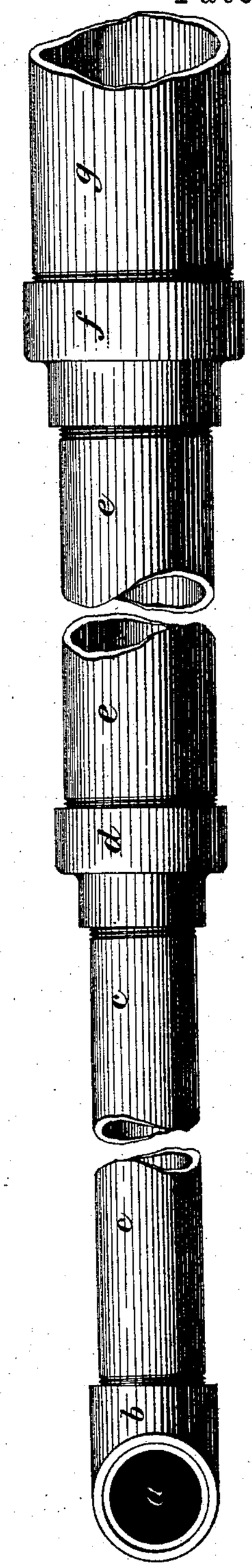
(No Model.)

G. WESTINGHOUSE, Jr.

LONG DISTANCE GAS DISTRIBUTION.

No. 365,454. Patented June 28, 1887.



Witnesses.
H. L. Gill.
J. H. Bakewell

Inventor.
George Westinghouse Jr.
by his atty's
Bakewell & Kerr

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., OF PITTSBURG, PENNSYLVANIA.

LONG-DISTANCE GAS-DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 365,454, dated June 28, 1887.

Application filed December 7, 1886. Serial No. 220,932. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, Jr., of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Long-Distance Gas-Distribution; and I do hereby declare the following to be a full, clear, and exact description thereof.

In the distribution of natural gas in pipes from the wells to distant places of use there is a very considerable loss in pressure and velocity, by reason of the friction against the sides of the conduit.

In laying the lines three important things have to be considered—the cost, the loss from leakage, and the danger resulting from carrying a high pressure of gas. By reason of the loss resulting from the friction the quantity of gas which can be delivered from a pipe of given diameter diminishes relatively to the distance from the well to the terminus of the pipe, according to the well-known law governing the flow of fluids under pressure, so that the distance at which a given quantity of gas can be delivered depends upon the pressure at the well and the size of pipe. The pipe of course must be of sufficient strength to resist the pressure. In a pipe line of uniform diameter of eight inches, twenty miles long (being the length and size of the lines laid between Murraysville and Pittsburg,) having a pressure at the well of three hundred pounds, the reduction of pressure due to friction is about six pounds to the mile in the beginning, gradually increasing, according to the laws governing the flow of fluids, to a loss of twenty pounds or more per mile. At three hundred pounds pressure each cubic foot of gas is equal to twenty cubic feet at atmospheric pressure. If the gas-main, thirty miles long, having an area of one square foot, so that each foot in length would be a cubic foot, had an initial pressure of three hundred pounds per square inch, the pressure at a point five miles distant from the delivery end would be about one hundred and fifty pounds per squre inch, and, the pipe being of uniform size, the gas which at first occupied a space one foot in length would at the reduced pressure occupy two feet in length.

It was the practice before the date of my invention to lay lines of uniform diameter from the well to the point of distribution, and when it was desired to increase the quantity of gas to lay an additional line. The pipe used previous to date of my invention varied from five inches to eight inches in diameter.

The use of a pipe of uniform size necessitates a very high pressure throughout the greater portion of the line, with a consequent loss by leakage, which is great when the pressure is high, and the liability of bursting the pipes and fittings.

Where a considerable quantity of gas has been rquired, the cost of constructing a plant of pipes of uniform size has been a serious disadvantage to the gas companies, and consumers have been obliged to pay an increased price for the gas, because of the increased cost of the plant needed for its supply. The quantity of gas carried through a line varies approximately, according to the square of the pressure, and consequently a line carrying seventy-five pounds pressure will take nearly one-half the quantity of gas through that it would at three hundred pounds pressure; and, again, the quantity of gas carried through pipes of the same length but of different diameters varies according to the square root of the fifth power of the diameters of the pipe. Taking two sizes of pipe—an eight-inch and a sixteen-inch, for example—the sixteen-inch has at the same pressure about six times the carrying capacity of an eight-inch, or with one thirty-sixth of the pressure will carry the same quantity.

The purpose of my invention or discovery is to provide an improved system of gas-distribution, whereby provision is made for the reduction of the average pressure carried through the line, an increased delivery obtained, the loss and danger from leakage and the liability of pipes and fittings to rupture lessened, and the first cost of the line reduced. To this end I increase the size and capacity of the gas-conduit at successive intervals, making its size at the well relatively small, and enlarging it progressively at one or more remote points, so that as the pressure diminishes the capacity of the conduit is increased.

Theoretically my invention is illustrated by a conduit made in form of a hollow cone, of which the apex represents the supply and

the base the delivery end; but in practice I do not make the increase in capacity so regular.

The accompanying drawing, showing a broken section, will illustrate the construction of a pipe line embodying my invention, as such lines may be made. Here *a* indicates the gas-well; *b*, the T-fitting at the top of the well-tube, by which the conductor-pipe *c* is connected thereto, said conductor-pipe being of any desired length; *d*, a coupling connecting the pipe *c* with a larger pipe, *e*, of any desired length; *f*, a coupling connecting the pipe *e* with a larger pipe, *g*, of any desired length. The pipes *c e g* are each composed of sections of pipe connected together by couplings in the usual way, and their relative lengths are determined by the necessities of each particular use or by the desire of the constructor of the line.

The advantage of enlarging the pipe is not only to lessen the average general pressure through the line, but also to provide a considerable reservoir capacity, and at the same time to greatly accelerate the flow of the gas from the well to the points of distribution.

The following will illustrate its practical application: Suppose a gas-line 9.45 miles in length, in which the pressure diminishes from three hundred and nineteen pounds at the well to sixty-five pounds at the other end. The first 2.84 miles of the pipe, in which the gas is reduced to one hundred and eighty-five pounds, may be composed of one eight-inch main. For the next 2.75 miles, in which the gas is reduced to one hundred and thirty-two pounds, one ten-inch conduit may be employed, and one twelve inch conduit for the next 3.84 miles, in which the pressure is reduced to sixty-five pounds. These figures are given merely for the purpose of illustration, and are taken from a gas line now in successful use which has been constructed in accordance with the principles of my invention.

Instead of enlarging the area of the conduit by means of a single pipe, I can use two or more pipes, the combined capacity of which is greater than that of the preceding section. This construction, however, is not as good as that first described.

The principal advantage of my improvement consists in the fact that, while the average pressure of the gas in the line is greatly reduced and leakage and danger lessened, the volume of the gas delivered is enormously in excess of that which could be delivered by a pipe line of the same cost and length and of uniform capacity throughout. The friction is reduced and expansion is provided for. It is desirable that the normal pressure should be greatly reduced at the point of utilization. This I accomplish in the conductor-pipe without the special provision of holders, tanks, or regulators, and without unnecessary loss of velocity and volume by friction.

The saving of expense and cost of pipe resulting from the use of my improvement is very great, especially on long lines. Near the well, where, by reason of the great density and pressure of the gas, only a small pipe can safely withstand the pressure, the pipe or pipes are of relatively small size and cost, and the larger and more costly pipes are used only as the diminution of pressure and density at remote points necessitate larger conduits. The general pipe capacity has to be determined by the necessities of each case.

When in the following claim I speak of increasing the capacity of the conduit as the gas-pressure therein diminishes, I do not mean to limit myself to a proportionate increase, as that would involve the construction of a conical pipe; but I do mean a conduit having two or more successive sections, each of greater area than the preceding section or sections; and when I speak of "high pressure" I mean a pressure above that usually carried on pipes for the conveyance of illuminating-gas.

What I claim as my invention, and desire to secure by Letters Patent, is—

An improvement in the art of long-distance gas transportation, which consists in conducting the gas from the point of supply at high pressure in a conduit or conduits having two or more successive sections, each section being of greater cross sectional area than the preceding section or sections, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 10th day of November, A. D. 1886.

GEO. WESTINGHOUSE, JR.

Witnesses:
R. H. WHITTLESEY,
THOMAS B. KERR.