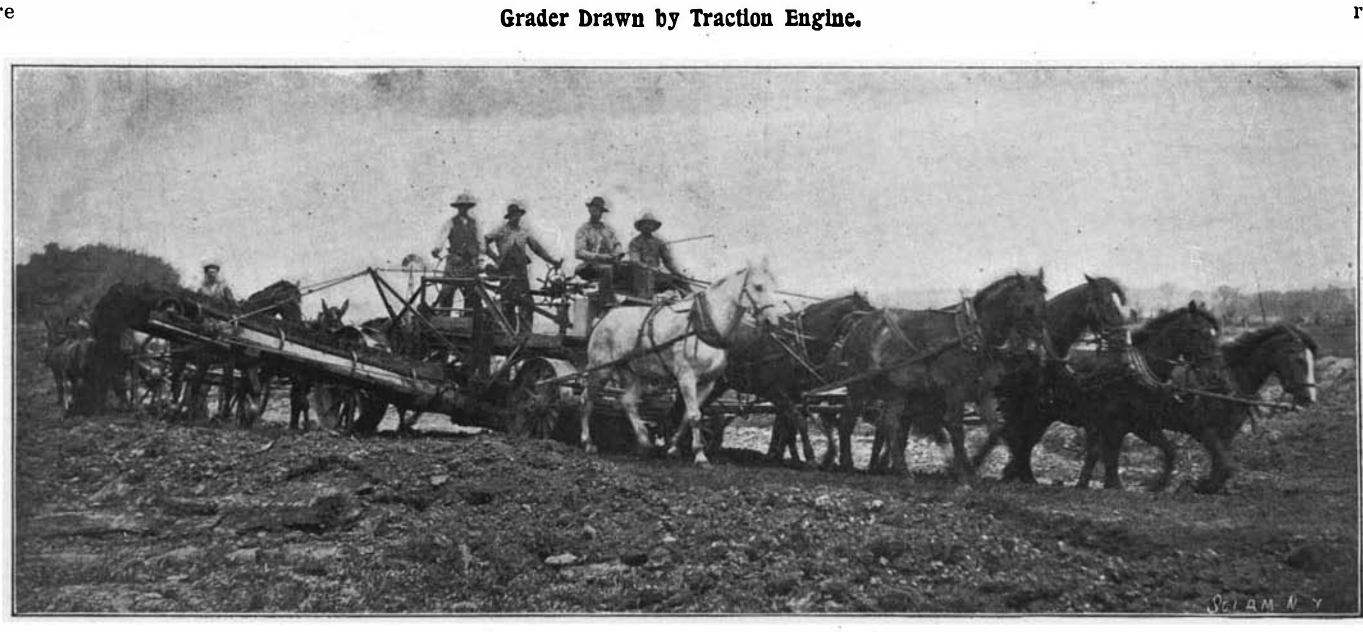
The steel-track wagon road consists of two parallel lines of steel plates or rails each eight inches in width and not supported on wooden cross-ties but simply made solid in the road by flanges projecting into the concrete of the roadbed. The rails are accurately spaced so as to receive the wheels of all vehicles of standard gage without regard to the width of tire, and each plate or rail is fitted with a flange on the inner side to prevent wheels from easily leaving the tracks. Unique roads of this type have been constructed in half a dozen different States, and in some instances the records made upon them have been little short of marvelous. In one instance a load of eleven tons which required twenty horses for its movement over an ordinary road was readily drawn along the steel track by a single horse. This load was twenty-two times the weight of the animal, but at Ames, Iowa, recently a horse started and moved on a steel-track highway a load fifty times the weight of the animal. It may be noted that the cost of the steel-track roads has ranged from $1,500 to $3,500 a mile, according to the original condition of the roadbed.

The extension of the good roads movement has resulted in a corresponding development of the engineering operations involved and of the machinery employed. Possibly the most interesting of all the forms of special apparatus which have been introduced for this work is the elevating grader which is utilized in reducing cuts several feet in depth. This machine elevates earth and drops it into wagons alongside, loading a wagon in twenty seconds. On an average such a machine will load into wagons in one day of ten working hours from 700 to 800 yards of earth.

The elevating grader is very heavy, and about twelve horses are required for its movement, some of the animals pulling and others pushing. The operating force consists of three drivers and two machine operators, one of the latter looking after the plow and the other giving attention to the elevating conveyor. The plow of this machine makes a cut twelve inches square. After a grade has been reduced a machine of this type may be employed if desired to elevate dirt to the center of the



Grader Drawn by Traction Engine.



Elevating Horse-Drawn Grader at Work.

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road, from whence it is distributed by graders of the ordinary type.

The construction of macadam roads on a large scale has naturally imparted a great impetus to the development of rock crushing apparatus. The first steel rock crusher was built ten years ago and a gradual improvement has since gone hand in hand with an increase of capacity. The most modern plants not only crush the stone but elevate it and separate it into sizes. The stone crushers weigh from two to eight tons each, require for their operation engines of from twelve to twenty-five horse power and give a product of from eight to thirty tons of crushed stone per hour. For separating the crushed stone into different sizes road makers usually use a portable storage bin which weighs 2,500 pounds and has three compartments, each of which will hold four tons of stone and which are provided with discharging chutes on either side so that wagons can load from both sides if necessary. For separating the crushed material into various sizes screens of different types are available. One of the most interesting forms of this apparatus is the revolving screen, which revolves on either a shaft or on rollers and into which the stone passes. Some of these screens are fifty-six inches in diameter, and inasmuch as each screen is punched with holes of two different sizes, three different sizes of product are obtained, one size passing through the one-inch holes, a second size passing through the two-inch holes, and the largest size passing out at the end of the screen.

Another class of machine in which great improvement is noticeable is the steam road rollers. The principle on which the newest machines are constructed is to make the wheels, which are absolutely necessary to carry the machine, act as the rollers proper. Road rollers range in weight from five to nineteen tons, and on the larger sizes the driving wheels are about 76 inches in diameter and have a facial measurement of from twenty to twenty-six inches. Rapid road building is still further facilitated by the use of spreading wagons, dump wagons, road plows and other improved forms of apparatus which are largely automatic in their operation and which contribute to an economy of time and money.

THE NERNST LAMP.

The Nernst lamp, as commercially developed by the Nernst Lamp Company, of Pittsburg, Pa., a Westinghouse interest, while not as simple in construction as the incandescent lamp, is much less complex than the arc lamp. Like the incandescent lamp, the radiating body is a filament heated by the passage of a current, either alternating or direct. The filament is a composition formed by mixing rare earths with a highly infusible body. As is well known, rare earths when heated to the approximate temperature of the incandescent lamp give a blinding, brilliant light, comparable in whiteness with the lime light or carbon in an arc. The quality of the light is remarkable for its beauty and close approximation to daylight, giving to colored objects their true appearance. This property makes the lamp especially desirable in stores, art galleries, drawing-rooms and the like. The absence of shadow, the steadiness of the light, the simplicity and low cost of maintenance,

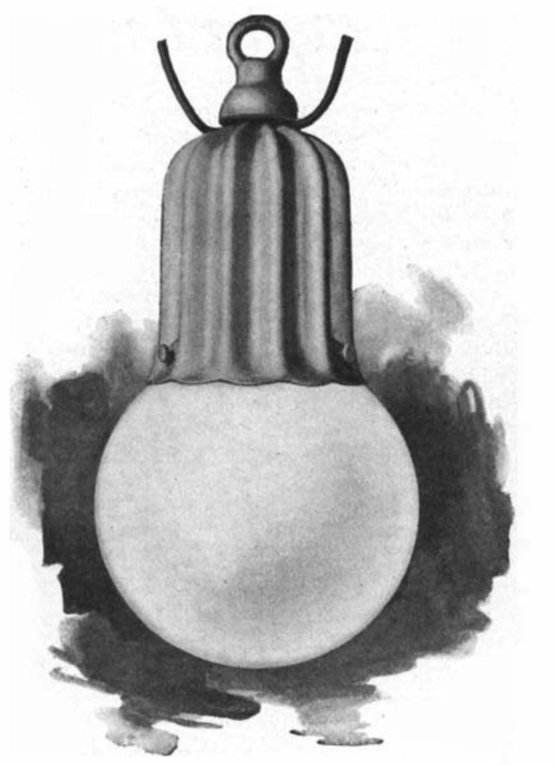

Fig. 5.—Six Glower Lamp—Out-Door Type.

together with its high efficiency, commend the Nernst lamp strongly to the lighting world. Depending as it does solely upon the heating power of the current, it can be used on circuits of 3,000 alternations. This

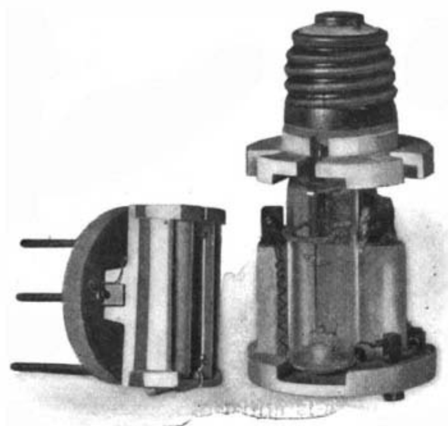

Fig. 3.—Parts of the Single Glower Lamp.

more than any other fact will cause it to displace the arc lamp.

The incandescent filament is a non-conductor at a low temperature, and therefore some device must be employed to raise its temperature before current can pass through it. Accordingly, a platinum resistance called a "heater" is provided for bringing the filament to a conducting temperature. The peculiar behavior of the filament or "glower," as it is commonly called, with reference to voltage and current, has given rise to the necessity of a steadying resistance. As the current in the glower is increased, the voltage across its terminals rises; at first rapidly, and then more and more slowly to a maximum, beyond which it again drops off with increasing rapidity as the current and resulting temperature through the glower continue to increase. Beyond the point of maximum voltage the decrease in resistance of the glower is so rapid as to make the current difficult of control. In fact, without the employment of a steadying resistance the conducting filament would rapidly develop a short-circuit and flash out. This tendency is counteracted by placing a steadying resistance, or "ballast" as it is called, in series with the glower. Such an arrangement keeps two points, between which is the glower and steadying resistance, at a constant potential and consequent steady current; in other words, the steadying resistance as placed in the actually constructed lamp rises in temperature and increases in resistance by as much as the glower diminishes. There are then three elements to be described—the glower, ballast and heater.

The glower for a 220-volt lamp is about 25 millimeters long and 0.63 of a millimeter in diameter. It is made by expressing from a die a dough made of the rare earth mixed with a suitable binding material, cutting the porcelain-like string thus made into convenient lengths, drying, roasting and finally attaching lead-in wires. Embedded in the ends of the glower are platinum wires ending in beads, so that any tendency on the part of the glower material to shrink—repeated heatings produce this effect; clay is the common substance that exhibits this property—can only result in tightening the contact, and maintaining intimate union between the platinum bead and the glower. To the platinum beads are fused short lead wires of platinum, to which in turn are fastened conducting wires ending in aluminium plugs. A bundle of the glowers is shown in Fig. 1. The glower is about as strong as a piece of porcelain of the same size, and it is difficult to break a short section. When properly made the voltage of the glower changes but slightly during its life, the tendency being to rise from two to four per cent in eight hundred hours.

It has been mentioned that the use of a steadying resistance is to keep the current in the filament constant; it must, therefore, act immediately or it is useless. As designed to meet this exacting requirement it is unique in construction and wholly effective in keeping the glower at a constant temperature. Iron wire is mounted in a small glass tube filled with an inert gas, so that no matter what temperature the iron takes it will not be affected. It would oxidize were not the air in the tube replaced by a chemically inactive gas. One of these is employed for each glower.

As already mentioned, the glower is non-conducting when cold, and means must be provided for bringing

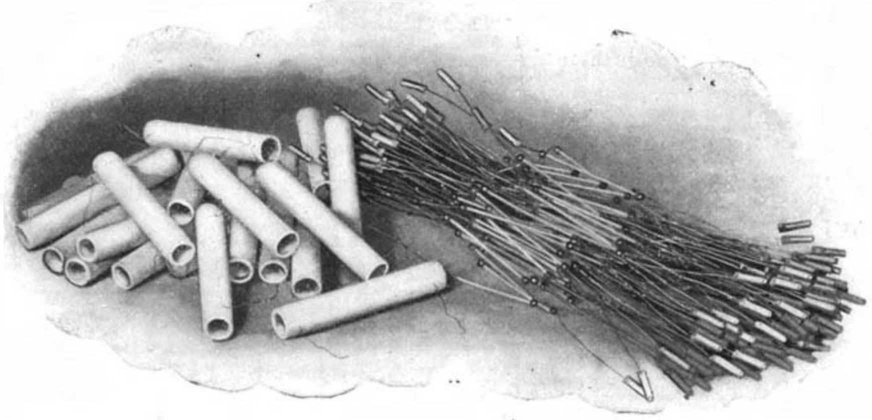

Fig. 1.—Heater Tubes and Glowers.

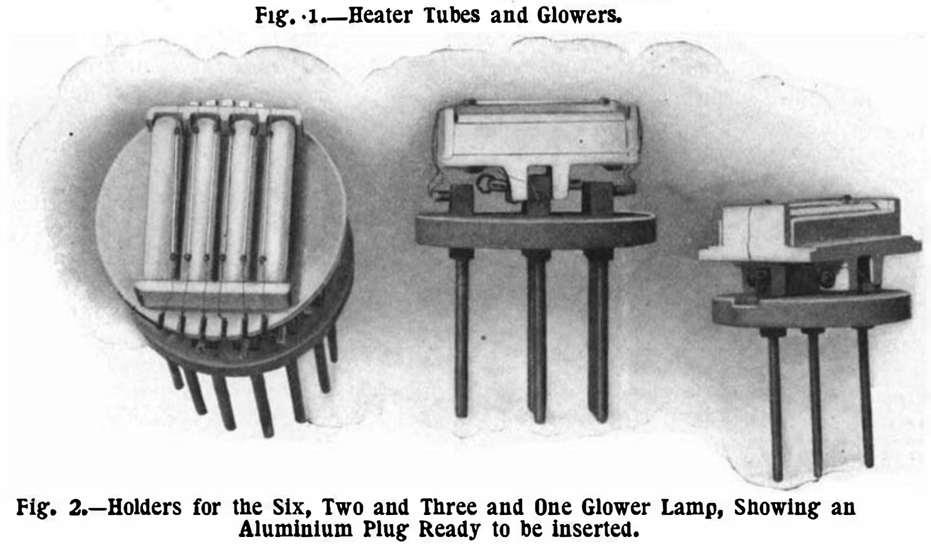

Fig. 2.—Holders for the Six, Two and Three and One Glower Lamp, Showing an Aluminium Plug Ready to be Inserted.

Fig. 4.—Gripping the Holder Without Disturbing the Glower.

THE NERNST LAMP.