No. 871,208. PATENTED NOV. 19, 1907.

A. COTTON.

JET BLOWER.

APPLICATION FILED APR. 16, 1906.

Fig:1,

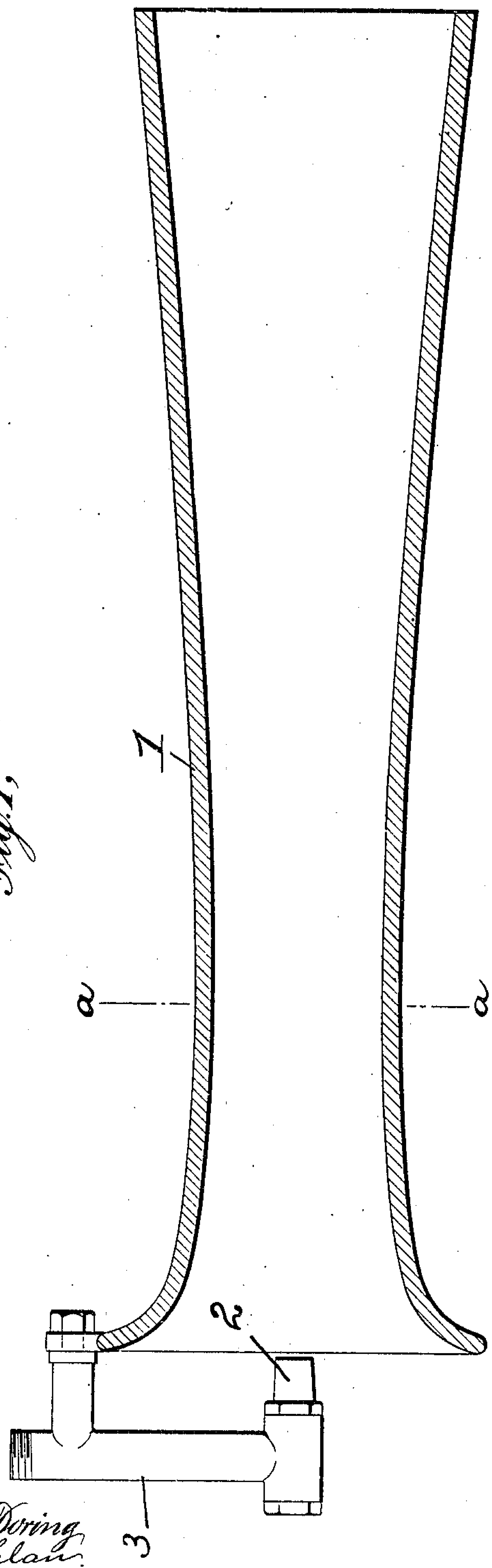


Fig:3.

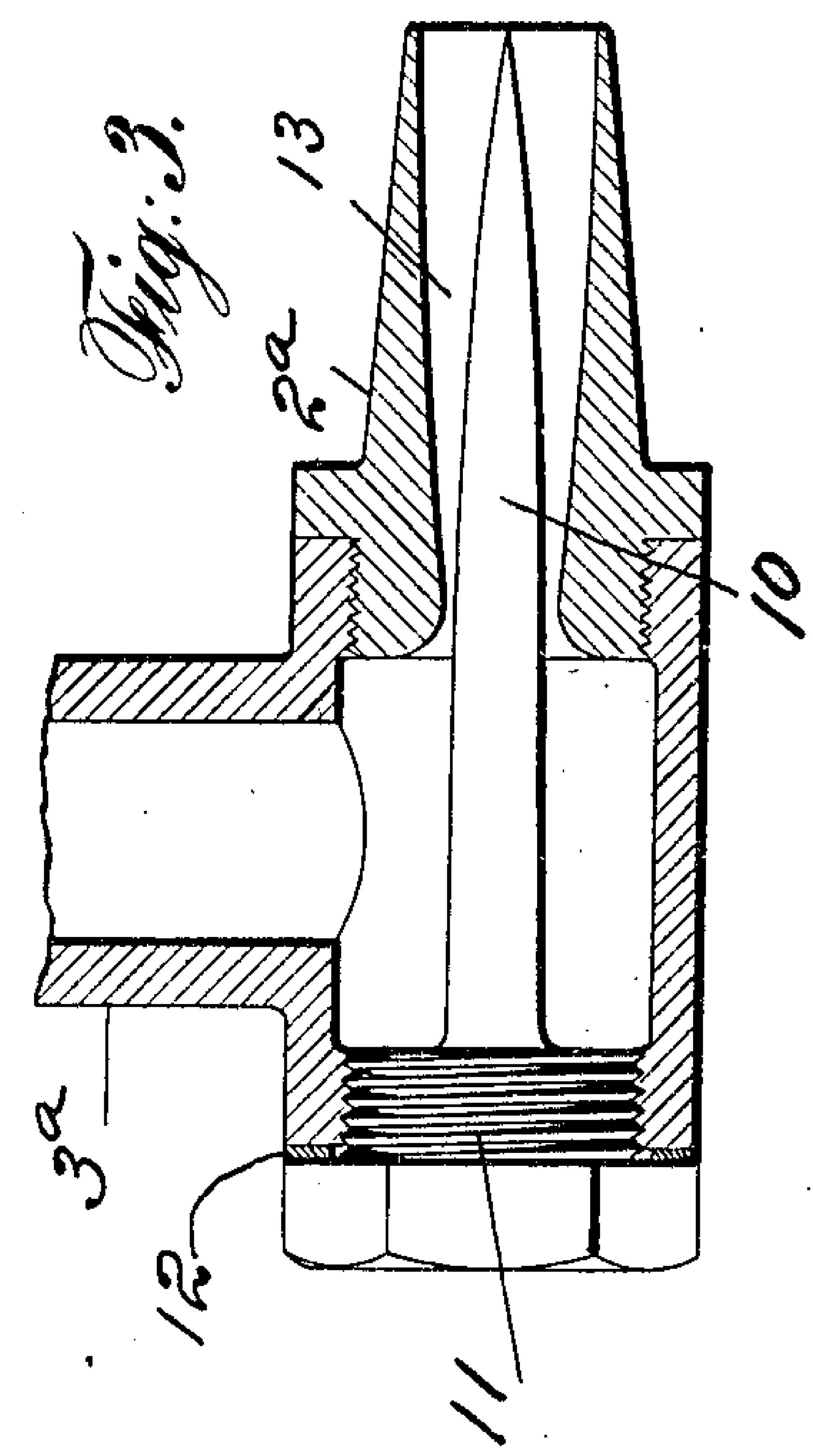
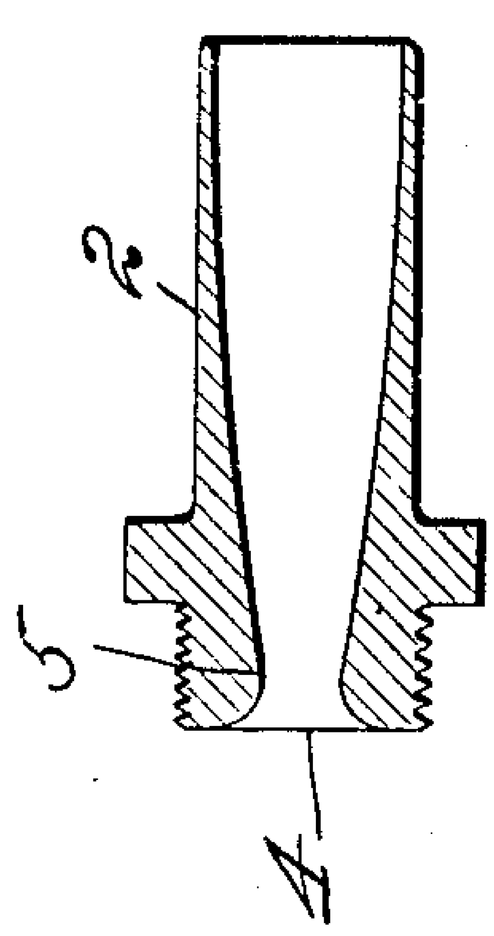


Fig:2,



WITNESSES

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JET-BLOWER.

No. 871,208. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed April 16, 1906. Serial No. 311,817.

To all whom it may concern:

Be it known that I, ALFRED COTTON, a subject of the King of Great Britain, residing at Newark, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Jet-Blowers, of which the following is a specification, reference being had therein to the accompanying drawing, in which—

Figure 1 is a longitudinal, vertical, sectional view of the conveyer, the nozzle being shown in side elevation; Fig. 2 a central longitudinal sectional view of the nozzle detached; and Fig. 3 a central longitudinal sectional view of a slightly different form of nozzle.

The invention relates to a jet blower designed for moving or forcing air or other gases, for forced and induced draft for boilers, and other furnaces, or for ventilating and like purposes. The motive jet may be of steam or compressed air or other gas.

The invention has for its special object to provide an efficient jet blower particularly adapted for the utilization of the expansive force of steam.

The invention consists in providing a nozzle of peculiar internal form to be used in combination with a conveyer. In the preferred form of the apparatus the conveyer is also of peculiar internal form. The nozzle consists mainly of two portions—a curved inlet having a gradually contracted throat, shaped similar to what is known as the "vena-contracta", and a divergent portion. The object being to produce a nozzle wherein there will be no conical or cylindrical portion in its internal form.

The conveyer consists mainly of three portions—the curved inlet having a contracted throat shaped similar to the "vena-contracta"; a curved converging portion extending inward a short distance from the throat, and a curved divergent portion extending from the point of smallest internal diameter to the discharge end of the conveyer. The object of this construction is to provide a conveyer which has no abrupt changes in its longitudinal contour and wherein there is no part which is straight in longitudinal section, that is to say, no part which is either conical or cylindrical.

Referring to the various parts by numerals, 1 designates the conveyer; 2 the nozzle and 3 the supply pipe and supporting bracket to which the nozzle is secured. The nozzle is arranged in such a position that its longitudinal center or axis is axially in line with the longitudinal center or axis of the conveyer. The nozzle is supported so that its discharge end is outside of the conveyer. It will of course be understood that the nozzle may project slightly within the conveyer, but I have found that any extension of the nozzle within the conveyer reduces the efficiency of the apparatus. The nozzle 2 is screwed or otherwise secured to the lower end of the supply pipe, and is formed with the inlet 4, said inlet terminating at the contracted throat 5. The inlet is circular in cross section and is curved longitudinally to conform to the stream-lines assumed by a fluid issuing through a hole in a thin plate, said lines being inwardly curved and known as a "vena-contracta".

From the contracted throat the internal diameter of the nozzle gradually increases to the outlet end. This divergent portion of the nozzle is so shaped that the increase in its internal area will be substantially equal for equal increments of length, throughout. The interior wall of this divergent portion of the nozzle is therefore concave in longitudinal section, the curve of this concave divergent part joining smoothly into the curve of the contracted throat to avoid forming abrupt corners or sudden enlargements in the interior of the nozzle. This is a great advantage in steam jet blowers as will be fully hereinafter set forth.

If the divergent portion of the bore of the nozzle is a true taper, then it is evident that as the diameter increases directly as the length, and as the area increases as the square of the diameter, the increments of area become greater for each increment of length. This is a great objection. In the use of nozzles in steam jet blowers it is evident that at the beginning of the divergent portion of the nozzle the pressure is highest and consequently there is the greatest expansive force at that point. Therefore, the greatest increase of area should be at that point, without, of course, forming any abrupt enlargements in the bore of the nozzle. As the velocity of the steam is increased by conversion of its expansive force into work or speed energy, less increase of area is necessary as this conversion progresses for the reason that a greater volume of steam now passes a given area in a given time. Still, further, as expansion progresses some condensation occurs which reduces the volume of steam reaching the largest diameter of the divergent portion necessitating less increase of area than if no condensation occurred. Thus it will be seen that to produce a nozzle of the highest efficiency, the divergent portion of said nozzle should not be truly tapered or conical but should be approximately conoidal or curved to secure an increase of internal area either equal or slightly less for equal increments of length throughout the divergent portion thereof, substantially as described and as shown in the drawing. I prefer to form the divergent portion of the nozzle so that a tangent to the extreme end of the curve, *i. e.*, at the outlet, will be parallel to the axis, or nearly so. A great advantage of this form is that the walls of the nozzle as seen in longitudinal section will be substantially parallel at the extreme outlet of the nozzle, thus the steam jet will be more compact as it issues therefrom and less liable to immediate spreading. It is very important in jet blowing apparatus to provide a nozzle of such shape that the steam will be maintained in a compact jet as it issues from the nozzle and for a considerable distance from the said nozzle. Any tendency on the part of the jet to immediately extend laterally or to become "woolly" reduced the efficiency of the jet.

By properly curving the divergent portion of the nozzle the increments of area for equal increments of length may be equal or decreasing toward the outlet. With highly superheated steam where little or no condensation would occur the increments of area may be made equal for equal increments of length; while with saturated steam involving condensation, the increments of area may become less towards the outlet for equal increments of length.

The conveyer of the blower is everywhere circular in cross-section and is made at its inlet end to conform longitudinally to what is known as a "vena-contracta". The curve of the inlet is followed by another and very gradual curve which beginning at the contracted throat ends at the point of smallest diameter indicated by the dotted line *a—a* in Fig. 1, and forms the converging portion of the conveyer. This smallest diameter is preferably at a point from the inlet end a distance equal to twice the length of the smallest diameter of the conveyer. From this point of smallest diameter the conveyer walls diverge on curved lines to the end of the conveyer so that the wall of said conveyer will be convex in longitudinal section. All these curves, that is to say, the inlet curve, the curve of the converging part and the curve of the divergent part are very gradual and are tangent to each other so that the bore of the conveyer has no abrupt changes in its longitudinal contour. Further, and this is important, there is no part which is straight in longitudinal section, that is to say, there is no part which is either conical or cylindrical. I have found this form of conveyer to be most efficient, as the inflowing lines of steam and air pass therethrough with the least possible friction and with the least retardation due to eddy-currents.

The curves of the inner wall of the conveyer are what may be called inward curves, that is to say, the chords of the curves are outside of the conveyer; while the curve of the interior wall of the divergent part of the nozzle is what may be termed an outward curve, the chord of the curve being within the nozzle.

The steam jet issuing from the nozzle being very compact and having fully or nearly fully expanded, increases slowly in cross-sectional area as its velocity is lowered by driving the air. The cross-sectional area of the steam jet does not increase sufficiently to fill the conveyer until at a point well beyond the smallest diameter of the conveyer, and as the longitudinal section of the conveyer is here an outward curve, the outside of the steam jet is very nearly tangent to this outward curve and consequently the filling of the conveyer by the jet is done smoothly and without the formation of eddies or otherwise retarding the onward flow of the steam and air. It will also be seen that the steam and air travel in substantially parallel lines as the stream lines of the jet do not greatly diverge until the air stream-lines are parallel or are diverging.

In Fig. 3 is shown a slightly different form of nozzle. The nozzle 2^a in this form of the device is interiorly of the same general form as that shown in Fig. 2, except that the contracted throat is somewhat larger than that shown in Fig. 2, while the outlet of the nozzle is of the same diameter. Extending into this nozzle is a central core 10, whose cross-sectional area within the nozzle decreases so that it is tapered to its forward end but is not conical. The longitudinal section of the tapered part of the core is convex, and this convex part extends from a point within the smallest diameter of the nozzle, that is to say, at the contracted throat thereof to the outlet end of the nozzle. This core is carried by a threaded plug 11 which is screwed into the supporting pipe 3^a, and by which said core may be longitudinally adjusted, said core forming the stationary inner wall of the nozzle. By placing washers 12 between the headed end of the plug and the supporting pipe, the core may be set at the desired position within the nozzle. By this means the area of the annular steam-way 13 through the nozzle and around the core may be proportioned similarly to the area of the nozzle shown in Fig. 2, that is to say, so that the proportion of increase in area for equal increments of length is equal, or gradually decreasing. By forming the core adjustable one nozzle may be used for different initial pressures of steam. It is to be noted that this core is not a needle valve in the ordinary sense of the term, but is for the purpose of varying the relative areas at the throat and outlet of the divergent portion of the nozzle, to suit different conditions of expansion.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is,

1. A jet blowing apparatus comprising a nozzle provided with an inwardly curved contracted entrance or throat and with a divergent portion extending from said throat to the outlet end, the wall of said divergent portion being outwardly curved on a longitudinal line to secure a decreasing increase of cross-sectional area for equal increments of length throughout the divergent portion of the nozzle, and a conveyer having an inwardly curved contracted throat, a converging portion adjoining the throat and a divergent portion extending from the inner end of the converging portion of the conveyer to the outlet end thereof, the interior wall of said conveyer being formed on inwardly curved lines whereby the interior of the conveyer and the nozzle will be curved longitudinally from end to end and will be circular in cross section at all points.

2. A jet blowing apparatus comprising a nozzle having an inwardly curved contracted entrance or throat and a divergent portion extending from the said throat to the outlet of the nozzle, the wall of said diverging portion being concave on a longitudinal line and so curved that there will be a decreasing increase in cross-sectional area of the nozzle for equal increments of length, whereby the degree of expansion will be substantially equal throughout the divergent portion of the nozzle; in combination with a conveyer having an inwardly curved contracted entrance or throat, an inwardly converging part extending inward from the throat and a diverging portion extending outward from the inner end of the converging portion.

3. A jet blowing apparatus comprising a nozzle having an inwardly curved contracted entrance or throat and a divergent portion extending from the said throat to the outlet of the nozzle, the wall of the said divergent portion being concave on a longitudinal line and so curved that there will be a decreasing increase in cross-sectional area of the nozzle for equal increments of length whereby the degree of expansion will be substantially equal throughout the divergent portion of the nozzle, in combination with a conveyer.

4. A nozzle for a jet blowing apparatus having an inwardly curved contracted entrance or throat and a divergent portion extending from said throat to the outlet of the nozzle, the wall of said divergent portion being concave on a longitudinal line and so curved that there will be a decreasing increase in cross-sectional area of the nozzle for equal increments of length, whereby the degree of expansion will be substantially equal throughout the divergent portion of the nozzle.

5. A jet blowing apparatus comprising a conveyer, a nozzle having an inwardly curved contracted entrance or throat, and a divergent portion extending from said throat to the outlet of the nozzle, the wall of said diverging portion being concave on a longitudinal line and so curved that the degree of steam expansion will be substantially equal throughout the divergent portion of the nozzle, a core extending longitudinally into said nozzle, said core being tapered from the contracted throat to its forward end.

6. A jet blowing apparatus comprising a conveyer, a nozzle having an inwardly curved contracted entrance or throat, and a divergent portion extending from said throat to the outlet of the nozzle, the wall of said diverging portion being concave on a longitudinal line and so curved that the degree of steam expansion will be substantially equal throughout the divergent portion of the nozzle, a core extending longitudinally into said nozzle, said core being tapered from a point adjacent to the said contracted throat to its forward end, the wall of said tapered part being convex, and means for adjusting said core longitudinally within the nozzle.

7. A jet blowing apparatus comprising a nozzle having an inwardly curved contracted entrance or throat and a divergent portion extending from the said throat to the outlet of the nozzle, the wall of the said divergent portion being concave on a longitudinal line and so curved that there will be a decreasing increase in cross-sectional area of the nozzle for equal increments of length whereby the degree of expansion will be substantially equal throughout the divergent portion of the nozzle, in combination with a conveyer, said conveyer being formed with an inwardly curved abruptly contracted throat, a slightly convergent portion extending from said throat and a gradually diverging portion extending from the inner end of the converging portion to the outward end of the conveyer,

the diverging portion being longer than the converging part and the converging part being longer than the abruptly contracted part, the inner wall of said conveyer being convex longitudinally from end to end of the conveyer and the conveyer being circular in cross-section at all points.

In testimony whereof I hereunto affix my signature in the presence of two witnesses this 14th day of April, 1906.

ALFRED COTTON.

Witnesses:

WM. R. DAVIS,

E. I. CAUGHLAN.