It was no part of any "invention" of this patentee that the straightedge should be of metal rather than celluloid, or any other material well known at the time as suitable for the severance of the ticket. The "invention," as such, is not divisible so that a metal straightedge, as distinguishable from a celluloid straightedge, could be an essential factor in one form, as distinguished from other possible forms. I cannot hold here that this patentee, by the use of the word "metal," has intentionally parted one portion of his invention from the remainder, thus monopolizing the one portion and giving the remainder to the public. Section 350, Walk. Pat., contains the following statement:

"The doctrine of equivalents may be invoked by any patentee, whether he claimed equivalents in his claim, or described any in his specification, or omitted to do either or both of those things. But where the patentee states in his specification that a particular part of his invention is to be constructed of a particular material, and states or implies that he does not contemplate any other material as being suitable for the purpose, it is not certain that any other material will be treated by a court as an equivalent of the one recommended in the patent. Combination patents would generally be valueless, in the absence of a right to equivalents; for few combinations now exist, or can hereafter be made, which do not contain at least one element, an efficient substitute for which could readily be suggested by any person skilled in a particular art."

This patentee did not state, nor does his specification imply, that the straightedge "to enable the desired portion of said strip to be readily detached without danger of tearing the same irregularly, and thus injuring the ticket," could not be of celluloid, or of hard rubber, or of wood, or of some other hard, but nonmetallic, substance. In view of the text quoted from Walker, and of such cases as Reece Button-Hole Mach. Co. v. Globe Button-Hole Mach. Co., 10 C. C. A. 194, 61 Fed. 958, wherein the opinion was by Judge Putnam in the court of appeals of the First circuit, it would be a mistake, as it seems to me, to hold that the doctrine of equivalents is not here applicable. I think the injunction should go as prayed in the bill, and it is so ordered.

CARNEGIE STEEL CO. v. CAMBRIA IRON CO.

(Circuit Court, W. D. Pennsylvania. September 5, 1898.)

1. PATENTS—USE OF DIRECT PROCESS IN MAKING BESSEMER STEEL—THE JONES MIXER.
   The Jones process patent, No. 404,414, as to its second claim, for a process "of mixing molten metal to secure uniformity of the same in its constituent parts preparatory to further treatment," which is carried into practical use in the manufacture of Bessemer steel by the direct process by placing and maintaining between the blast furnaces and the Bessemer converters a receptacle or mixer, into which the ununiform products of the different furnace charges are poured and allowed to mix, the converters being charged from such receptacle, which is so constructed and operated that a sufficient quantity or pool of the molten metal always remains therein to dominate the resulting mixture when new charges are added, is novel, and involves invention, and was not anticipated by prior patents or publications, English or American, nor by any process in prior use in the art.
2. SAME—INVENTION—PRESUMPTION FROM ISSUANCE OF PATENT.
   The issuance of a patent is prima facie evidence that the patentee was the first inventor of what he described and claimed.

3. SAME—ANTICIPATION OF PATENT FOR A PROCESS.
The fact that the apparatus used by a prior patentee might be employed in practicing the process of a later patent is not sufficient to constitute an anticipation, if the later patent was the first to suggest such use.

4. SAME.
In order that a prior patent or publication may render void a subsequent one, the information therein given must be so full, clear, and precise that one skilled in the art, and acting in the then state of knowledge, can, from such patent or publication, perform the process or make the thing covered by the patent sought to be anticipated.

5. SAME.
In determining a question of anticipation by an earlier patent it is a pertinent and reasonable inquiry, if it be true that the disclosures of such patent were substantially those of the one in issue, why, during a period of many years, was it not practically applied to the same use? This inquiry is especially pertinent when a great branch of industry long recognized the need supplied by the patent in issue, and such need was discussed at gatherings of those interested in practical problems of the art.

6. SAME.
The process of Jones' patent, in suit, *held* not to be anticipated by Whitney's prior process of mixing metal for use in casting car wheels, the subject-matter of the process being different, the essential purpose of each being nonessential and ineffective in the other, and the Whitney process failing to disclose the principles of the Jones process, or to teach how the difficulties in Bessemer practice could be avoided. The use of an old method applied to a new object, and conjoined with other elements, which co-operate with it to produce a new result, is not a mere double use.

7. SAME—PROCESS—PATENTABILITY.
The process of the Jones patent, in suit, for preparing blast-furnace metal for use in a converter by first passing it through a dominant pool of molten metal, whereby its thermal state and the proportions of its chemical constituents are changed, is patentable as a process. The essence of the invention lies, not in the mixing vessel, but in the action of the enveloped mass of fluid metal, which modifies and grades each entering charge, and makes the difference between successive outgoing charges nonabrupt.

8. SAME—DISCLAIMER BY PATENTEE.
The power to disclaim is a beneficial one, and should not be denied, except where it is resorted to for a fraudulent and deceptive purpose.

This is a suit in equity for the infringement of a patent for a process used in the manufacture of Bessemer steel by the direct method.

Bakewell & Bakewell, Thomas B. Kerr, and P. C. Knox, for complainant.

James I. Kay, P. T. Dodge, and Francis T. Chambers, for defendant.

BUFFINGTON, District Judge. This case concerns the art of steel-making. As the difficulties which the patent sought to obviate in that art arose in the Bessemer process, and its practical application has been wholly therein, an account of such process, and its relation to and effect on the art would seem proper, if not, indeed, indispensable, to a proper understanding of the case. And as this patent underlies, and in a measure possibly dominates, the successful commercial converting of Bessemer steel by the direct process, the importance of the question involved must be a sufficient warrant for this unusually lengthy opinion. Tersely stated, the Bessemer process consists in blowing air through molten pig iron placed in a refractory lined vessel called a "converter," whereby the oxygen combines with, and burns out, the carbon and silicon. It was probably the most potent factor in broadening the scope of the steel industry, cheapening its product, making possible its use in new and wider fields, and its substitution for iron. While the foundation of this advance is based on Bessemer, improvements were made by others. Touching only on such as are pertinent here, we note that when iron was thoroughly decarburized a certain necessary amount of carbon was restored to the metal by Mushet's method of introducing ferro-manganese, or spiegeleisen. With the Bessemer invention was soon seen the possibility of making steel by what was known as the "direct process"; that is, taking the molten metal direct from a blast furnace, and subjecting it in a fluid state to the Bessemer process. The immense saving in both labor and plant appliances in case this could be successfully done was self-evident; but grave difficulties in the way of such use soon became apparent, and threatened, unless met, enforced abandonment of such direct process. What these difficulties were will appear from a study of the thermal and chemical, or quasi chemical, elements of molten metal treatment. From the heat-yielding capacity of silicon the high temperature needed for heating, and keeping heated, the fluid in the converter was obtained. Such high stage of heat was imperative from the fact that as the fluid, by the consumption of carbon and silicon, approached the condition of pure iron, its melting point rose, and, unless a correspondingly high temperature was kept up, the fluid grew thick or pasty,—an objectionable condition. Much of the heat generated by carbon oxidation passed off with the carbonic oxide gas, but the oxidized silicon formed slag, which remained in the converter, and the intense heat caused by the burning of the silicon was thus retained and utilized. Its varying degree, however, was a source of serious trouble. Such trouble arose in this way: If the metal contained a high percentage of silicon, the resultant heat was proportionately great. If such heat was excessive, and not controlled or neutralized, overblown or wild heats of steel resulted, which could only with difficulty be deoxidized with manganese, and which likely resulted in a bad product. On the other hand, if the fluid mass was too low either in initial temperature or in silicon percentage, these factors, if not corrected, produced chilled heats, or scrap. To neutralize or convert as far as possible these adverse unfavorable conditions was the province of an adept, skillful, and expert blower or converter man. That such qualities were indispensable will appear from attendant conditions. The converter reactions were rapid, the entire operation lasting but 10 minutes. The peculiar appearance of flame jetting from the converter mouth was an index to the blower man of the thermal character of the charge. If he thought it too hot, he added varying, but sometimes large, quantities of cold steel scrap, which absorbed the heat necessary to melt it, and so reduced the average temperature of the mass. Steam blown in with the air through the tuyeres was also used to produce the same effect. By reducing the amount of scrap, or omitting it altogether, varying conditions of heat were met. An excessively cold heat might also be "side-blown," or the converter turned on its side, so that a portion of blast passing over the surface increased the heat by burning the iron itself. This, however, greatly increased waste. The situation called for quick decision and rapid execution, and a mistake in either direction spoiled the steel. Moreover, one converter charge was neither an index of its successor nor a sequence of its predecessor. Each one was unique in character, and required individual and varying treatment. This arose from the shifting, unaccountable, and seemingly arbitrary working of blast furnaces, or, indeed, of a single furnace. As illustrative of such workings, we quote, as fairly representative, the testimony of Mr. James Gayley, superintendent of complainant's blast-furnace department, who says:

"The conditions under which a blast furnace is operated are such that the slightest change in composition of the ore, fuel, or the limestone will produce a respective change in the composition of the metal; and even so slight a change in conditions as represented by a change in the content of moisture in the atmosphere produces, all things being considered, the widest fluctuations in the composition of the pig metal; and, inasmuch as the conditions of the atmosphere are beyond control, so it is impossible to control the product of a blast furnace in point of uniformity of composition. * * * For instance, a slight change in the composition of the material charged into the furnace produces an irregularity in silicon in the metal. This variation is again produced by a change in the volume or temperature of the air that is blown in, or by a change in the composition of the slag, and also in a very marked manner by the least change in the content of moisture in the atmosphere; as, for instance, a day in which the atmosphere is very humid, the moisture entering the furnace with the blast requires an undue expenditure of heat in the zone of combustion, and produces a metal that is low in silicon. Again, on a day when the atmosphere is very dry, the opposite conditions exist, and there is produced a metal unusually high in silicon, either of which is undesirable in Bessemer steel operations. * * * Blast furnaces of the same size and interior shape, and charged with the same mixture and weight of ores, will vary in the character of metal produced just as much as if all the above conditions were different. * * * In our furnaces of standard capacity we blow 35,000 cubic feet of air per minute. If the moisture in the air is one grain per cubic foot, on this basis we blow in about 25 gallons of water per hour. The average content for the year is about 5 grains of moisture in a cubic foot of air, which would represent 125 gallons of water per hour going into the furnace in the condition of aqueous vapor. As is well known, the humidity of the air may change decidedly from day to day; as, for instance, in summer time, while to-day we might have 5 grains of moisture in a cubic foot of air, to-morrow our hydrometer might show 8 grains, and sometimes 10 grains, thus changing suddenly from 125 gallons of water per hour to 200 or 250 gallons. This moisture must be dissociated in the hearth of the furnace, and absorbs heat rapidly, causing violent fluctuations, unless quickly perceived and controlled by manipulation of the hot blast. The change in the humidity of the air is the most troublesome element to contend with in the manufacture of pig iron, and the margin or surplus in the heating capacity of the stoves is not always sufficient to meet it."

These varying conditions, results, and product incident to blast-furnace practice produced corresponding irregularity in the working of converters. Cold blow followed hot blow, and vice versa. The conditions were so varying that it was difficult for the converter men to correct the heats, and the workings were so uncertain that it was impossible to produce a uniformly good quality of steel. That these grave difficulties existed, and bade fair to defeat the use of the Bessemer direct process, is shown, first, by the resort of manufacturers to the more expensive cupola practice; next, by the literature of the art; and, lastly, by the proofs in the case. As molten pig metal in a converter is the base of Bessemer steel, and as pig metal at high temperature is tapped in that state from blast furnaces, it requires no argument to show that the direct process is the natural and logical theoretical one to adopt in economic Bessemer steel-making. Rehandling and reheating are done away with. When we consider the vastness of the product, and that the cost of these items, even when done on a large scale, is possibly 60-odd cents per ton, we gain some idea of the economic advantages of the direct over the nondirect or cupola method; in addition to which metal in remelting is subjected to objectionable contamination from coke. The direct process was one of the original ideas of Bessemer, and he purposed the use of his process in that way. The theoretical possibilities of it, and its great economic elements, have proved a constant temptation to its adoption; but in spite of this the practical obstacles in the way of its successful practice led quite generally to the use of the indirect or cupola system. In it the product of blast furnaces was cast into pigs. These, when cold, were assorted, selected, and remelted in cupolas. By this means a molten product of the desired composition, substantially uniform in character, and suited for successful converter treatment, was secured. But the system involved the necessary rehandling and remelting of the product, maintenance of a cupola system, and the contamination of the metal with sulphur emitted from the coke used in remelting. That serious obstacles to the use of the direct process in connection with Bessemer converters existed is shown, as we have said, by the literature of the art. In 1872, Mr. Z. S. Durfee, himself a distinguished metallurgist, in the specification of United States patent No. 122,312, offered in evidence by the respondent, clearly states these obstacles, and says by reason of them the direct process has been abandoned by many proprietors for the nondirect, in spite of its greater expense. His language was:

"In the manufacture of steel by the pneumatic or Bessemer process a great saving of fuel and iron, of wear and tear of furnaces, and of labor would be effected were it possible to make uniformly good products of the desired temper by converting the crude iron immediately it is tapped from the blast furnace in which it is made. This plan has been, and may still be, practiced to a considerable extent; but it has been found that by reason of the irregular working of blast furnaces, and the consequent varying character and quality of the crude iron produced, it was always very difficult, and in most cases impossible, to secure such uniformity in the converted metal as was essential to success in the business. Hence, at several establishments, where the plan of taking the fluid iron as it was tapped from the blast furnace, and pouring it at once into the converter, had been practiced, it has been abandoned, the proprietors preferring to incur the expense of handling and remelting the crude iron after it had been cast into pigs, in order thus to secure the advantage of carefully selecting and mixing the materials for each charge to be converted."

In "Engineering," a London publication of 1877, appears an article by Messrs. Smith and Holley, describing the construction of the Vulcan Works at St. Louis. Mr. Holley, who designed them, was one of the most noted of American steel engineers, and was subsequently employed by the American Bessemer manufacturers to study and report advances in the art. In this article Mr. Holley, in describing the plant, says it is arranged for the direct process. Mr. J. E. Fry, who was employed at the works from 1881 to 1883, says the cupola system alone was employed. The Holley appliances for the direct process remained unused where they were constructed in the works, and the other needed apparatus was never completed.

The discussions of the scientific societies of an art may be taken as a fair index of most advanced theoretical current thought and practical results. A careful perusal of the proceedings of such bodies is instructive in those regards. The Journal of The Iron and Steel Institute of Great Britain, at its London meeting of 1874, contains a discussion at considerable length of the direct process as applied to Bessemer converters. A careful examination of these discussions satisfies us—First, that the members were keenly alive to the advantages and economics of the direct process; second, they recognized the obstacles in the way of such use by reason of the eccentric character of furnace working and product; third, while they hoped it would be, they recognized the problem had not then been solved. The consensus of opinion was fairly summed up by one of the delegates, Sir James Ramsdell, who said:

"With reference to Mr. Williams' remarks as to the proposal for running the fluid iron direct into the Bessemer converter, the subject has been under the consideration of the Barrow Company for some time; in fact they had tried some practical experiments, and arrived at the conclusion, as far as their knowledge went, it was a very doubtful undertaking. Certainly, they could not produce the quality of steel that was necessary to satisfy the market at that time."

In the president's address certain pending experiments in the line of the direct process were referred to, the use by the French of the direct process commented on (a success, by the way, attributable to the highly manganiferous character of the ore used, and not to any causes pertinent to the patented process now under consideration), and urging of progress in that regard by English manufacturers. In an article on Bessemer works, Sir Lowthian Bell, a recognized authority in the metallurgical world, summed then present conditions by saying:

"So far as I know, the Americans, like ourselves, have done nothing in imitating the French by running the iron from the blast furnace direct into the converter."

A perusal of these papers shows the keen appreciation by the English manufacturers that they must find some way of using the direct process. This was emphasized by the paper read by a Brussels engineer on the successful manufacture of Bessemer steel at the Seraing Works by the direct process, where the manganiferous quality of the ore used was such that no spiegel had to be introduced at the end of the blow. It was recognized that these favorable conditions did not exist in England, and that some other way must be devised of overcoming these recognized obstacles.

In volume 5 of the transactions of the American Institute of Mining Engineers, 1876–77, an elaborate paper on the history of Bessemer manufacture in America was read by Mr. Robert W. Hunt. In it he attributed much of the then advance to Mr. Holley, and in recounting his share said: "He substituted cupolas for reverberatory furnaces. These points," he says, "cover the radical features of his innovation." This brings us to considering the Holley report of 1877, which deserves careful attention, both from its importance in the literature of the art, and also from the fact, as we shall see later, that it is cited and strongly urged as an anticipation of the patent in suit. Mr. Holley's position in the art was unique. He was a metallurgical engineer of distinction, and was employed as consulting engineer by practically all the American Bessemer manufacturers. It was his duty to yearly visit the European works, keep in close touch with the advance of the art, and suggest desirable changes. From respondent's proofs we learn that the reports of Mr. Holley to the American manufacturers "received most careful consideration at their hands, and from time to time, and when deemed advisable, the American practice was altered in view of the information so furnished. These reports were regarded by the various organizations as most valuable ones, and upon their receipt were given most serious consideration." From this and numerous other references in the proofs, we are warranted in regarding Mr. Holley's report, so far as it went, as a careful, just, and expansive resumé of then conditions. A study of the report shows conclusively that in Mr. Holley's judgment, the direct system, at that time, if not a failure, was at least imperfect and incomplete; that the source of difficulty was clearly located, and fully understood; that, while the general lines on which the remedy was to be sought were indicated, and the desired end stated, the means by which it was to be done were not pointed out; and that the indirect or cupola system was deemed the preferable and the only practical practice in the then state of the art. In these respects the report utters no uncertain sound. He says:

"Running iron from the blast furnace directly into the Bessemer converter has now been practiced long enough in Great Britain to test the commercial advantages of the system, to show its incompleteness, and to suggest a remedy."

What that incompleteness is, is accurately stated:

"It should appear, I think, from the facts stated: First. That we are not, in the present state of the art, incurring an important loss by selecting and remelting pigs. This remark will probably apply even to those works which include a considerable and convenient blast-furnace plant. If, with a less experimental ore supply than we have, and a better average blast-furnace practice than our own (although it may not be better than our best), and so great a number of furnaces that one or another may be relied on for approximately suitable pig,—if with all these advantages the English works are in such serious trouble about silicon that they are devising expensive remedies in the way of mixing furnace products, then it seems reasonable to suppose that we, with our more experimental ores, and less refined practice and fewer furnaces, should encounter still more serious embarrassments."

That these troubles were present in the English practice is made clear. Thus, he says of the West Cumberland practice:

"These savings amount to $1.25 gold per ton on rails, but must be considerably more were it not for excess of scrap, due to the silicon running too low, and to second quality of steel, due to its running too high. * * * Although the results are constantly improving, it is admitted at West Cumberland that the cupola practice is still the best for special steel, where great regularity is required."

In the Barrow practice he also reports the continued existence of the same trouble, and that any improvement is not from mixing, but from better blast-furnace practice. Thus it is said:

"While the Barrow ores have much more silica than those used at West Cumberland, and hence make a hotter blowing iron, there is considerable trouble from cold charges, and quite as much from waste and cold shortness, caused by too much silicon. * * * With Barrow ores alone the silicon in the pig averages 3½ per cent., and may be kept pretty regular; but a varying quantity of varying Irish ores is also used, and these are said to cause the irregularity. Whatever the cause, the silicon is constantly varying as much as 1 per cent.; that is, from about 2 to 3 per cent."

Even the Creusot practice, which he says is the best, and which, as we have seen, had the advantage of a high manganiferous grade of ore, was not wholly satisfactory. Thus, it is said:

"Yet, with all the care taken at Terrenoire and at Creusot, with manganese as a heating element, there is more or less trouble from the variation in the temperature of the charges."

As we read the proofs, there were at the time of this report no American Bessemer plants following the direct process. After an examination of all these foreign works, Mr. Holley advises continuation of the indirect or cupola practice. He advises, therefore, that his clients confine their efforts to increasing the uniformity and standard of blast-furnace practice, and securing a more uniform product. By means of this they would obtain increased value for the pig sold and a cheapened product in what they used. These factors for raising the standard he had previously indicated as "more care as to the selection of ores, the size of ore and limestone, the distribution of materials in the furnace, the temperature of the blast, and all elements of uniformity." Now, practically summed up, Mr. Holley at the time saw in the best English and continental practice nothing to remedy the known and conceded defect in the system, viz. nonuniformity of product. It is clear that at that time the defect had not been practically met. The mode of meeting it was pure theory. As he himself said: "Ores will never be uniform; hence uniform results in the Bessemer department can hardly be expected, unless a number of blast furnace charges are mixed. This would seem to be the theoretical solution of the problem." Now, while it is true that Mr. Holley expressed in a general way his belief that this difficulty of nonuniformity could be met, it is equally true he disclosed no plan of doing it. Indeed, there was no inducement for him to do it for his clients, for he says, "We may congratulate ourselves that the direct metal users have no advantage over us in the present stage of the art." It is therefore clear that, as he then saw conditions, he merely advised, as we have said, the adoption of better furnace practice in the cupola system as a preparatory step towards the ultimate adoption of the direct process. The contention that he had then even theoretically shown how the mixing could be done is negatived by his own statement:

"When the way to its successful adoption is demonstrated, the direct process will undoubtedly have great advantages, even over the present practice on the continent, which employs manganiferous ores. But until this large scale mixing is developed, it should not appear that the use of our comparatively irregular blast-furnace metal, and more especially the use of part blast furnace and part cupola metal, can result in any substantial saving."

These are words of future possibilities, not of already discovered practical processes which would anticipate a subsequent inventor in the enjoyment of the fruits of his genius. The disclosures or suggestions of Mr. Holley are to be judged, not in the light of subsequent development, but of contemporaneous practice; and, tested by that standard, we see no evidence of any process or means of solving the admitted difficulty. That such was the case is evidenced by the fact that Mr. Holley never used the direct process at the Vulcan Works, which he was then constructing, and in the next year's (1878) Journal of the Iron and Steel Institute it was stated, in a discussion showing the improvements in the cupola practice, that:

"Mr. Holley had of late taken very decided views on that subject, and had quite come to the conclusion that the hoped-for advantages had not resulted altogether, because you had not absolutely in your control to get a uniform metal from the blast furnace."

While we thus have, from the statement of Mr. Holley, who both sides concede was a master of the situation, the confession that securing the necessary uniformity of product for the direct process had not then been solved, it would seem scarcely needful to go into the patents of the prior art to find in them a theoretical solution which Mr. Holley's ability, knowledge, and employment had not as late as his report led him to find there or elsewhere.

In 1882 the direct process was installed by the Carnegie Company at their Edgar Thomson Works, near Pittsburg. The proof is clear that the grave known difficulties of the nonuniformity in the direct process were met for several years. Mr. Carnegie, of that company, says:

"There were both advantages and disadvantages. The advantages were that we got less sulphur in the metal by the direct process, and we also thought that we would save cost; but the disadvantages were so great that we often debated whether to abandon the process or not. We found it impossible to get uniform quality of rails as well as by the cupola method. We found that we could not take metal as the furnaces made it. We tried to fill the furnace cars partly from one furnace, partly from another, but this was not found practicable; trying to tap furnaces at irregular times producing irregular working."

Mr. Gayley testifies of the difficulties encountered. He says:

"Under this system of operation we found that the work in the Bessemer department, compared with the former practice by the use of cupolas, was very irregular. One cast of iron would be quite low in silicon, and would cool off the converters to such an extent that the next cast would have to be taken from a furnace that was higher in silicon than was desired in order to restore the heat in the converter. Sometimes a few casts might be very close in their composition, and the results would be very good, but the general experience showed that great variation in composition was the rule; and so great was this variation that special men were employed at the Bessemer department, at high salaries, in order to devote their time to the judging and correcting of this variation in temperature induced by the variation in silicon, to overcome the bad results that were obtained; and, in addition, the force of chemists had to be doubled, and various other expenses gone to, in the endeavor to overcome this great variation in composition. For instance, a slight change in the composition of the metal charged into the furnace produces an irregularity in silicon in the metal. This variation is again produced by a change in the volume or temperature of the air that is blown in, or by a change in the composition of the slag, and also in a very marked manner by the least change in the content of moisture in the atmosphere; as, for instance, a day in which the atmosphere is very humid, the moisture entering the furnace with blast requires an undue expenditure of heat in the zone of combustion, and produces a metal that is low in silicon. Again, on a day when the atmosphere is very dry, the opposite conditions exist, and there is produced a metal unusually high in silicon, either of which is undesirable in Bessemer steel operations. * * * Our analyses showed that each ladle in the cast varied from each of the others, and sometimes within very wide limits; and also that the average analysis, even from each furnace, varied to a great extent from the furnace from which metal was taken just before or after; and that this variation in composition of metal going through the steel works produced great irregularity in practice by reason of the conditions being so variable,—as, for instance. one cast of iron, or a ladle or two in the cast, might be of very low silicon content, producing a chilled heat of steel in the Bessemer department, causing a loss of metal, and injury to the apparatus. In order to offset the ill effects that were produced, which consisted partly in cooling down the converters to a great extent, the next cast would have to be drawn from a furnace that was abnormally high in silicon. This was necessary in order to restore the heat in the converter, and remove any scull that had been formed, and thus required the operators to work with metal that was widely divergent in composition and likewise in quality."

Mr. Julian Kennedy, a mechanical engineer of wide scientific knowledge and much practical experience in the use of the Bessemer process, who was called on behalf of the complainant, thus strongly set forth the difficulties in the use of the process:

"Ever since the invention of the Bessemer process it has been well recognized that great economies could be attained by transferring the molten metal from the blast furnace to the converter without allowing it to solidify. Until within a few years, however, this direct process, as it has been called, has not been generally used. It is easy to see why this was the case. The fluctuation in the chemical composition of the metal from the blast furnace was too great to allow that degree of uniformity of product in the Bessemer steel produced from it, which is absolutely necessary in the case of steel rails, for example, which must be as reliable as human skill can make them, and where no reasonable expense can be spared to make them perfectly safe and trustworthy. A very few broken rails in a track, with the damage to property and human life which this might cause, would far more than offset any possible saving in a year's work, due to the use of the direct process. For this reason the practice, until within comparatively recent years, has been to cast the metal in pigs, then to analyze it, and reject any portion not closely approximating a rigid specification in its chemical composition, and to select, mix, and then melt the approved metal in cupola furnaces. By this means very great uniformity of chemical composition of the remelted metal can be obtained, and good and reliable steel made from it with regularity and certainty."

Mr. M. J. Dowling, now superintendent of the converting department of Jones & Laughlin, where the cupola or direct process is used, and formerly employed at the Edgar Thomson converting department, in both the direct and cupola systems, says:

"During my experience with the direct process, the difficulties were many more chilled heats, and many more skulled ladles, and much more scrap than with cupolas. * * * As far as my recollection serves me, I should say that the amount of chilled heats with the direct process over the cupola process would be fully 50 per cent. I have seen as many as 14 consecutive chilled heats with the direct process."

Mr. Perry D. Mackey, foreman of the Edgar Thomson converting works, and employed there since 1879, nine years of which he served as a blower, described the practical difficulties of the work in the direct process. In answer to the question, "Is it possible, practically, to run the converters without producing chilled heats, where there are sudden changes in the silicon of the furnace metal, and, if not, why not?" he said:

"No, you cannot do it. The reasons are the changes are so sudden, and varying so greatly, that a blower is unable to keep pace with it. The consequence is, he will underscrap one heat, spoiling it by being too hot; the other he would overscrap, causing its conversion to chill. * * * On the other hand, the direct iron is very irregular, varying from white iron, or low silicon iron, to as high as 4 per cent. silicon, making the converting mill very irregular and very unreliable. The variations being so great in iron of the one cast, it is an impossibility for the blower to follow it, and in consequence he has chilled heats and very bad material. Low silicon iron requires no scrap, while 4 per cent. silicon would require from 8,000 to 9,000 pounds of scrap. The variations between the two the blower regulates according to his previous heat, as I have stated before. Had he been using iron requiring from 8,000 to 9,000 pounds of scrap, and prepared for his next heat the same amount of scrap, the consequence would be that he would have a chilled heat. What I mean by a 'chilled heat' is a heat that would be a dead loss to the company."

Mr. Watkin Y. Williams, now in charge of the converting mill of the Johnson Company, of Lorain, Ohio, and employed as foreman and scrapper at the Bessemer plant of the Edgar Thomson Company for nine years, testified of the work there as follows:

"Q. In the use of metal taken directly from the blast furnace, will you state whether sudden changes in the character of the metal made the scrapper apt to make mistakes in the amount of scrapping, and, if so, will you please explain the same? A. Yes. We were expected to keep an even temperature, and with the two extremes of hot iron and cold iron coming so suddenly, it was almost impossible to keep them of an even temperature. Q. What effect would such mistakes have upon the steel? A. The steel we failed to reduce to a proper temperature would become brittle and unsafe, while the extreme cold heats would make more scrap."

Mr. George Lauder, a member of complainant company, testifies to the grave character of the difficulties his firm met in the use of the direct process. He says:

"During the whole period of the use of the direct process, we had a great deal of trouble on account of the number of defective rails we made, and the irregularity in quality of the first quality of rails we sent out. At times this reached such alarming proportions that we frequently discussed the question whether it would not be advisable to return to the cupola practice. The only alleviation we had during that time was to use more cupola metal whenever the furnaces went off."

Mr. Kennedy, to whom reference was made above, testifies that during the time of his employment at the Bessemer works and as consulting engineer, the question of the extension of the Bessemer plant of the complainant company was taken up by Mr. Gayley and himself. Speaking of a time when the direct process had been in use for several years, he says:

"After studying the results which had been obtained at the Edgar Thomson Works and elsewhere in the use of the direct process, I consulted with Mr. James Gayley, and we agreed that in the building of a new works it would not be profitable to use direct metal, but that, on the contrary, the disadvantages resulting from the irregularity in the product were so great that it would be better to go to the expense of building and using cupola furnaces. We did not then perceive any means adequate to overcome these disadvantages."

The proof of these grave difficulties, challenging the successful commercial use of the direct process, is so convincing that they corroborate the statement of Mr. William Metcalf, a witness whose practical experience, scientific attainments, and high position in the American metallurgical world enabled him to know and speak with weight in his art. Our examination of the literature of the art and the proofs of this record warrant us in agreeing with his summary, which was:

"For some years previous to the development of the Jones apparatus and process, all the metallurgic world was crying out and studying and searching for the same method by which they could successfully and practically use the metal direct from a blast furnace in a Bessemer converter, to avoid the cost of remelting in a cupola, and also the injury that the melting in a cupola does to the iron. The object in using iron direct from the blast furnace in the Bessemer process is twofold: First, quality; and, second, economy; or vice versa, as people look at those things. All of the evidence of the literature of the Bessemer process goes to show that for years there were serious efforts being made to devise a practical method of using the iron direct from the blast furnace, and to get rid of the serious trouble there is from the fact that a blast furnace is liable to change suddenly, and produce an iron varying so much, in silicon particularly, and also in carbon, as to cause very sudden changes in the working of the iron in the converter, rendering it liable at one time to have the vessels and everything sculled by a cold heat, or have everything burnt out and ruined by a too hot and wild heat. The whole object then was to get some mean of the product of the blast furnace which would avoid these extremes. These extremes did occur in practice, as the records show, and were such as to practically eliminate the benefit which it was well known would exist if the metal could be used directly from the blast furnaces."

In this state of the art, application was made for the patent in suit by Capt. William R. Jones, now deceased, then superintendent of the Edgar Thomson Bessemer plant. He was a steel man of long experience, and in his special employment had full knowledge of the difficulties met in the use of the direct process at the Edgar Thomson Works. Simply stated, Jones' idea was the creation and maintenance of a great pool of metal between the blast furnace and converter plants, through which all incoming and outgoing metal must pass. By this means each converter charge from this homogeneous mass was so closely akin in heat and constituent parts to the one preceding and to the one following it, the differences were so gradual and regular, that it was an index to the converter man of the thermal and chemical character of the one to follow. To replace the withdrawn converter charges, fresh additions of blast furnace molten metal were constantly added. Now, while as we have seen from the proofs, these additions were nonuniform in heat and constituent elements, and each of them probably—certainly possibly—variant from the converter charge just drawn, yet their divergent qualities were, by the assimilating character of the dominant mass, toned and averaged to its character, and were thus sheared of their capacity to harm. To illustrate: If we take a mixing vessel containing 90 tons of molten iron, whose content of silicon is 2 per cent., add to this a charge of 10 tons of molten iron containing 4 per cent. silicon, we have a resultant mixture 2.2 per cent. of silicon. Now draw off 10 tons from the mixer, and add 10 tons more containing 4 per cent. of silicon, we have a mixture containing 2.38 per cent. of silicon. By again drawing off 10 tons, and replenishing with 10 tons more of iron containing 4 per cent. of silicon, we have a mixture containing 2.54 per cent. of silicon. It is therefore plain that with a mixer thus operated, it is possible to have wide variations in the composition of the blast furnace metal charges added, and at the same time the successive withdrawals for the Bessemer converter show quite small and gradual changes of composition. The heat of the detained mass is affected by the incoming charges just from the blast furnace, but the heat of such addition, whether relatively high or low, must mingle with, be modified by, and average with the heat of the larger and dominating mass. It will thus be seen that each individual incoming charge loses and merges its dangerous individuality (i. e. its heat and constituent composition) in the average of the dominating mass, and the withdrawn charges are from such slow, shifting, average mixture. It is therefore apparent that each converter charge is an index in heat and composition of the one to follow. This simple, common-place, practical principle, which, after all, is the underlying principle of the governor in the use of steam, and the fly wheel in the regulation of power, Jones embodied in his process patent, No. 404,-414, issued June 4, 1889. Infringement is alleged of the second claim. The process, so far as this claim is concerned, is disclosed and described in the specification, and from it we quote. Having first stated "that the primary object of my invention is to provide means for rendering the product of steel works uniform in chemical composition," the specification recites the fact of nonuniformity of blast-furnace product, and the results produced thereby. As we read this specification it contemplates, as far as the claim under consideration is concerned, two disclosures, viz.: First, obtaining a homogeneous mixture; and, secondly, using such mixture as an effective means to avoid abrupt variations. As bearing on the first purpose, viz. obtaining a homogeneous mixture, the specification first recites the difficulties met with, and which render such mixture desirable. In that regard it says:

"The consequence of this tendency of the silicon and sulphur to segregate or form pockets in the crude metal is that the product of the refining process in the converters or otherwise in like manner lacks uniformity in these elements, and therefore causes great inconvenience and loss, making it impossible to manufacture all the articles of a single order of homogeneous composition. Especially is this so in the process of refining crude iron taken from the smelting furnace, and charged directly into the converter, without remelting in a cupola; and, although such direct process possesses many economic advantages, it has, on this account, been little practiced."

It then states how the homogeneous mixture is obtained, viz.:

"For the purpose of avoiding the practical evils above stated, I use in the refining process a charge composed not merely of metal taken at one time from the smelting furnace, but of a number of parts taken from different smelting furnaces, or from the same furnace at different casts, or at different periods of the same cast, and subject the metal before its final refining to a process of mixing, whereby its particles are diffused or mingled thoroughly among each other, and the entire charge is practically homogeneous in composition, representing in each part the average of the unequally diffused elements of silicon and sulphur originally contained in each of the several parts or charges. By proceeding in this way, not only is each charge for the refining furnace or converter homogeneous in itself, but, as it represents an average of a variety of ununiform constituent parts, all the charges of the converter from time to time will be substantially uniform, and the product of all will be homogeneous."

The specification then describes the gist of the invention, viz. the process of using this homogeneous mixture as a controlling dominant pool. This is preferably accomplished by a large, refractory lined, covered vessel, pivotally mounted, and provided with an intake hopper and an outlet discharge pipe, so located that a considerable quantity of molten metal must constantly remain in the vessel. The description of the vessel, its mode of operation, and functional purposes are thus set forth:

"It consists of a covered hollow vessel * * * lined with fire brick or other refractory lining, which would be of sufficient thickness to retain the heat of the molten contents of the vessel, and to prevent chilling thereof; * * * may be of any convenient size, holding, say, one hundred tons of metal (more or less); * * * one end—the rear one—being considerably deeper than the other. * * * At the front end is a discharge spout, which is so located that the bottom of the spout is some distance above the bottom of the vessel,—say two feet in a hundred-ton tank, and more or less, according to the capacity of the vessel,—the purpose of which is that when the metal is poured out of the spout a considerable quantity may always be left remaining and unpoured, and that whenever the vessel is replenished there may already be contained in it a body of molten metal with which the fresh addition may mix. I thus secure, as much as possible, uniformity in character of the metal which is fed to and discharged from the tank, and cause the fluctuation in quality of the successive tappings to be very gradual. The mode of operation of the apparatus is as follows: When the vessel is in the backwardly-inclined position shown in Fig. 1, it is ready to receive a charge of metal from the car 7. Before introducing the first charge, however, the mixing vessel should be heated by internal combustion of coke or gas, and, when the walls of the vessel are sufficiently hot to hold the molten metal without chilling it, it is charged repeatedly from the car, 7, with metal obtained either from a number of furnaces, or at different times from a single furnace. The charges of metal introduced at different times into the metal, though differing in quality, mix together, and when the vessel has received a sufficient charge its contents constitute a homogeneous molten mass, whose quality may not be precisely the same as that of any one of its constituent charges, but represents the average quality of all the charges. If desired, the commingling of the contents may be aided by agitation of the vessel on its trunnions, so as to cause the stirring or shaking of its liquid contents. The mixing chamber being deeper at its rear than at the front end, as before described, and its normal position when not discharging metal for the purpose of casting being with the bottom inclined upward toward the front or discharging end, and the bottom of the spout being situate above the bottom of the vessel at its forward end, it is adapted to receive and hold a large quantity of molten metal without its surface rising high enough to enter the discharge spout. * * * The tilting of the vessel does not, however, drain off all the contents thereof, a portion being prevented from escaping by reason of the elevated position of the spout, 6; and as the vessel is replenished from time to time each new charge mixes with parts of previous charges remaining in the vessel,

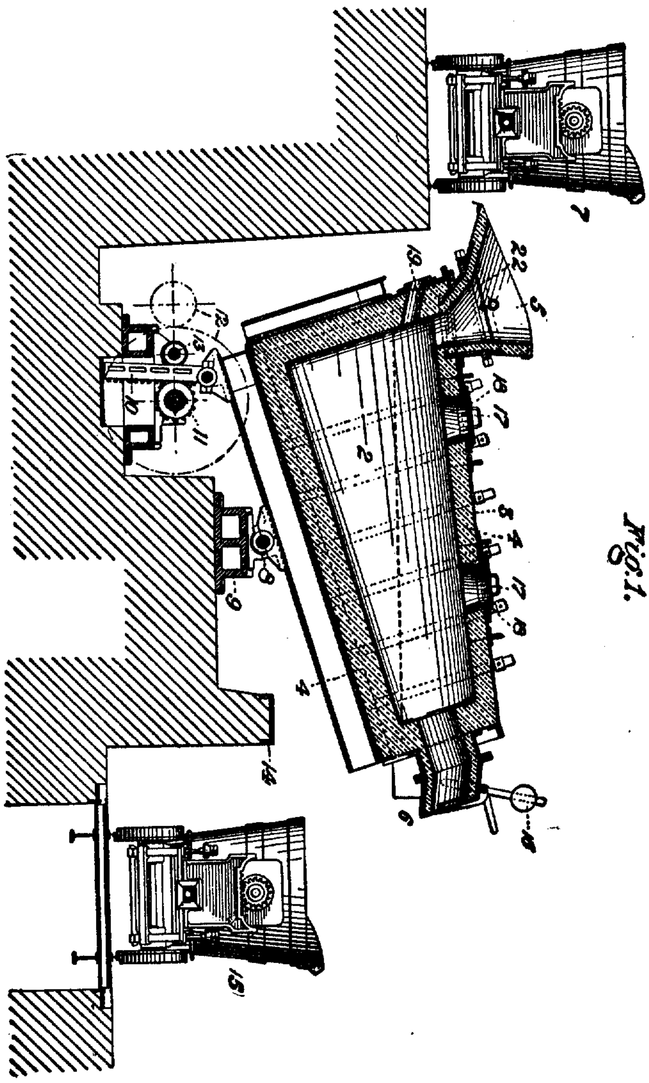

Fig. 1.

by which means any sudden variations in the quality of the metal supplied to the converter is avoided."

Upon these disclosures is based the second claim, which is as follows:

"In the art of mixing molten metal to secure uniformity of the same in its constituent parts preparatory to further treatment, the process of introducing into a mixing receptacle successive portions of molten metal ununiform in their nonmetallic constituents (sulphur, silicon, etc.), removing portions only of the composite molten contents of the receptacle without entirely draining or emptying the same, and successively replenishing the receptacle with fresh ununiform additions, substantially as and for the purposes described."

Stress is laid by respondent on certain other statements in this specification. What their bearings may be in determining the validity or the meaning of the first claim it is neither our duty or purpose to now say. As we construe the second claim, these statements do not apply to the specific process disclosed in the specifications and embodied in that claim. As we construe that claim, it does not apply to the entire art or process of mixing molten metal, but to a mixing process which is "preparatory to further treatment." What that further treatment is is made clear by the specification. It is to "a process of mixing" "before its final refining," and its purpose is to "cause the fluctuations in quality of the successive tappings to be very gradual." It would therefore seem that the metal to be mixed was metal direct from the blast furnace, and the further treatment was Bessemerizing in the converter. That this "further treatment" could not be the mere casting in pigs would seem apparent from the fact that a relatively more uniform pig product could be obtained by emptying the vessel, and then refilling it, than by the continuous method indicated in the claim.

That the Jones process was a radical and important one, that the benefits and profits arising from its use were great, there can be no doubt. The size of the record, the number and character of experts testifying and of the counsel concerned, and the earnestness with which this case has been contested, in themselves confirm the testimony of its value in the art. But the testimony itself in that regard is quite convincing. Indeed, we do not understand the respondent's witnesses in effect deny the value of the process. What they allege is that it was not original with Jones, but was well known years before. The regard in which it is held by practical and theoretical minds is shown in the record by a number of witnesses to whom reference has already been made. Mr. Metcalf testifies that:

"The Jones mixer has the advantage in the Bessemer practice of equalizing or making more uniform the temperature of the charges from the different blast furnaces, one hot and one cold and one medium, so that the changes in the iron as it goes to the converter are minute, gradual, and such as the blower can see and handle without difficulty, so that, while he may work from quite a low temperature to a very high one, he may still produce good results if the change is gradual, such as he can see from heat to heat. * * * That the clear advantage in the Jones method is this slow and minute change in the character of the metal, as against the sudden change in the blast furnace. This is accomplished by putting successive charges into a large pool of metal, and withdrawing it from a different portion of the pool, in such a way that the iron has some time to mingle and make a nearer average mean mixture than it would have if it were taken direct from the furnace to the blower, or if it was simply dumped into a huge vessel in whole taps, and drawn out again, and the vessel drained and carried off without time being given and care used to produce this averaging up, and this slow changing of the composition of the metal."

Mr. Mackey, speaking of the difference between the Jones and the prior practice, says:

"There is a great difference between the two. You pour a low silicon into the mixer; then you pour a higher silicon in. That gives you a more uniform iron. Where, on the other hand, you pour five ladles in small amounts direct from the furnace, one of those conversions may chill, the other may be so hot that the blower would be unable to have his temperature regulated properly, and that would also be spoiled by being too hot."

Mr. Kennedy says:

"The Jones method has made the direct process, which was attended with great danger and difficulties before the date of his invention, a thoroughly practicable and successful one. Instead of it being a question of great doubt whether to run the metal direct to the converter or remelt it, as it was up to the time of Jones' invention, no one would now think of building a new works, containing both furnaces and converters, without arranging to mix the metal by the Jones method, which not only effects an immense saving in the cost of operating the works, but enables a uniformly good product to be made, and also a purer product than can be obtained from cupola metal, which absorbs and is contaminated by sulphur from the coke which constitutes the fuel of the cupola."

Mr. Sherrerd's estimate is as follows:

"I saw the Jones' mixer in use at the Edgar Thomson Steel Works not a very great while after it had been put in,—I think in the fall of 1889,—and, on its operation being explained to me, I was struck with the benefits to be derived from getting metal free from the sudden changes in composition and temperature, and this point I appreciated very thoroughly when we commenced to use direct metal from the blast furnaces at Troy without a mixer, some two or three years later. The blower or scrapper has to determine how to handle a heat very quickly, and he bases his judgment somewhat upon the heat phenomena connected with the preceding charge of metal. He has means at hand to control quite wide variations in composition and temperature, and can take advantage of these means if only warned in time. It has been my experience that the metal coming from the blast furnace is liable to vary greatly in both composition and temperature from cast to cast, and these variations are so great that the blower or scrapper has little to guide him to the successful manipulation of the charge. The metal coming from the Jones' mixer, on the other hand, changes comparatively slightly from ladle to ladle, and he can accommodate himself readily to these changes."

Mr. Joseph Massenez, a Belgian engineer, in a leading paper read before the British Iron and Steel Institute of 1891, stated that:

"This disadvantage of the irregular composition of the individual blast-furnace charges is obviated in a simple and effective manner by W. R. Jones' mixing process. * * * Only a portion of the pig iron placed in the mixer is taken for further treatment of steel, whilst new supplies of pig iron are brought from the blast furnace. In this way homogeneity sufficient for practical purposes is obtained."

In discussing this paper at that meeting, the eminent English metallurgical authority, Sir Lowthian Bell, stated that:

"Since they had begun to use the mixer, the defectives, from whatever cause, had fallen to something like half of what they had been before. The expense of working the mixer was little or nothing."

It is contended, however, that the Jones process was anticipated by the English patent of Deighton, No. 3,672, of 1873, for an improvement in the manufacture of Bessemer steel. The authorities leave no doubt as to the character of the disclosures necessary in a prior patent or publication to avoid a subsequent one, to wit, the information therein given must be so full, clear, and precise that one skilled in the art, and acting in the then state of knowledge, can, from such a patent or publication, perform the process or make the thing covered by the patent sought to be anticipated. Walk. Pat. No. 57; Curt. Pat. No. 378; Roberts v. Dickey, 4 Fish. Pat. Cas. 552, Fed. Cas. No.

11,899; Seymour v. Osborne, 11 Wall. 555; Eames v. Andrews, 122 U. S. 55, 7 Sup. Ct. 1073; Downton v. Milling Co., 108 U. S. 470, 3 Sup. Ct. 10; Cawood Patent, 94 U. S. 704. In the light of these requirements, let us see whether what is essential and vital in the process was given to the public by Deighton. In this inquiry the burden is on the respondent, for the grant of the patent is prima facie evidence that the patentee was the first inventor of what he described and claimed. Seymour v. Osborne, 11 Wall. 516. In determining a question of this character it is a pertinent and reasonable inquiry, if it be true that the disclosure of an earlier patent was substantially that of Jones, why, during a period of many years, was it not practically applied to the same use? Regulator Co. v. Copeland, 2 Fish. Pat. Cas. 221, Fed. Cas. No. 2,866. And when a great branch of industry recognized the need of just such a process, where that need was a subject of discussion at gatherings interested in practical questions of the art, the inquiry becomes more pertinent and the harder to answer. That no one practiced the alleged anticipation, and that no one saw, or even suggested, such possibilities in it until after the later discovery was announced, are cogent facts which warrant the most convincing assurance to a court that such knowledge was conveyed in a neglected and dormant patent. In his original or provisional specification, Deighton made no reference whatever to the direct process. His device was for use in the cupola or indirect system alone, and is for converter replacement or substitution to secure continuous working of the plant. No mention is made of mixing metal. The mischief complained of was the time lost in repairing converters, and the remedy proposed means for quick removal of damaged converters and substitution of fresh ones. It will thus be noted that neither mixing metal nor the direct process were the primary or principal objects of the patentee. In the final specifications there is added what is alleged to be the anticipation. This consisted in placing an intermediate vessel between blast furnaces and converters, and into which the metal was run. As carrying forward the originally avowed purpose of the patentee, viz. replacement to secure continuous work, the patentee says of the vessel, "When the vessel in use requires repair, it is replaced by another, kept ready for use." It was also arranged on scales, so that the exact amount desired for converter charges could be tapped. On the subject of mixing the disclosures were these:

"Instead of manufacturing Bessemer iron or steel from pig iron which has been melted in cupolas, my invention also consists in taking the molten metal directly from the blast furnace to the converter, in which case I prefer to arrange the Bessemer plant in a line at right angle to a row of two or more blast furnaces, and place a vessel to receive the molten metal tapped from two or more blast furnaces to get a better average of metal, which will be more suitable for making Bessemer steel or metal of uniform quality, the vessel or receiver being placed on a weighing machine so that any required weight may be drawn or tapped from it and charged into the converter."

The mode of operation is thus described:

"Y^1, y^2, y^3, y^4, are gates or channels from [for?] the molten metal from each furnace, which channels lead to a receiving vessel, m, which is placed low enough to give fall for the molten metal to flow from the blast furnaces to this receiver, m, which forms a receptacle for mixing the molten metals from two or more of the smelting furnaces. * * * From the receiver, m, the mixed molten metal is tapped and flows down the swivel trough, n, into the converter (a). By placing the vessel, m, on a weighing machine, it can be readily ascertained when the exact quantity required has been tapped from it into the converter. When the vessel in use requires repair, it is replaced by another kept ready for use. When, from any cause, the converters are not at work, the metal from the blast furnaces can be run into pigs, the space (q) on each side of the building for the converters being formed into converter beds."

What disclosures are therein made? In reality, is there anything, so far as the present question goes, except providing blast furnaces, a converter, an intermediate vessel, and troughs leading from the furnaces to the vessel, and from the vessel to the converter? Conceding these are the means by which the much-desired mixing can be accomplished, nothing whatever is said as to the method in which these means were used. In so far as the present patent goes, there was necessarily nothing novel in the mechanical instruments employed, but the gist and life of Jones' invention was in the process of using the mere mechanical means. On these vital points, without knowledge of which the public would not learn and could not practice the Jones process, the Deighton patent is silent. As to when the tappings are to take place, whether the entire furnace product is to be tapped at once or only a part drawn and like proportions from other furnaces; whether the entire contents of the vessel are to be used in the converter before resort is had to the furnaces for additional supply, or whether this was a mere matter of convenience, depending on the exigency of events; whether a large amount, or, indeed, any amount, was retained in the vessel, which would approximately average each incoming portion to the retained mass; whether the patentee had found a conjoint process of so adding the molten iron, maintaining a pool and withdrawing the converter charges that a practical graded uniformity of product as well as heat of product could be secured,—are points on which no light is given, or, indeed, mention made. Conceding, for present purposes, that the patent shows mixing, it must not be overlooked that mixing alone is not sufficient to obtain the results of the Jones process. It was already known that the mixture of different tappings produced a more uniform product. In fact, the cupola system is in substantial form the embodiment of that principle; but other steps must be added, and it is on these steps, on which the Deighton patent is simply silent, that Jones built and made a success of the direct Bessemer process. When the necessity for disclosure is absolute, silence is fatal.

It is true, witnesses testifying in the light of subsequent disclosures now say they find in the Deighton patent the substance of Jones'. If Deighton saw as much, if he had a full, clear, and precise knowledge of Jones' process,—and he must have such knowledge to have disclosed it in his patent,—it is a singular fact that no one discovered what he meant until after the Jones process was in successful operation. Searching thoroughly through the literature of the art in the record, we find no trace of Deighton's patent as a factor therein. The patent itself seems to have been allowed to lapse in a few years; and when it thus became open to free use, the art, judging from its acts, saw nothing to adopt in it, and the statement of Mr. Snelus at the British Iron and Steel Institute of 1878 (see journal introduced by respondents,—Record, vol. 3, page 1104), was "that no one in England, as far as he knew, was using any intermediate receiver between the blast furnace and the converter." To our mind, the true place of this Deighton patent in the art is in the line of the Holley receiving ladle. Like that appliance, it afforded a means for storage and weighing. But, being capable of tipping, and pouring charges, the Holley ladle was an advance on it. In both the primary objects were storage and weighing. That some mixing was incident to the practice is true, for mixing is a recognized operation of nature where two or more quantities of fluid are run together; but, as we have said, mixing ending with mere mixing is not the Jones process. Its gist is using that mixture as a dominant, intermediate pool to tone or transform eccentric incoming charges into approximately regular, graduated, outgoing ones. Thus it will be seen that, while Deighton's patent was a possible step forward, he wholly failed to reach, much more disclose, the vital point of the Jones process. It is contended, however, that the respondents have secured satisfactory results, practically those obtained by the Jones process, from an experimental plant constructed in accordance with the instructions of Deighton's patent. This plant was constructed after suit was brought, and no opportunity given complainants to inspect the same or to witness its operation. Waiving, for the present, the objection promptly made to evidence concerning such plant and its operation, we are by no means satisfied that the means used were a reproduction of Deighton's, or the process employed was not the identical one of Jones. It is clear that, to be illustrative and reliable, an experimental plant should be a substantial reproduction. Here we have a departure. Deighton uses troughs from the furnace to the vessel, while the reproduced plant uses ladles. On respondent's side it is testified that this was a matter of no moment; on the other side it is testified quite positively, and we find no contradiction in that regard, that the iron coming down a runner from a blast furnace carries with it a large amount of sand, which chills very rapidly. So, also, in regard to the cover used on the receiver. There is no warrant for it whatever in Deighton. As to its importance there is conflicting testimony. Respondent claims it was a matter of indifference. If so, it, as well as the ladle noted above, should have been omitted. But under the proofs we cannot agree with respondent's contention. Indeed, the absence of all reference to a cover in Deighton and the placing of one on the experimental plant are suggestive. The cover seems to be a feature of a mixing vessel essential to the successful maintenance and working of a dominant pool. It was used in the experimental plant. It was not mentioned in the Deighton patent. Conceding the competency of the evidence (upon which we express no opinion), by reason of the variations noted we do not regard the experiment as fairly illustrative.

The patents of Witherow, No. 315,527 and No. 327,425, both granted in 1885, are cited as anticipations. Turning to the earlier, we find not a process, but an apparatus, patent. The patentee's avowed purpose was "to facilitate and cheapen the conversion of crude cast iron into ingot iron or steel by the Bessemer or pneumatic process." The suggested means were utilization for converting purposes of the blast forcing and heating apparatus of the furnace. This he does by placing a blast connection between the Whitwell stove and the converter. Of the economic and metallurgic advantages resulting from his device he says:

"My invention is applicable without change, and with great economy, to existing blast-furnace plants. Such an application utilizes the blowing engines and blast-heating stoves of the plant, and consequently saves the expense of constructing separate ones for the converter, and at the same time does not interfere with usual and ordinary operation of the blast furnace. It also saves the cost of a cupola for melting the metal to be charged into the converter, for it brings the latter near to the blast furnace, so that it can be charged directly therefrom."

A study of the patent shows to the candid mind that this was all Mr. Witherow believed himself to have invented, and all he disclosed to the public. That the use of an intermediate storage receptacle was a mere incidental, mechanical, temporary expedient, and that storage, and not uniformity of even individual fillings, much less continuous, gradual, changing uniformity of product, was its function or purpose, is clear from the specification. Thus he says:

"Extending from the blast furnace to the charging hole of the converter is a charging spout of the usual construction. This spout enables the converter to be charged from time to time directly from the blast furnace."

This clearly shows that the avowed object of the invention could be carried out, and was intended to be ordinarily carried out, directly from blast furnace to converter. The advantage gained lay wholly in the patentee's judgment in the use of the furnace hot blast in the converter. Thus he says:

"The use of the hot or superheated blast is of great advantage in case the molten metal in the converter becomes too cold for its proper treatment therein, as in case scrap is charged, or the heat-producing elements are exhausted, or nearly so; for the heat imported by the blast so increases its calorific power as to enable it to restore the metal to its proper condition of fluidity. Thus, much of the danger of the metal's chilling in the converter is taken away. It also augments and intensifies the reactions in the converter, shortening the blow, and aids in the dissociation of the impurities, which may be tapped off during the blow."

He has added to the system an intermediate storage vessel, because "it is often undesirable to tap the metal from the blast furnace every time the converter, which is relatively much smaller than the blast furnace, is charged." It was preferably constructed to take the whole amount of a cast, but might be made for a smaller quantity. The vessel was mounted on a hydraulic piston placed in a fire-brick pit, and was raised therefrom, and its contents tapped into converters, "of which there may be several," or it could be dropped below the floor surface, and the pit closed by a suitable cover. By this means the patentee proposed to maintain the heat of the metal, so as to keep it as long as necessary in the proper molten condition for tapping off into converters, "of which there may be several." It will thus be seen that the purpose of this vessel was storage, and storage alone. There is no reference whatever to the subject of mixing. That the means used by Witherow might be employed in the Jones process is not to anticipate Jones' patent if he was the first to suggest such a use. That storage, and storage alone, was in view by Witherow is also shown by the fact that he suggests its use in the cupola or indirect process, where its desirability for storage is manifest, but for mixing comparatively needless. In the second patent we find an advance in the same general lines as in the preceding, viz. in storage. The obstacle to be overcome is stated by Witherow in these words:

"The difficulty of using the molten metal from the furnace in the converter consists in keeping the large quantity of metal from the latter in a proper condition for use in the furnace. The time between charges of the converter is usually twenty minutes and upwards, and the metal from the furnace must be kept in condition to be tapped from time to time as needed. This is the object of my invention."

To this end he provides a vessel, styled a "receptacle," of sufficient size to hold the entire cast of the furnace, provided with a cover and tuyères to blow down on the surface of the metal. This blast agitated the bath, and caused the formation of a slag surface, which prevented excessive oxidation and loss of heat by radiation. Such is the entire disclosure of the patent. It is storage and heat conservation alone. No mention of mixing whatever is made, or are the evils of nonuniformity of the furnace product recognized. The purpose, object, and means of the two patents are wholly in a different direction. It is significant in both that neither of the terms used, viz. "distributing receptacle" and "storage receptacle," suggest the design of mixing, while the mention throughout of but a single blast furnace in both (so frequently recurring as to be of marked significance), and the use of several converters with such single furnace, would indicate that a speedy emptying of the vessel was the process in the patentee's mind. If he had any conception of the Jones process in view, he was happy in veiling it. To see in these patents a number of furnaces, and but a single converter, instead of the several specified, and that the process involved the tapping of such imaginary furnaces into the vessel, and the use of but a single converter to deplete it, and the consequent maintenance of the Jones dominating pool, conveys some notion of the distortion demanded to find the Jones process in the Witherow patents.

Considered as an anticipation, the English patent of 1856 to Tabberner, No. 2,061, deserves but brief reference. So far as pertinent to the question in hand, it teaches the use of a number of small furnaces instead of one large one, and from which frequent tappings are made "into one large reservoir, from which the molten metal may be drawn for casting from." Although the patentee makes no reference whatever to mixing and to the advantages to be gained therefrom, so that there is no disclosure on that point, yet conceding, as respondent's expert claims, "that Tabberner understood fully the art of mixing metals from a number of smelting furnaces in one large reservoir, from which the molten metal may be drawn for use as required" (a general principle, as we may say, which had been recognized for years before), yet on the subject of maintaining and using the contents of the molten pool as a dominant and unerring agent for receiving nonuniform products, and delivering an approximately uniform one,—in other words, on the gist of the Jones process,—Tabberner is silent. The fact that this patent practically antedated the Bessemer process, and the difficulties which the direct use of that process disclosed so many years, is itself suggestive that it does not anticipate.

The discussion of these patents, and the reasons which satisfy the court that they do not anticipate the Jones process, renders needless a discussion of the many others cited as anticipations.

It is alleged, however, that the Jones process was disclosed by Mr. Snelus in discussions reported in the Journal of the British Iron and Steel Institute. Such a contention is, in our judgment, based solely on selecting excerpts of what he said, removing them from their surroundings, and reading them as though they were connected and delivered together. Read as they were reported, and in the light of their surroundings, they do not disclose the Jones process. Mr. Snelus' views in the report of 1874 were in substance these: He advocated the use of the direct process; the trouble he discussed therein was variation in silicon; that there was no great difficulty in this after they got the furnace working properly; the metal could be analyzed, and if too siliceous could be toned by adding nonsiliceous cold pig. To facilitate this, as we gather, he urged running the metal into an American intermediate ladle, and "they could then deal with it as they liked." This intermediate ladle was advocated as a means for aiding in treatment, and no reference was made to mixing in general or the Jones process of continuous maintenance of a dominating pool. That his notion of the function of a vessel was as a storing vessel, and not as a mixing one, is emphasized by his statement, so late as 1878, in the discussion reported in the journal of that year, that "the great drawback to the direct casting process was that you could not always get your metal at the exact time you wanted it." He believed it would be found that the great advantage the Bessemer works in America had was the intermediate receiving ladle, etc., which was designed by Mr. Holley, and which was universally used there, although it was never used in England. It is true, he adds that he thought the ladle was important "both for saving time and for facilitating the admixture of iron," and that thereby you could "hold it in readiness, so that at a moment's notice you could take your iron into the converter, and also obtain a better mixture." But this bare idea—and that is all it was—cannot, under the decisions noted, be regarded as a disclosure of the Jones process of the use of a dominant pool to produce a relatively uniform product from nonuniform constituents. Against objection, respondents introduced the record of the Institute of 1891, subsequent to the patent, and allege that Mr. Snelus therein claimed that 12 years before he had disclosed the mixer process. Waiving for present purposes the question of the competency of the evidence, we cannot agree with the conclusion drawn therefrom by respondent. At that meeting Mr. Massanez had, in the paper under discussion, and to which reference has been made above, given credit by name to the Jones mixing process, as having in a simple and effective manner done away with the disadvantage of the irregular composition of blast furnace charges. Mr. George Lauder had given the mixer great credit for "the magnificent blast furnace practice brought before the institute at its meeting in New York, by Mr. Gayley." And Sir Lowthian Bell stated that, "since they had begun to use the mixer, the 'defectives,' from whatever cause, had fallen to something like one-half of what they were before." Mr. Snelus' remarks were brief, and near the close of the discussion. In them he made no claim that the Jones process was his, or that he had disclosed it. Far from it; he said he had seen the mixer Sir Lowthian Bell had spoken of, and bore testimony to the accuracy of his statements. He said that 12 years ago he made part of an apparatus for a large mixer, but he was stopped before completing it. What the mixer or the process he proposed were, he did not state. He further said he had many talks about the success of the operation with the late Mr. Holley, who assured him that there could be no difficulty in it; "he was now pleased to find that these ideas had borne fruit." These statements by Mr. Snelus cannot, in our judgment, be regarded as a claim by him of an invention which had been expressly attributed at the beginning of the discussion to Jones, which had not been questioned by one of the speakers, which was certainly not denied by Mr. Snelus. In summing up his connection with the process, we find nothing but an account of a partly finished and abandoned construction of 12 years before, and conversations with Mr. Holley, who expressed his belief in the solution of the question. To construe these remarks into a disclosure of the Jones process would, in our judgment, be to award Mr. Snelus what he never claimed; much more,—never taught the public.

From the literature anticipations of this process, let us turn to alleged anticipations by way of actual use. We discuss in detail but two, the cupola ladle and the Whitney car-wheel practice, they being fairly representative, and bearing the seemingly closest relation to the Jones process. Failing to find anticipations in them, discussion of other uses, further removed, is needless. In searching whether a practice anticipates, it is fitting to ascertain and recognize clearly what object was in view in such use. Thereby we are the better able to ascribe just and exact significance to the means used to secure such end. Now, while there are variations and nonuniformity in the product of cupolas in the Bessemer cupola practice, and while the workings and product of such cupolas are at times nonuniform and divergent, yet the general fact remains that the product is so substantially homogeneous that the metal for converter use can be taken direct from the cupolas, and used with commercial success. This fact is shown by the continued and successful practice of the cupola process in England for years before the use of an intermediate ladle was known. It is shown by the testimony of Mr. Forsyth, a well-known theoretical and practical metallurgist, called by respondents, who says that, in the exclusive use of cupola metal in Bessemer practice, the degree of nonuniformity of the metal was not such as to make a mixer necessary. Whether such results were obtained through the comparative thoroughness of pig selection, or whether the cupola itself served as a mixer, the fact remains that good commercial results were obtained from its product. These facts have been clearly set forth by respondent's witness, Mr. Hunt, who says:

"In most cupola practice a great variety of metals are used, varying greatly in both their physical and chemical characters, and it is often the case that, through such mixture in the cupola, that metal is utilized which could not have been used at all if taken direct from the blast furnace; that is, should the blast furnace have been working so badly that the produced iron was unfit for the Bessemer practice, it would be homeopathically mixed with better material in the cupola, which after melting would be averaged up in the accumulating cupola ladle, and thus ultimately make good steel."

There was therefore no crying need in that practice for a radical change in the line of greater uniformity. While greater uniformity was desirable, it was not an indispensable requisite. But the needs and lacking elements of the process were two,—storage and weighing of charges. Out of these needs grew the Holley intermediate ladle. These were the causes, object, and functions which respectively created it and functionally used it.

That the foregoing statements and conclusions are based on facts will appear from the proofs. Prior to the introduction of the Holley ladle, the tapping from an individual cupola was not sufficient for a converter charge. Moreover, a stinted supply of metal from the cupola left the converter department idle, and delay or derangement in the converter department necessitated running the cupola metal into pigs. These needs suggested the use of a balancing, intermediate factor, and found expression in the Holley ladle. By means thereof, metal drawn from one cupola, in itself insufficient for a converter charge, could be held until another cupola supplied the needed amount; and, on the other hand, if there was delay in the converter department in using the metal, it could be held there until needed. The purpose was storage, and the ladles were functionally used for that purpose. If the production exceeded converter capacity, there was storage of more metal. If the converter capacity exceeded the supply, there was less or even no storage. It will thus be seen that the quantity of metal in the ladle was dependent on the relative workings of converter and cupola. It was also modified by the practice of weighing. To insure full converter charges, weighing was adopted. It was made possible by the ladle, and as short weight was objectionable, and resulted in short heats and poor product, the keeping of an overweight in the ladle resulted. Now, that mixing of some character took place in the ladle during these operations, that where it took place the resultant was a homogeneous average of all constituent ingredients contained, are facts to gainsay which would be to question nature's laws; but the indisputable fact remains that such mixing was accidental, eccentric, and nonsystematic, and therefore not of a systematic, regular, functional type, or for a systematic, functional purpose. That storage and weighing—mere mechanical processes—were the ladle functions recognized and valued in the mind of the steel maker is shown by the literature of those years. In the transactions of the American Institute of Mining Engineers for the Centennial year is an able and exhaustive paper on Bessemer manufacture in America, by Mr. Robert W. Hunt, one of the foremost representatives of metallurgy in this country. In summing up the art, Mr. Hunt attributed a large part of its advance to Mr. Holley, gives the ladle great credit, and makes this highly significant statement, which, coupled with the entire absence of reference to mixing, becomes even more significant. He says:

"The result of his thought gave us the present accepted type of American Bessemer plant. * * * He substituted cupolas for reverberatory furnaces, and last, but by no means least, introduced the intermediate or accumulating ladle, which is placed on scales, and thus insures accuracy of operation by rendering possible the weight of each charge of melting iron, before placing it into the converter."

Mr. Holley himself (see article on Bessemer machinery in London Engineering, 1873) describes the function of his ladle in these words:

"Interposing ladles between the cupolas and vessels is important in many respects: First. The cupola cannot be so economically and regularly worked if its hearth has to fill up with the whole 12,000 pound charge of iron every hour. Second. The weight of the charges should be somewhat uniform to promote uniformity of the accuracy of blowing, and to recarburize with a fixed percentage of spiegeleisen. This can only be accomplished by weighing the charge between the cupola and the vessel; and the ladles are placed on scales for this purpose. Third. Several charges are often run into the ladles when the converting department is not ready for them; otherwise, the cupola would have to be dumped, and part of a day's work lost."

Four years later (see article "An Analysis of the American Bessemer Plant," in London Engineering, 1877), he also describes the purpose of the ladle, thus:

"The cupola ladles facilitate the distribution of metal to the vessels. They form reservoirs which make the melting department and the converting department independent of each other, within limits. This advantage was not fully appreciated until the large productions of the last two years were attempted. Should any delay occur in casting, in preparing a vessel, or from any cause, the melting department keeps right on, for these three ladles will hold six vessel charges, which may be stored and converted when the converting department is ready for them. Cast iron will 'live' in these thickly-lined ladles, when covered with charcoal, for several hours. But it is necessary to put these ladles on weighing machines, so that either uniform vessel charges may be run out, or so that the spiegeleisen may be proportioned to such charges as are run out."

Now, it is highly significant that in neither of these descriptions does Mr. Holley (who certainly knew better than others the functional purposes for which his ladle was intended) intimate that it was to perform functions analogous to those of the Jones mixer. Avowedly, it was arranged to enable the iron to be weighed, and also to give a reserve storage capacity; but there was no mention of carrying a constant body of iron therein for the purpose of promoting uniformity between successive charges.

That storage and weighing were the marked function of the accumulating ladle is evidenced by the practice of the respondent company. In 1871 it installed a 21,000 pound ladle, when its converter charges were 12,500 pounds. In 1877 it increased this ladle to 28,000, the converter to 15,500; in 1889 the ladle to 32,000 to 35,000, the converter to 26,000 to 28,000. In other words, in 1877 the capacity of the accumulating ladle above a converter charge was 3,500 pounds; in 1877, 12,500; in 1889, 7,000 pounds. It will thus be seen that the outgrowth of 18 years' experience with the accumulating ladle had led, not to an increase, but to a marked decrease, of its functions to form a dominant, governing pool. In 1871 the capacity of the ladle in excess of converter charge was 3,500 pounds. Assuming that amount was left in the ladle, and that 12,500 pounds were then added, the proportion of the residue or dominating pool to the incoming metal was as about 8 to 12. In the latest development of the ladle the residue had dropped to 7,000 pounds, while the incoming metal had raised to 28,000 pounds; so that the proportion of the dominating pool to the incoming metal had changed from 3 and 2 to 1 and 4. The significance of these figures requires no comment. The fact is that a moderate proportion seems to have been left in the ladle to insure continuous working and proper weighing, and that the ladle was proportioned accordingly. That an intermediate storage vessel was more imperatively called for in the cupola practice is well set forth by Mr. Hunt, who says:

"Again, a great advantage of such a reservoir is making the various departments of the establishment, to a certain degree, independent of each other. If you do not have such a reservoir in the cupola practice, and delays occur in the converting works, it would necessitate taking the blast off of the cupolas; and, should such delay extend over a considerable period of time, the melted metal in the hearth of the cupola would either chill up and render it necessary to drop the bottom of the furnace, or else it would have to be tapped off in some convenient manner, and thus become awkward to handle as scrap. On the other hand, when running on direct metal, should delays occur at the converting works, the metal from the blast furnace can be cast into pigs of commercial and uniform size and shape, which could be subsequently melted in cupolas or used for other purposes, and thus the regular working of the blast furnace not be disturbed."

While mixing in an accumulating ladle might take place, the proofs show that whether it did take place was wholly a matter of working conditions, and not of design. Mr. Hunt, called by respondents, says, in reference to the Cambria practice:

"Whether or not the metal was left after pouring the charge depended upon the relative speed at which the cupola was melting, and the metal being converted in the converters. If the blowing was close up to the melting, the metal would be poured as soon as sufficient amount for a heat was accumulated. If, on the contrary, the melting was ahead or faster than the converter, there would be frequently a large proportion of another heat retained in the ladle after pouring, and into which more metal would be tapped from the cupola."

It would thus seem that no effort was made to secure the possible advantage of mixing at the respondent's works; and Mr. Fry, a witness for complainant, who was superintendent for 10 years of this practice, testifies most positively—and I find no direct contradiction of his testimony by Mr. Hunt, who was in general charge of the Cambria plant—that there was no recognition at that time by Mr. Holley or Mr. Hunt, by himself, or by any other person, of any mixing operation by the cupola ladle, such as is secured by a dominant pool. Golding, for six years superintendent of the Pennsylvania Steel Company, says that, under the charging practice at Steelton, no such mixing occurred; that the vessel was generally drained at each charge; and that "the object of using the ladle for the purpose of a mixer was not once thought of by me, nor by any one, as far as I know." Mr. John S. Kennedy, superintendent of the blast furnaces of the Pennsylvania Steel Company from 1881 to 1887, testifies substantially to the same effect. He says:

"I never knew of the ladle being used for mixing purposes. If such was the practice, I would have known of it. * * * The capacity of the ladle was so small, and the size of the pool of metal, when there was a pool, was of such varying size, that I do not see how any mixing could be accomplished. * * * The ladle was often drained."

In line with what we have said in regard to making the relative size of the ladle less at the Cambria Iron Works, and thus negativing the contention that its mixing function was fully recognized, it is here to be noted that in the Pennsylvania Steel Company practice their ladle was reduced in size from 15 to 10 tons. Moreover, that the function of the ladle in the cupola system was not mixing is shown by the fact that, in the light of disclosures of late years of the great benefits accruing in the direct system from mixing, the Jones & Laughlin cupola plant, a progressive firm, of this city, continues, as testified in this case, to use ladles between the cupola and converter, which only contain a single converter charge, and with them produce a uniformly high grade of metal.

We next turn to the Whitney car-wheel practice, which is alleged to anticipate the Jones invention. This particular use dates back almost 50 years, and is fairly representative of ordinary, well-known foundry practices. The same general method was in use in foundries connected with Bessemer plants. The inquiry, therefore, reasonably and properly arises: If the analogy and adaptability of this practice were so apparent, why were they not recognized and the practice used to remedy the long-felt and well-recognized evils of the Bessemer direct process? That they were not so recognized affords substantial grounds for questioning their alleged analogy and adaptability (in and of themselves and without the aid of other elements involving invention) in that regard. That this foundry practice was well known, that its general features were practiced in close proximity to and in common with steel-making, that it concerned a large and well-known branch of industry, that no such analogy and adaptability as are now contended for were discovered and practically applied through a long period of urgent calls for relief, are facts which should lead a court to carefully scrutinize the opinions of those who now say that such practice afforded and suggested to the mind of those skilled in the art the means of relief which all wanted, but none saw.

We must avoid being misled by mere terms and subjects of work. While Jones and Whitney both desired the melting of metals, yet they had widely different objects in view. Whitney's purpose was to cast molten metal into a finished product, Jones' merely to prepare molten metal for further treatment, to wit, decarburizing it into steel. The sine qua non of purpose in Whitney was product uniformity. Uniformity of quality in car wheels is required, so they will stand strain and uniform wear. In the Bessemer direct process, you cannot secure, initially or by treatment, uniformity of molten metal. So far as yet developed, the best you can do is to make the nonuniformity gradual, and not abrupt. In Whitney, nonuniformity, whether gradual or abrupt, would be alike fatal. In Whitney, relatively absolute uniformity is an essential of product and a sequence of material used. In Jones, uniformity is a nonessential—in fact, a nonattainable—attribute of product, and is a necessary nonsequence of material used. In Whitney, we remelt in a cupola metal which has already undergone the refining process of the blast furnaces. In Jones, we take metal direct from the furnace, and discard the cupola. It will thus be seen that, apart from the wide difference between the primary work of a huge blast furnace, the base of all metallurgy, and the cupola of the founder, a mere subdivision of that art, we find in the Jones and Whitney processes a substantial difference of purpose, of process, and of subject-matter of work.

The vital necessity of a constant, unvarying uniformity in car-wheel product is apparent from the liability to accident resulting from its absence. Without entering into a detailed statement, it is sufficient to note that the faces of the car-wheel flanges must be chilled to stand wear. Chilling is at the expense of tensile capacity; hence the unchilled iron back of the flange must afford the tensile strength required in the wheel. The chilled flange, therefore, must be of sufficient, but not more than sufficient, depth. To successfully secure enough, and yet not too much, exterior chill, molten metal of uniform character is necessary. But, in addition to the uniform character of the metal in a single wheel, each wheel must in itself be uniform with its companion wheels, so as to stand the same strain. Respondent's counsel quote with approval the testimony of complainant's witness, Mr. James Gayley, to the effect that:

"It is necessary that each wheel should be like the others, not only made during the same day, but the same throughout the month and throughout the year. This is very important, as the car-wheel maker who risks a change in the composition of the wheels risks his reputation and his trade."

We start, then, in the Whitney process, with the end in view of attaining and maintaining an unbroken dead line of uniformity. Now, to do this, we initially use chosen grades of metal, which, it is to be noted, have already undergone the refining process of the blast furnace. Mr. Whitney testifies that a great variety of metals are used; some of high chilling quality; some of low pig metal and broken car wheels, which it is to be noted had undergone several stages of refining process.

"We never introduced iron," he says, "into the mixture without first testing that iron by itself,—the great variety of tests to ascertain its special individual character. Having ascertained that for each iron that we used in the mixture, we mixed them in the proportion which our experience dictated, so as to produce the best results. That was the first step towards securing uniformity; that is, I mean by mixing them we regulated the proportion and amount of each iron to be used in the mixture; that is, we would have 100 pounds of this iron, 200 pounds of that iron, 300 of another, and so on; that was determined in the office. We formed that mixture of iron from our experiments. Then that mixture was weighed in draughts of about 2,000 pounds each, each draught consisting of its proper proportions of these several different irons, as I have named,—100 pounds of one, 200 of another, etc. Then those draughts were charged into the cupola upon a bed of coke between each draught of iron until the cupola was full, when the blast was put on as this iron melted. I may say, in passing, that it was charged when we were running full heats in three cupolas especially set apart for melting wheels. As it melted in these three cupolas, a spout leading from each cupola conducted it into the large ladle which stood in front of them. That ladle held from 12 to 15 tons of molten iron, according to the way in which it was lined up with firebrick. When the ladle was nearly full, we began to pour from it into the smaller ladles, each one of which held enough for one wheel. If it was an ordinary sized wheel, it would hold enough for one wheel; and, if the wheels were smaller ones, it held enough for two or three. As that drew the molten iron from the ladle, and the iron continued to melt, the ladle was constantly being filled from the cupola; and it was kept full until all the iron charged into the three cupolas was melted, and the bottoms dropped. Then the iron was continued to be poured out of the large ladle until it was all used, those two methods making the uniform mixture; that is, we mixed it in a solid state, first by our charges, and then in the molted state in the large ladle. * * * As the mixture was charged into each cupola, as I have stated, it was made up of irons from various furnaces, some iron having one quality and some another. As it is melted in each cupola, it did not all melt at the same time; and, if we had drawn it directly from the cupola into the small ladle from which we poured the wheels, one wheel might have been poured out of very hard iron, another out of very soft iron, and so every shade between. There would have been no uniformity in our work. But by taking it from the three cupolas, all melting the same charges of iron, and collecting them in a molten state, the inequalities of melting were all overcome, and a uniform product produced. * * * They were generally tapped very simultaneously. The iron melted very uniformly as a rule in each cupola, so that once iron enough for a wheel was melted in each cupola it was drawn out into a ladle. There were generally enough for three wheels drawn at a time into the large ladle. About a wheel would melt in each cupola, and the three cupolas were tapped about the same time."

Now, from these facts it would seem—First, the process was so adjusted that a filled reservoir contained the character of iron desired; and, second, that the care in selection of material was such that no incoming charge was of a character sufficiently variant to change the uniformity of the reservoir contents. This last fact is highly significant, and illustrates the extent and marks the limitation of the process. That it went further than this is not proven, and that it illustrated more cannot be contended; for, if the primary selection was such that any tapping was of so variant and eccentric a character as to change the level of uniformity of the homogeneous product once obtained in a filled reservoir, then the reservoir's contents was not fitted for car-wheel casting. That mixing took place may be conceded, but it was a mixing of constituents which could only and must eventually result in unvarying uniformity. To that extent we may concede it taught mixing; but there its teachings ended, and that was just where the need of the direct process began. When it came to treating a succession of tappings so marked and eccentric as to change the average of the intermediate vessel's contents, and result in the outgoing of a nonuniform varying product, Whitney taught nothing, for in his practice the possibility of such a condition was obviated by the preparatory painstaking choice of material. In considering Whitney's teachings to kindred arts, it must not be forgotten that, fairly considered, storage was the principal object of his reservoir, and mixing the mere incident. That storage was the prime necessity will appear from the fact that foundry casting was a congested process, restricted to a few hours of the day, and applied to a number of relatively small objects, and each flask filled by hand pouring. During such hours it was continuous, rapid, and the only work done. Filling in succession at a cupola tap single ladles of a capacity for a single car wheel would have been intolerable, even if practicable, as business expanded. As cupolas and flasks increased in number, an intermediate storage reservoir became a necessity. It would therefore seem that the substantial teaching of the foundry practice was storage rather than mixing. The minute, painstaking, preliminary selection of material in car-wheel practice showed that the substantial mixing, the mixing essential to success, was done by the founder ("that was determined in the office," Mr. Whitney says) before the metal was put into the cupola, and not after it came out. It would seem, therefore, that the foundry reservoir would be regarded by workers in kindred arts more as a storage than as a mixing receptacle. Whatever grounds there are for contending that its teachings were such as to point the cupola Bessemer worker to the use of an intermediate reservoir, certainly it did not inform the direct Bessemer process worker how to avoid his difficulties. The problems confronting Whitney and Jones were not the same, as we have seen; the subjects of work and the objects in view were different.

That a dead level of uniformity of blast-furnace product would have obviated the evils of the direct system goes without saying. But the crude, unrefined character of the ore, the variant, eccentric character of furnace working, and other factors made, and even now make, such uniformity a simple impossibility. The uniformity reached in Whitney's practice was therefore no solution of the treatment of nonuniformity of blast-furnace product. The question facing Jones was not how to reach uniformity, but how to obtain a gradual, nonabrupt nonuniformity. Conceding that Whitney may have taught Jones (what is in fact a simple law of nature) that, by intermingling different constituent elements, you secure an averaged whole, yet there he stopped, for, when the blast-furnace man had that mixture,—the mixture of Deighton, of Witherow, and others,—his difficulty was still unsolved. Nor did it teach him what the Whitney process did not involve, namely, the process of using that mixture as a governor or a dominant pool, by which he could treat charges of a character so radical as would avail to vary the entire pool, and obtain from such a graduated, nonabrupt product. Now, while it may be urged that this change was a simple one, yet it occurred to no one. In the light of accomplishment, changes may seem simple, but what is seemingly simple in the brightness of solution may have been very obscure and hard to discover as an original conception. At any rate, in this step, simple or abstruse, was the future of the direct process. Its principle, too, was so novel, and the application of it so original, that, even after Jones announced it, experienced steel men failed to grasp its significance. This is conceded by such persons. Mr. Gayley, the superintendent of the Bessemer department of the Edgar Thomson Works, says:

"I remember very clearly the occasion of first filling the Jones mixer at the Edgar Thomson Works. Without any conference with Capt. Jones, the inventor, we had concluded at the furnace department that the way it would be operated would be to fill the mixer up, drain it out entirely, and then fill it up again; and, as a mere matter of fact, after being filled, we stopped casting; and I gave orders to draw no more metal until the mixer was nearly empty, and just long enough before so that we could charge it a second time as rapidly as possible. I recall that, standing alongside of the mixer with Capt. Jones, when two or three heats were withdrawn, he asked me why there were no filled ladles there to keep the mixer full. I replied that I supposed the mixer would be drained before recharging, and that I had not given any orders for metal to be supplied. Capt. Jones replied that his intention was to keep the mixer always full, and to issue orders to that effect. * * * As this was at variance with what I had conceived as the method of operation, it impressed itself very clearly upon my memory."

Mr. Lauder, of the complainant company, says:

"The question of adopting the mixer was brought up frequently before it was decided to experiment. I recollect distinctly that I opposed it strenuously. I asked if any man had done it before, not only Capt. Jones, but from almost anybody that I thought I could get information from. The answers were uniformly in the negative. For this reason I kept up my opposition to the experiment, on the ground that it was too much of an experiment altogether for us manufacturers to meddle with. It was only after continued and urgent representations that I acquiesced in the experiments we made."

Mr. P. T. Berg, mechanical engineer at the complainant's works, says:

"The general expression of opinion at the Edgar Thomson Works was that the mixer would be a failure; that it would be impossible to keep the metal liquid; and that the metal would scull badly."

Mr. Thomas James, master mechanic, says Jones told him he was going to build a mixer to hold a hundred tons, and witness told him he would have a crane that would lift that amount, "that it would only be a question of time until it would chill up solid."

That the operation of the mixer was novel and experimental in the eyes of Bessemer manufacturers is shown by the fact that they wanted to see what its results would be. Mr. L. Robert Forsyth, then chief engineer of the Illinois Steel Company, who was called by respondent, says:

"Some years elapsed after the installation of the mixer at the Edgar Thomson Works of the complainant before another mixer was put up at any other works. * * * I believe the mixer is now in at four works besides those of complainant. * * * Undoubtedly, the manufacturers were waiting to see how the process would result, and what difficulties arose in operating the mixer."

Another fact should not be overlooked which shows the inherent limitations of the Whitney practice, and the extent of its teaching. If it taught mixing it stopped there, and did not teach the continued maintenance of the pool as a means of securing a graded product, which is the essence of the Jones process. This is shown by the fact that, except for mere mechanical operative convenience, there was no purpose in the Whitney practice in maintaining a pool. In Whitney, the reservoir once filled produced the uniformity desired, and uniformity of product was secured even if the contents were wholly withdrawn. In fact, such was the invariable practice after the cupolas had melted their contents. This was, for aught that appears, the practice in Deighton and Witherow, but this was not the Jones process. The heat condition, absolutely necessary in the steel-maker's art,—for heat is the base of that art,—presented a different problem; and it was found that, unless the fresh supply metal was constantly added to the pool, the variant heat conditions, so fatal to successful conversion, began to appear, and resulted in enforced resort, as the latter part of the metal was reached, to the wasteful practice of side-blowing. Moreover, it is to be noticed that while all the purpose of Whitney could be secured by filling and then entirely emptying the reservoir, to wit, a uniform product, the effect of Jones, to wit, a nonabrupt change of product, could not be secured, for the contents of one reservoir would be no index of the character of its successor.

It is also to be noted that the substance of this practice is found in Kirk's Treatise on the Founding of Metals, in an account of the Wheeling Foundry practice, as follows:

"A quantity of molten iron should be kept in the cupola or in a large ladle, so as to give the different brands of iron a chance to mix. In most all the foundries at Wheeling, West Virginia, the cupolas are never stopped from the time the blast is put on until the bottom is dropped. A large ladle is set on trestles in front of the cupola, in such a manner that the iron can run into it from the cupola, and be poured out into the smaller ladles at the same time. The iron is all run out of the cupola as fast as it is melted, and is mixed in the large ladle. I think this is a good way of mixing iron."

This volume was cited in anticipation on the application. The subsequent issue of the patent evidences the judgment of that office that it did not constitute an anticipation.

But, conceding for present purposes that what there was of Whitney's practice was embodied in Jones' process, does that certainly prove it an anticipation? We think not. The purpose of Whitney was, as we have seen, relatively absolute uniformity of product. That result was never attained by Jones or any one else in the direct process. His object was graduated, nonabrupt change. Jones' object was not, and from basic conditions could not be, produced in Whitney's practice. Therefore, the objects were different. Such being the case, the use of Whitney's entire process in co-operation with other elements or change of process or method to accomplish the novel result which Jones produced can in no sense be termed a double use. It would be the use of an old method, conjointly with other elements, to produce a different and new result. The old element may remain unchanged, but the action of other elements co-operates with it conjointly on the common object, and produces a new result. The new process, to wit, the Jones process, is applied to a different object; and a new result, viz. graduated, nonabrupt converter charges, result from such application. It therefore comes within the spirit of Whitney v. Mowry, 2 Bond, 45, Fed. Cas. No. 17,592, and Cary v. Wolff, 24 Fed. 139, and kindred authorities.

In Mowry v. Whitney, 14 Wall. 640 (a case, by the way, involving the wheel practice of Whitney), is found in Mr. Justice Strong's opinion what we regard as the underlying principle which differentiates the Whitney practice from the Jones invention. The question in issue being a peculiar kind of annealing, and the subject of discussion prior practices, it was said:

"It is unnecessary, however, to describe these devices. It does not appear that in any of them the idea existed of making a car wheel with chilled tread, straight plates, and solid hub, annealed and cooled so as to leave it uninjured by the strain attendant upon the unequal cooling of the thick and thin parts. Annealing some kinds of castings was known and practiced before 1847. This is abundantly proved by the witnesses, and various modes of annealing plain castings had been described by scientific writers both in this country and abroad, before that time. But there is no evidence that we have been able to discover that cast-iron car wheels had ever been subjected to an annealing process, in connection with slow cooling, before the process was invented or discovered by Whitney. In all the experiments made for annealing other castings, the object sought was different; and in them all, as well as in the process described in the publications given in evidence, the effect on the annealed metal or glass was not to leave them in the condition in which it was sought to bring car wheels, with the crystallization or chill of the periphery unimpaired, and the plate or thin part unaffected by strain. Cast-iron railroad wheels are castings of a peculiar kind. The methods of slow cooling, or of annealing and slow cooling, which were applied to other castings before 1849, were not adapted to their peculiarities, or to what they needed. They are not homogeneous throughout. They are of different thickness in their several parts, and hardened at the tread, while the plate and hub are not crystallized, but are soft and tough. These different qualities of the different parts it is necessary to preserve, and what was needed when Whitney's invention was made was to preserve them, and at the same time relieve against any strain, caused by equal cooling, which might impair the strength of the wheel."

For the reasons we have stated, we are therefore of opinion that Whitney's practice was not an anticipation. We are further of opinion that the Jones process was novel, and involved invention, and, for reasons hereafter stated, was the proper subject for a process patent. And, in concluding this branch of the case, we deem it proper to say that careful study and matured thought satisfies us that the Jones invention was a marked advance in the steel-maker's art. In other cases it has been held that, if the change in question is one which would not occur to the practiced eye of the ordinary mechanic, such fact might tend to show that the step involved invention. But here was a step—a desideratum—which not the skill of the ordinary mechanic, but the keenest intellect of men technically taught in the schools of different countries, and practically trained at the furnace bosh, was seeking for years to reach, and failed to attain. A great industry was interested and alert upon the solution of the question. The evil was a recognized one, and was discussed at the gatherings of the master minds of that industry; but no one met it until the simple and effective key furnished by Jones unlocked the gate which had so long barred advance.

It is, however, further contended that the claim in issue is not a process, within the meaning of the patent law, and therefore not patentable. An examination of the cases cited satisfy us that it is. Section 4886, Rev. St., authorizes the grant of a patent to any person who has invented or "discovered any new or useful art, * * * or any new and useful improvement thereof." Cochrane v. Deener, 94 U. S. 780, defined the term "art," as used in the statute, to be synonymous with "process"; and a "process" was defined to be "a mode of treatment of certain materials to produce a given result; an act or series of acts performed on a subject-matter to be transformed and reduced to a different state or thing." This is but a restatement, in substance, of what was so clearly stated in Corning v. Burden, 15 How. 252:

"It is for the discovery or invention of some practicable method or means of producing a beneficial result or effect that a patent is granted, and not for the result itself. It is when the term 'process' is used to represent the means or method of producing a result that is patentable, and it will include all methods or means which are not effected by mechanism or mechanical combinations."

These principles (recognized in the supreme court of the United States, in Locomotive Works v. Medart, 158 U. S. 68, 15 Sup. Ct. 745), from the pens of two men who were singularly happy in stating in simple language the pith of an abstruse subject, as Justices Grier and Bradley, are a safe guide in the somewhat abstruse field of process patents. Applying them to the case in hand, we see that the operation of Jones is a method of treatment, as opposed to a mechanical operation. There is nothing mechanical in the relation of the tank to the fluid. The molten metal enters a fluid; it leaves still a fluid. It is not diminished in quantity or affected in quality by any active, operative, mechanical operation of the inclosing tank. The tank is a mere envelope or chamber, whose purpose or function is to hold the fluid during the process. It is like the necessarily heavy boiler used in the process in Tilghman v. Proctor, 102 U. S. 707; the furnace used in the process of annealing of Mowry v. Whitney, 14 Wall. 620; or the stove used in Neilson's hot blast, Neilson v. Harford, Webst. Pat. Cas. 312–371. The marrow and essence of the Jones operation lies, not in the enveloping vessel, but in the action of the enveloped fluid. That treatment, change, a new result, take place between the fluid's entrance and its exit, is clear. The change that takes place is both thermal and quasi chemical in its nature. It is also of a kind or degree that can be effected in no other way than by passage through or incorporation with the enveloped fluid mass. The incoming charge loses its individual constituent and thermal character. It merges them in the detained mass. It partakes of the character of each of the constituent portions of that mass when it enters it, and, on its exit, leaves its influence behind, to affect, modify, and grade each new incoming addition. It would seem from the nature of things that each resultant, outgoing charge was different from every incoming one, and, therefore, there must be change in the state, if not in the thing itself. In truth, in fact, in practical effect, the graduated, nonabrupt outgoing charge has changed from the moment of its entrance, and that change, all important and vital, was wrought by operation of the bath, not by the vessel. If change of state or transformation without mechanism or mechanical operation be a test of process, the change here is more marked than that of the air in Neilson's hot blast. There the change was merely thermal, and the air could return to its original condition. Here the change was not only thermal, but constitutional or constituent. A different atomic, constituent body, designedly made so, was the result of Jones' treatment.

The Neilson Hot Blast is cited in text-books and reports as a case of typical process. See Tilghman v. Proctor, 102 U. S. 707; O'Reilly v. Morse, 15 How. 62. Accepting it as such, it may be described as a process for preparing air for use in blast furnace by first passing it through a dominant heating medium, whereby its thermal state is changed for functional purposes; while the Jones invention of the claim may be described as a process for preparing blast-furnace metal for use in a converter, by first passing it through a dominant pool of metal, whereby its thermal state and proportions of chemical constituents are changed for functional purposes. If the law has rightly adjudged Neilson the inventor of a process, it should likewise adjudge Jones. While the former changed the nature of the blast alone, but did not, save in quantity, change the product itself, the other changed the very nature of the product, and made it susceptible of more successful use in the direct Bessemer process.

Has infringement been shown? In this connection the question of the apparatus employed is of importance only as bearing on its adaptability for the practice of the Jones process, for infringement of process, not apparatus, is charged. Respondent's apparatus consists, since November, 1895, of a large, covered, refractory lined vessel of about 300 tons capacity, adapted to be tipped by hydraulic pressure, having a receiving hopper at the rear, and a pouring spout at the front. Both a blast-furnace plant and a cupola system supply metal for its Bessemer converter plant,—the former about two-thirds, the latter one-third, the metal used. It is to be noted that the cupola system continues, since the installation of the reservoir, to deliver its metal by ladle to the converter direct, and not through the reservoir. The metal from the blast furnace enters the receiver in approximately 15-ton ladle lots, and is withdrawn in approximately 12-ton ladle ones. Mr. Joseph Morgan, Jr., chief engineer of the respondent company, states that, "in accordance with the natural way of using a reservoir, it is ordinarily kept well filled up." The minimum amount maintained in respondent's reservoir is proved by Mr. Levi D. Upton, as follows:

"Q. Did you see any mark upon the mixer, and, if so, was your attention called to it in any way? A. My attention was called to a chalk mark, which, by the way, I had noticed before, on the side of the mixer. They told me they didn't allow them to run that chalk mark below the floor. When it came to the floor, they still had retained in the mixer about 175 tons. Q. Please state what you mean by the chalk mark coming to the floor. A. What they call the mixer floor is where the men work to rotate or tilt the mixer, and, if the mark they have on the mixer goes on the floor out of sight, they cannot tell how much they have left. Q. Am I to understand you that the mixer was not to be tilted more than enough to bring the chalk mark on a level with the mixer floor? A. That is the meaning I wish to convey, and, if they hadn't enough to make out their heat without going below the floor, they wait till they get more in. Q. Who explained this to you? A. The superintendent of the Bessemer department. Q. What is his name? A. F. G. Parker. Q. I understand, then, if the chalk mark did not go below the level of the mixer floor, there would be 175 tons of metal retained in the mixture. Is this correct? A. Yes, sir."

Mr. Parker was not called to dispute this statement.

Mr. John E. Fry, an experienced theoretical and practical steel maker, testifies of the operative process, as follows:

"On Monday, March 29, 1897, I saw the metal mixer used at the Cambria Iron Works. Its principle of construction is similar to the Jones mixer, and its operation is identical with that set forth in Jones' patent. When I saw it in use, it contained a relatively large body of molten metal, which had been brought to it from the blast furnaces while liquid, and relatively small portions of such metal were added to its contents from time to time; and other portions were poured from it into a charging ladle, and taken to the converters for conversion into steel. In these operations, care was taken to maintain in the mixer a relatively large quantity of metal, so that the portions added would remain for a sufficient time subject to the mixing effects of the mixer before being withdrawn; this to 'average up' the chemical constituents of the metal, and make the fluctuations gradual, as is done in the Jones method. Owing to, or in conformity with shop rules, the withdrawals of converter charges of mixed metals were made with approximate regularity of time intervals, and the additions and withdrawals were made as near 'time about' as possible. The additions were about one-fourth larger than the withdrawals; say, five of the latter to four of the former, so that the additions were balanced by the withdrawals. An oilvapor jet was used for heating the empty mixer preparatory to serving it with metal at the beginning of the week's work, but, after a quantity of metal was added that was above the established minimum of one-half full, there was no further need for the vapor jet, and it was shut off. The normal position of the mixer when not in use was upright, and in this position it received the additions of molten blast-furnace metal. In making a withdrawal, the mixer was tipped or rocked forward, and it was returned to its normal condition when the withdrawal had been made. A mark was placed on the outside of the mixer, so as to move relatively to the motion of the mixer in pouring out metal. This was a chalk mark or white line, and, in addition, there was a graduated gauge board. The mark was placed relative to a fixed point, so that about one-half the capacity of the mixer would represent the minimum amount of metal desired to be retained for mixing effects."

It is quite clear, in view of these facts, that infringement takes place. That initial mixing, rather than storage, is the purpose of the reservoir, is shown by the fact that the cupola metal is not stored, but served direct in ladles to the converter plant. And that the homogeneous mixture once obtained is used as a dominant pool to produce a graduated, nonabrupt product, is shown by the chalk line minimum limit of 175 tons. With such a permanent dominant pool in constant use, we are clear that respondent's practice infringes the second claim of the Jones patent in both letter and spirit. Indeed, Mr. Morgan himself says: "With the exception of additions of cupola metal, I do not know that there is any material difference between our practice and that described in the second claim." The exception noted can have no effect on the question of infringement. In substance, as carried on by respondents, it is a disconnected operation, wholly independent of the mixer; the only exception being, where there was not sufficient cupola metal for a full converter charge, the shortage was drawn from the mixer. For the reasons stated, we are of opinion that infringement of the second claim is shown.

As bearing on the question of the admission in evidence of the disclaimer filed in evidence, we are of opinion that there was no unreasonable neglect or delay in filing the same, and it was promptly called to the attention of the court, and offered in evidence thereafter. We will admit it in evidence, and in our consideration of the patent have so considered it. The power to disclaim is a beneficial one, and ought not to be denied, except where it is resorted to for a fraudulent and deceptive purpose (Sessions v. Romadka, 145 U. S. 41, 12 Sup. Ct. 799), of which there is no proof in this case. Having been made after suit brought, the decree entered will be without costs. Smith v. Nichols, 21 Wall. 117. Let a decree be prepared and submitted.

DONNELL v. BOSTON TOWBOAT CO.

BOSTON TOWBOAT CO. v. DONNELL.

(Circuit Court of Appeals, First Circuit. October 4, 1898.)

Nos. 210 and 211.

1. COLLISION—TUG AND TOW—FAILURE TO SLACKEN SPEED IN FOG.

Unless under special circumstances, a tug and tow are bound by articles 13 and 18 of the sailing rules; and a steamship, having in tow a barge 280 feet in length, and carrying sail, which saw an approaching bank of fog five or six minutes before entering it, but did not signal the tow to take in sail until after entering the fog, and did not slacken speed