United States Supreme Court
CARNEGIE STEEL CO v. CAMBRIA IRON CO, (1902)
No. 17
Argued: Decided: May 5, 1902

This was a bill in equity filed in the circuit court for the western district of Pennsylvania by the Carnegie Steel Company against the Cambria Iron Company, for an injunction and the recovery of damages for the infringement of letters patent No. 404,414, issued June 4, 1889, to William R. Jones, of whom plaintiff was the assignee, for a 'method of mixing molten pig metal.'

In his specification the patentee declares that the--

'Primary object of my invention is to provide means for rendering the product of steel works uniform in chemical composition. [185 U.S. 403, 404] In practice it is found that metal tapped from different blast furnaces is apt to vary considerably in chemical composition, particularly in silicon and sulphur, and such lack of uniformity is observable in different potions of the same cast, and even in different portions of the same pig . . . . 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 often 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 practised.'

'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 and segregated 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 uniform constituent parts, all the charges of the converter from time to time will be substantially uniform, and the products of all will be homogeneous.'

'To this end my invention may be practised with a variety of forms of apparatus,-for example, by merely receiving in a charging ladle a number of small portions of metal taken from several ladles or receiving vessels containing crude metal obtained at different times or from different furnaces, the mixing being [185 U.S. 403, 405] performed merely by the act of pouring into the charging ladle, and other like means may be employed. (The clause in italics was subsequently disclaimed.) I prefer, however, to employ the apparatus shown in the accompanying drawings, and have made it the subject of a separate patent application, serial No. 289,673, and, without intending to limit the invention to the use of that specific apparatus, I shall describe it particularly, so that others skilled in the art may intelligently employ the same.'

'My invention is not limited to its use in connection with converters, since similar advantages may be obtained by casting the metal from the mixing vessel into pigs for use in converters, puddling furnaces, or for any other uses to which pig iron may be put in the art.' (This paragraph subsequently disclaimed.)
(The apparatus is represented by the drawing here inserted.)

'Referring now to the drawings, 2 represents the reservoir before mentioned. It consists of a covered hollow vessel having an outer casing 3, of iron or steel, which is suitably braced and strengthened by interior beams and tie-rods, as shown in the drawings. The whole exterior of the vessel is lined with fire brick or other refractory lining, which should be of suffi- [185 U.S. 403, 406] cient thickness to retain the heat of the molten contents of the vessel and to prevent chilling thereof. The vessel is strongly braced and supported by braces and tie-rods, and may be of any convenient size, holding, say, 100 tons of metal (more or less), and its shape is preferably such as shown in the drawings, being rectangular, or nearly so, in cross section and an irregular trapezium in longitudinal section, one end being considerably deeper

than the other. At the top of the deeper end, which I call the 'rear' end, is a hopper 5, into which the molten metal employed in charging the vessel is poured, and at the front end is a discharge spout 6, which is so located that the bottom of the spout is some distance above the bottom of the vessel,-say 2 feet in a hundredton 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 the character of the metal which is fed to and discharged from the tank, and cause the fluctuations in quality of the successive tappings to be very gradual.'

'For convenient use of the apparatus I have found it best to so arrange it that it is adapted to receive its charges of metals from cars or bogies 7, which run on an elevated track at about the level of the normal position of the hopper 5, and to discharge its contents into similar cars or bogies 15 on a track below the spout 6. In order to facilitate the charging and discharging of the metal, the vessel is set on journals or bearings 8, which have their bearings in suitable pedestals 9, and its rear end is provided with depending rack bars 10, which are pivotally connected with the bottom of the mixing vessel 2, and are in gear with pinions 11, the shaft of which is connected by gearings 12 with the driving mechanism of a suitable engine. The pinions are held in gear with the rack bars by idler wheels or rollers 13. As the journals or bearings 8 are located on a transverse line somewhat in advance of the center of gravity [185 U.S. 403, 407] of the vessel, it tends by its own weight to tilt backward into the position shown in Fig. 1, but may be restored to a level position by driving the pinions 11, and thus raising the rack bars 10 until the front part of the bottom of the vessel comes in contact with a rest or stop 14.'

'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 vessels 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 cars 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 vessel, 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 obttom of the spout being situend, end, and the bottom of the spout being situate 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 discharge spout 6 is furnished with a movable cover operated by a weighted lever 16, which, when closed, serves to exclude the outside air and prevent a draft of air through the vessel and the consequent rapid cooling of the molten contents. If care is exercised in keeping the cover closed, the metal can be kept in a fluid condition for a long time, the heat being kept up by repeated fresh charges of molten metal, and, if necessary or found desirable, by burning gas introduced by a pipe or pipes into its interior.' [185 U.S. 403, 408] 'After the vessel is properly charged, the metal is drawn off into the cars 15 from time to time, as it is needed, by opening the door or cover 16 of the spout 6 and driving the engine 12 so as to elevate the rear end of the vessel and tilt it forward, and thus to discharge any required amount of its contents in the manner before explained into the cars 15, which are transported to the converters, or the metal is cast into pigs or otherwise used. (Italics disclaimed.) 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, by which means any sudden variations in the quality of the metal supplied to the converter is avoided. Instead of discharging the metal into the cars 12 and carrying it in the cars to the converters or casting house, the vessel 2 may be so situate relatively to the other parts of a furnace plant as to deliver its contents immediately to the converters or other place where it is to be utilized.'

'I find it in practice very advantageous to employ two or more mixing vessels constructed substantially as I have described, and to draw a portion of each converter charge from each of the mixing vessels. My invention is, however, not limited to the employment of two or any specific number of such vessels.'

'I shall now describe, briefly, other parts of the apparatus which are desirable and important in its practical use.'

'At the top of the vessel 2 are manholes 17 designed to permit of access to its interior for the purpose of repairing or fixing the lining. These holes are provided with suitable covers 18 to exclude cold drafts of air from entering the interior. There is also a hole 19 at the rear end of the vessel near the top, through which a rabble may be inserted for the purpose of assisting or accelerating the mixing of the molten metal, and at the other end, at the level of the bottom of the interior, there are holes 20 provided with suitable spouts to enable all the molten contents to be drawn off when it becomes necessary to do so. (See Fig. 3.) The holes 20 should be provided with suitable stoppers.' [185 U.S. 403, 409] 'I claim--
'1. In the art of refining iron directly from the smelting furnace, the process of equalizing the chemical composition of the crude metal by thoroughly commingling or mixing together the liquid-metal charge and subsequently refining the mixed and equalize charge, substantially as and for the purposes described.
'2. 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
The answer set up the invalidity of the patent by reason of an insufficient specification, anticipation, want of novelty, and abandonment; and also denied infringement.

Upon a hearing upon the pleadings and proofs, the circuit court held with the plaintiff, and found that the process was patentable; that it was not anticipated; that it was of great utility and importance; and that defendant had infringed the second claim. 89 Fed. 721.

A decree having been entered for an injunction and an account of profits and damages, in accordance with this opinion, the case was carried to the court of appeals, which ordered the decree of the circuit court to be reversed, and the case remanded to that court with direction to dismiss the bill. 37 C. C. A. 593, 96 Fed. 850. Whereupon plaintiff applied for and was granted this writ of certiorari.

Messrs. Thomas W. Bakewell, Thomas B. Reed, Philander C. Knox, and Thomas B. Kerr for petitioner.

Messrs. James I. Kay, Francis T. Chambers, and Philip T. Dodge for respondent. [185 U.S. 403, 410]

Mr. Justice Brown delivered the opinion of the court:

Steel is a product, or, perhaps, more accurately, a species of iron, refined of some of its grosser elements, intermediate in the amount of its carbon between wrought and cast-iron, and tempered to a hardness which enables it to take a cutting edge, a toughness sufficient to bear a heavy strain, an elasticity which adapts it for springs and other articles requiring resiliency, as well as a susceptibility to polish, which makes it useful for ornamental and artistic purposes.

Pig iron, which was the original basis for the manufacture of all iron and steel, is made by the reduction of iron ore in large blast furnaces, which are filled with layers of ore, charcoal or coke, and flux. By the agency of this the iron is melted out and falls to the bottom of the furnaces, is drawn out through openings for that purpose into canals, and finally into molds, where it solidifies into what are termed pigs. Prior to the invention of Sir Henry Bessemer, steel was manufactured from a pig-iron base by a tedious and expensive process of refining in furnaces adapted to that purpose. The process was so costly that steel was little used except for cutlery and comparatively small articles. and was practically unknown in the construction of bridges, rails, buildings, and other structures where large quantities of iron were required.

In 1856 Bessemer discovered a process of purifying iron without the use of fuel, by blowing air through a molten mass of pig iron placed in a refractory lined vessel called a converter, whereby the silicon, carbon, and other nonmetallic constituents were consumed, and the iron thus fitted for immediate conversion into steel by recarbonization. The present process of recarbonization was a supplementary invention of Mushet, who accomplished it by the introduction of ferro-manganese, or spiegel-eisen, while the iron in a molten state was issuing from the converter, in which it had been purified, and was thus converted into steel. The process of running molten metal from blast furnaces into pigs and remelting them in cupola furnaces for use in a converter was termed the indirect process, and was generally used prior to the Jones invention. [185 U.S. 403, 411] His process is thus described by Bessemer in his patent of 1869: 'The most

important of these operations consist in melting the pig metal, transferring it in the molten state to the converting vessel, blowing air through it, and converting it into a malleable metal, mixing the metal so converted with a certain quantity of fluid manganesian pig iron, pouring the mixed metals into a casting ladle, and running it from thence through a suitable valve into ingots or other molds, and the removal therefrom of the ingots or other cast masses when solidified.' This invention of Bessemer, simple as it appears, may be said not only to have revolutionized the manufacture of steel, and to have introduced it into large constructions where it had never been seen before, but to have created for it uses to which ordinary iron had been but illy adapted.

While in the Bessemer specification of 1856 it is said 'the iron to be used for the purposes of my present invention may be conveyed by a gutter in a fluid state direct from the smelting furnace where it has been obtained from the ore,' without the expense and delay incident to the intermediate cupola process, practical experience, in this country at least, showed that the refining of iron without first casting it into pigs, selecting or mixing the pigs, and remelting them, was attended with such expense that the entire abandonment of the practice was seriously considered. The difficulty was in the material variations between different portions of the same cast, and even different parts of the same pig,-an irregularity which was increased when the metal was drawn from several furnaces. There was added to this frequent changes in the character and composition of the ore, coke, and limestone flux with which the furnace was charged. The consequence was that the nonuniform chemical composition of the metal from the molten blast furnaces yielded products of steel, such as rails and beams, which were not only irregular chemically, but of irregular and uncertain final condition,-some sound, others of imperfect strength and full of flaws.

These irregularities were in a measure obviated, not only by a careful selection of pigs beforehand, but by the necessity of employing upon receiving ladles or reservoirs into which the [185 U.S. 403, 412] product of one or more cupola furnaces was drawn off into such reservoirs, which were made large enough to hold the product of two or three furnaces, and from which the molten metal was withdrawn into the converters. Had the amount required for the converters in each case been the exact product of one or more cupolas, no reservoirs would have been necessary, but as the demand was variable, a storage of molten metal was required to retain the product of one or more cupolas, until it was required for the converters. Of course, as the product of two or more furnaces was drawn off into these receiving ladles, there would be some intermixing of those products, although the receiving ladles do not appear to have been used for that purpose, the operators relying more particularly upon the careful selection of pigs beforehand, to obtain the requisite uniformity for conversion into steel. The ladles being open at the top, the molten metal could not long be retained in them, and in the best practice it was so arranged that the withdrawals from the reservoir were made every few minutes, and without regard to the amount left in the reservoir after each withdrawal. It will be borne in mind that the object in either case, whether by direct or indirect process, is to obtain, as far as possible, a uniform product of iron for the converter.

'These results,' said one of the witnesses (Kennedy), speaking of the process used before that of Jones, 'are not obtained by the practice of taking metal from two blast furnaces by running a train of ladles in front of them and tapping into each ladle half a charge and following it from a second furnace. By such practice, of course, there is some independent equalization of the composition of each ladle or of the ladles of each group, but it affords no further advantage, and in fact would not obviate the difficulties of direct metal working. It does not enable the converter manager to foretell the character of each charge from the character of the preceding charge, and would therefore entail the uncertainties of operation and the irregularity of the product which the Jones method avoids.'
It had long been an object of manufacturers that steel should be made directly from the molten metal, as it comes from the blast furnaces, without having to pass through the intermediate [185 U.S. 403, 413] or cupola process, which involved the casting of the furnace metal into pigs. These, after becoming cold, were assorted, broken up, recharged and remelted in a cupola furnace, and then placed in a converter for conversion into steel. By this cupola process a product, practically uniform in character and suitable for further treatment in the converters, was secured, but at the expense (more than 60 cents per ton) of rehandling and remelting the iron as it come from the blast furnaces, in cupolas, and the contamination of the metal with sulphur evolved from the coke in the process of remelting. The obstacles connected with this method and the difficulties attendant upon the use of the direct process are thus comprehensively set forth by Mr. Julian Kennedy, one of the experts:

'Ever since the invention of the Bessemer process it has been well recognized that great economics 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.'[185 U.S. 403, 414] Speaking of a time when the direct process (before that of Jones) had been in use for several years he said:
'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 difficulties connected with the prior devices are also stated in an article by Mr. Holley, published in 1877, from which we extract the following paragraph:

'Third. The embarrassing feature of the direct process is the irregularity in the heat-that is to say, in the silicon of the charges- resulting in the large amount of scrap due to too little of this element, and in the increased number of second-quality rails due to too much of it; while in France, where 3 to 5 per cent of manganese is the heating ingredient, there may always be an excess of this latter element without injuring the quality of the steel, although the variation of heat is here, also, a serious difficulty. In other words, it has not yet been practicable to work the blast furnace with sufficient regularity to realize approximately the theoretical advantages of the direct process.'
'Fourth. The obvious remedy is to mix a number of blast-furnace charges, so as to reduce the irregularity to a minimum. Two systems of doing this are on the eve of trial: The one is simply mixing so few charges in a tank that the metal will be drawn out before fore it chills; the other is to store a larger number of charges in a heated tank,-that is to say, in an immense open-hearth furnace.'
'A few words of history may be of interest. Mr Bessemer's early intention was to use blast-furnace metal direct. The earlier Bessemer practice, especially that in Sweden, was with metal right from the blast furnace. But this practice did not make headway, except where there was from 3 to 5 per cent of manganese in the pig blown, for reasons just mentioned; [185 U.S. 403, 415] so that while it soon became standard at Terrenoire and elsewhere in France, as well as in Sweden, and to some extent in Germany, yet in England it was not only unused, but pronounced impracticable so late as September, 1874.'
This difficulty,-and it seems to have been so serious as to render the direct process commercially impracticable,-Jones sought to remedy, and did remedy, by creating a covered reservoir of molten metal between the blast furnaces and the converters, in which should always be maintained a large quantity of metal, happily termed by the district judge a dominant pool, which sould be drawn off in small quantities at a time, and replenished by a like quantity of metal from the blast furnaces. In this way, while the metals taken from the several blast furnaces might differ in their heat and constituent elements, yet, being received and mixed with the molten metal in the dominant pool, they were, when discharged from the reservoir, approximately, though not perfectly, uniform, the original variations having been lost in their mixture with the dominant pool. 'It is therefore plain,' says the district judge in his opinion, '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 is not insisted that this method gave absolutely uniform results, 'nor,' says the witness Fry, 'did the inventor, as I understood him, comprehend such, but, on the contrary, he recognized the practical impossibility of

rendering uniform a continuous supply of metal, and desired only to reduce the abrupt changes of the several portions added to the gradual changes of the portions withdrawn, and this is what he worked out from his invention in a thoroughly practical way.'

While the patent in suit is for a process, and not for a mechanism, the process will be the more easily understood by a reference to the apparatus above reproduced, which consists of a [185 U.S. 403, 416] reservoir, or closed receptacle, commonly termed a 'mixer,' lined with fire brick of sufficient thickness to retain the heat of the molten iron, and of such size and strength as to be capable of receiving and retaining a large amount-'say, 100 tons'-of molten iron. This reservoir is mounted upon journals, and is adapted to be tipped so as to receive at one end molten metal from the blast furnaces, carried to it in cars, and by being tipped in the other direction, to discharge the same into similar cars, in which it is carried to the converter. The essence of the invention lies in the fact that the tip is so regulated by a stop that the reservoir can never be wholly emptied, but a 'considerable quantity' of metal always remains,-a dominant pool, into which successive additions are received.

That the invention is one of very considerable importance is attested by the fact that it was not only put into immediate use in the Edgar Thomson works at Braddock, then owned by the plaintiff, but has since been adopted by all the leading steel manufacturers in this country, and by many similar works in Europe, where the patent was sold for 10,000. Mr. Carnegie, one of the witnesses, says of it: 'There were both advantages and disadvantages [in the direct process used prior to Jones's invention], but the disadvantages were so great that we often debated whether to abandon the process or not. We found it impossible to get a uniform quality of rails as well as by the cupola method. . . . When we were still anxiously struggling with the problem, and undecided whether to continue or abandon it, Captain Jones . . . told us that he believed he had invented a plan which would solve the problem. . . . We thought so well of the idea-I was so convinced of its reasonableness-that I directed him to go ahead with his invention. . . . Captain Jones did so, and almost from that day our troubles ended. He had scored a tremendous success; another step forward was taken in the manufacture of steel, and we are using the invention to-day. . . . Without this invention I believe that we should have abandoned the mode of running direct from the blast furnace. Above all things, the manufacturer has to regard the uniformity of product, [185 U.S. 403, 417] the equality of rails; and this uniformity cannot be obtained without Jones's invention, as far as I know.'

It is true that what is termed the direct process was used in connection with the Bessemer invention in some foreign countries, notably Sweden and France, with more or less success, due to the peculiar character of the ores used in those countries; but such attempts in this country had proven practically failures, and had been abandoned. In regard to this the witness Kennedy said:

'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's 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.'
Indeed, the value of the process is not wholly denied, though much depreciated, by the defendant, which relies rater upon the fact that it was well known in the art, and that so far as it is described in the Jones specification and drawings it was not infringed by it.

1. We now proceed to an examination of the question of anticipation, in support of which a number of English patents are produced, which will be briefly considered: First, the British patent to Tabberner of 1856, the object of which was, as stated by the patentee in his specification, 'to dispense with the necessity of employing one or more large furnaces, and to use in lieu thereof several small furnaces, the combined capacities whereof are equal to that of one or more large furnaces, and to cause these small furnaces to discharge their contents at short intervals of time into one large reservoir, from which the molten metal may be drawn for casting from. . . . The [185 U.S. 403, 418] principal features in this invention consist in directing the blast to the body or belly of the furnace, as well as to the hearth thereof, for the purpose of

fusing or smelting the entire mass of ore in the furnace simultaneously, or nearly so. . . . The mode hitherto practised in smelting furnaces has been to direct blasts into the hearth only thereof, thereby requiring several hours to smelt or fuse the contents of a large furnace.' The specification is somewhat blind, and it is difficult to see what definite or valuable result is obtained by the use of several small instead of one large furnace, except, perhaps, a quicker heating and less delay in its practical operations; but it is sufficient for the purposes of this case to say of it that it contains no suggestion of a mixing of different casts for the purpose of obtaining a more uniform product, and that the invention has no relation to a further treatment or refining. It does contemplate the use of a reservoir, but there is no suggestion of a reservation in such reservoir, of a quantity of molten metal. It is not denied that the use of a reservoir from which molten metal may be drawn long antedated the Jones patent. But the best that can be said of the Tabberner patent is that, if the reservoir had been of sufficient size and properly constructed so as to never be completely emptied, it might have been adapted to carry out the Jones process; but there is no evidence that it was ever so constructed, or that the production of a uniform discharge from the reservoir was contemplated. That it could not have been intended for the purpose of carrying out the Bessemer process, or any other process, for the use of blast-furnace metal in a converter, is evident from the fact that the patent was nearly simultaneous with the Bessemer patent, of the existence of which the patentee appears to have been entirely ignorant.

The English patent to Deighton of 1873, for 'improvements in the arrangement and mode of working an apparatus for the manufacture of Bessemer steel,' contains the closest approximation to the principle of the Jones invention. If this does not anticipate, none does. The primary object of the patent seems to have been to prevent the loss of time while the converters are being cooled and relined or repaired, and again [185 U.S. 403, 419] prepared for work, by providing that the converting vessel shall be so arranged that it can be readily detached from its actuating mechanism and lifted bodily out of its bearings by a suitable crane or other lifting mechanism, and a spare converter substituted in its place.

There is, however, a further provision in the patent, as follows:

'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 a 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 specifications provide for manufacturing Bessemer steel directly from the smelting furnace by employing gates or channels for molten metal from each furnace, leading to a reservoir, which is placed low enough to give fall for the molten metal to flow from the blast furnace to this reservoir, which forms a receptacle for mixing the molten metal from two or more of the smelting furnaces. From the reservoir the mixed molten metal is tapped, and flows down the swivel trough into the converter. By placing the reservoir on a weighing machine, it can be readily ascertained when the exact quantity required ascertained when from it into the converter. The sixth claim of the patent is for 'the system or mode of arranging and working Bessemer converters with a receiver or receptacle for mixing the molten metal from two or more smelting furnaces to get a more uniform quality of metal, substantially as hereinbefore described and illustrated by the drawings.'

While Deighton seems to have conceived the idea that uniformity of product was necessary to the successful use of the direct process, and might be attained by mixing the dischage from several blast furnaces in an open reservoir, standing between [185 U.S. 403, 420] the furnaces and the converter, the dominant idea of the Jones invention, that a constant quantity of molten iron should always be kept in such reservoir to serve as a basis for such mixture and an equalizer of the different discharges, does not seem to have occurred to him. As the discharge pipe was located at the bottom of the reservoir, it was certainly possible to empty it entirely, and the testimony in the case indicates that this was the natural method of operation. If this were so, then the reservoir accomplished nothing beyond the mixing of each batch of metal introduced into it from the different blast furnaces. There is nowhere in the specification a suggestion of supplying to and withdrawing from the reservoir small amounts at a time, a constant quantity of metal being retained in the reservoir for the purpose of equalizing the different products of the

blast furnaces. While the Deighton reservoir, if a cover had been added to it, might perhaps have been utilized for that purpose, there is no evidence that such use ever occurred to the inventor. Indeed, the absence of a cover to the reservoir is evidence, even to a nonexpert, that it was not contemplated that a permanent quantity of molten iron should be retained in it, since a radiation of heat would thereby be produced and the contents skulled or crusted over with a layer of refuse iron or slag. The testimony is clear that the Jones process cannot be carried on in an open reservoir, and the absence of a cover is conclusive that it is not so used.

It is insisted, however, that defendants have demonstrated, by practical experimentation with a plant constructed according to the specification of the Deighton patent, that the results are practically the same as those obtained by the Jones process. This plant, however, was constructed after suit brought, long after the Deighton patent had been allowed to expire, and with no opportunity afforded the plaintiffs to inspect the plant or witness its operation. The tank was fitted with a cover, and a constant pool of molten metal retained in it; but this was not the Deighton process, but the Jones process adapted to the Deighton device. Were this evidence admissible at all, we are satisfied that it is met by the fact that if the Deighton patent had been adaptable to the Jones process, it is scarcely possible [185 U.S. 403, 421] that its merits should have failed to seize upon the attention of manufacturers, who would have brought the patent into general use, instead of allowing it to lapse for the nonpayment of a comparatively small fee. As something in the nature of the Jones process was needed to enable steel to be manufactured directly from the product of blast furnaces, the utility of the Deighton patent for that purpose would at once have been recognized and its success assured. But evidently that patent was not the final step in the accomplishment of the mixing process. It contributed nothing to the art of manufacturing steel, and, although issued in 1873, was allowed to lapse in 1876, after an apparently unprofitable existence for three years, by reason of the nonpayment of the stamp duty necessary to keep it alive. It is sufficient to say of it that it fails to disclose, fully and precisely, the essential features of the process covered by the Jones patent. Walker, Patents, 54; Seymour v. Osborne, 11 Wall. 516, 555, 20 L. ed. 33, 42; Illinois C. R. Co. v. Turrill, 94 U.S. 704 , 24 L. ed. 241.

Although Deighton was an employee of the Moss Bay Company of Workington, England, if any attempt were made by this company to make use of his process, it evidently amounted to nothing, since one of the writers, Snelus, contributing to the Journal of the Iron and Steel Institute, 1876, says: 'One 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 that it would be found that the great advantage the Bessemer works in Americal had was the intermediate receiving ladle, which was designed by Mr. Holley, and which was universally used there, although it was never used in England. The Moss Bay Company attempted to modify the thing some time ago, and put up a heating furnace; but that, to his mind, was a step in the wrong direction. Anyhow, the thing had failed, and no one in England, so far as he knew, was using any intermediate receiver between the blast furnace and the converters.'

This defense presents the common instance of a patent which attracted no attention, and was commercially a failure, being set up as an anticipation of a subsequent patent which has proved a success, because there appears to be in the mechanism [185 U.S. 403, 422] described a possibility of its having been, with some alterations, adaptable to the process thereafter discovered. As hereinafter observed, a process patent can only be anticipated by a similar process. It is not sufficient to show a piece of mechanism by which the process might have been performed.

In the American patents to Durfee, Nos. 118,597 and 122,312, both of 1871, the desirableness of manufacturing steel directly from the blast furnace is recognized, and in his second patent he says: 'That 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 practised 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 practised, 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.'

He proposed to accomplish this by using a reverbatory gas furnace, into which the crude iron from the blast furnace is poured, and in which it may be mixed with other irons, and so treated as to insure uniformity. Pig iron of different qualities, or any metals or metalloids or fluxes, can be added and mixed with the metal as may be necessary to bring it to the required character. The process is so manifestly different from that described by Jones that it demands no further attention. if it were put in practice at all, it seems to have proved a failure, as, although an English patent was taken out by Durfee, it was allowed to lapse by reason of the nonpayment of the stamp duty. [185 U.S. 403, 423] Two American patents to James P. Witherow, No. 315,587 and No. 327, 425, both issued in 1885, are pressed upon our attention. In the second patent, the only one necessary to notice, he restates the advantages of the direct process and the difficulties theretofore encountered in its practical operation. 'In the manufacture of steel by the pneumatic process, the converters are charged with molten metal, the product of the blast furnace. This metal is usually cast in the form of pigs, then remelted in the cupola as needed, before being charged into the converter. . . . It is very desirable to take advantage of the molten condition of the metal as it comes from the blast furnace for its use in the converter, because thereby the remelting of the metal and the expense of the construction of a cupola may be avoided. The charge of the converter is from one to five tons, and the casting of a blast furnace runs usually from ten to fifty tons. The difficulty of using the molten metal from the furnace to the converter consists in keeping the large quantity of metal from the latter in a proper molten condition for use in the former.' He proposed to remedy this by a reservoir provided with a suitable cover and with tuyeres 'which blow down upon the surface of the metal for the purpose of maintaining its heat and fluidity.' As this reservoir was apparently adapted to hold a single cast, and therefore must be emptied before another cast was received into it, it was impossible that Witherow intended by its use to practise the Jones process. There is no suggestion anywhere in the patent of a desire to retain a quantity of metal in the reservoir to serve as a basis for mixing the various products of the blast furnace, which was the dominant idea of the Jones patent. To anticipate a process patent, it is necessary not only to show that the prior patent might have been used to carry out the process, but that such use was contemplated, or that the leading idea of the Jones patent of maintaining a dominant pool in the reservoir was such a use of the Witherow patents as would have occurred to an ordinary mechanic in operating his device. Whether the reservoir in the Witherow patent was partly or fully emptied seems to have been a matter of complete indifference to the inventor, and the idea of maintaining a constant quantity therein seems to have [185 U.S. 403, 424] never been conceived by him. His design seems to have been merely to provide a reservoir for the storage of the large quantity of metal from the blast furnaces, and to maintain its heat until the comparatively small quantities required in the converters had been drawn off for use. As he states in his specification: 'The metal is usually tapped from a blast furnace once in every six hours, and the quantity thus cast is many times in excess of the charge of a converter,' which 'is from one to five tons,' while 'the cast of a blast furnace runs usually from ten to fifty tons.' While the metal is tapped from the blast furnace once in every six hours, 'the time between charges in the converter is usually twenty minutes and upwards, and the metal in the furnace must be kept in condition to be tapped from time to time into the converter as needed.' This appears to have been the whole object of the invention.

The same remark may be made of all these prior devices. While all contemplate the reservoir between the blast furnaces and the converters, such reservoir is used for storage and for such incidental steps toward uniformity as the necessary mixing of the different products of the blast furnace would lead to, while in none of them is there a provision for supplying and withdrawing from the mixer such quantities of metal at a time and the retention of a considerable quantity of metal in the reservoir as a necessary prerequisite to that uniformity of product which was recognized as the great desideratum, and was the constant effort of manufacturers to secure. Granting that some of these devices may have been made use of to carry out the Jones process, none of them in practical operation seems to have been effective to secure the desired result. A process patent, such as that of Jones, is not anticipated by mechanism which might with slight alterations have been adapted to carry out that process, unless, at least, such use of it would have occurred to one whose duty it was to make practical use of the mechanism described. In other words, a process patent can only be anticipated by a similar process. A mechanical patent is anticipated by a prior device of like construction and capable of performing the same function; but it is otherwise with a process patent. The mere possession of an instrument or piece [185 U.S. 403, 425] of mechanism contains no suggestion

whatever of all the possible processes to which it may be adapted. New Process Fermentation Co. v. Maus, 122 U.S. 413, 428 , 30 S. L. ed. 1193, 1198, 7 Sup. Ct. Rep. 1304. If the mere fact that a prior device might be made effective for the carrying on of a particular process were sufficient to anticipate such process, the absurd result would follow that, if the process consisted merely of manipulation, it would be anticipated by the mere possession of a pair of hands.

True, if the process were the mere function of a machine, another machine capable of performing the same function might be an anticipation; but this is not because a process can be anticipated by a mechanism, but because, as we have held in several cases, the mere function of a machine is not patentable as a process at all. Corning v. Burden, 15 How. 252, 14 L. ed. 683; Risdon Iron & Locomotive Works v. Medart, 158 U.S. 68 , 39 L. ed. 899, 15 Sup. Ct. Rep. 745.

To enable the Jones process to be successfully carried out it is necessary (1) that the intermediate reservoir or mixer should be of large size, 'say, 100 tons' capacity; (2) that it be covered to prevent the access of cold air from without; (3) that it be provided with a stop, so that it may not be tilted so far as to be emptied of its contends; (4) that a quantity of molten metal so large as to absorb all the variations of the product of the blast furnace received into it and thus to unify the metals discharged into the converters, be constantly retained in it. None of the prior patents or processes to which we are referred meets these requirements. Indeed, it is scarcely too much to say that none meets more than one of them. When we add to this that none of them was ever used, or was ever susceptible of being used, without material alteration, to carry out the Jones process, it is evident that the defense of anticipation by prior patents rests upon a slender foundation.

Certain discussions, reported in the Journal of the British Iron and Steel Institute, are relied upon as embodying a description of the Jones process. Running through all these discussions there is the same idea of the difficulties experienced in the practical carrying out of the direct process by reason of the want of uniformity in the different products of the blast furnaces, and the possibility of remedying this and [185 U.S. 403, 426] thereby doing away with the expense of remelting the pig iron in cupolas by a mixture of such products in a reservoir intermediate the furnaces and the converters; but the dominant idea of the Jones patent, of maintaining a permanent and large quantity of molten metal in the mixer for that purpose, does not seem to have occurred to any of the writers upon the subject. Through all these papers there is an admission of practical failure in the efforts theretofore made to obviate the difficulty, and a half-expressed hope that American ingenuity might ultimately solve the problem. Some of the expressions, taken by themselves, seem to foreshadow the Jones idea; but there was nothing in any of these discussions that filled the requirement of the law (Rev. Stat. 4886) of a description in a publication sufficient to anticipate the patent.

In some of the very works where attempts had been made to adopt a direct process they were abandoned as unprofitable, and the Jones invention subsequently adopted. The witness David Evans, manager of certain iron works in England and Wales, sums up his testimony in the following answer: 'Prior to the invention of Captain Jones several firms used the direct process, but the results were not very satisfactory, as explained before, through want of uniformity. The results obtained gave a large number of defectives. But since the adoption of the mixer at the various works I have been engaged, we have reduced the defective or second- class rails fully one half, and also saved the remelting.' Indeed, it is stated by several of these writers that the adoption of the Jones invention reduced the defective rails to something like half of what they were before.

Out attention is also challenged to certain unpatented practices, among which is one known as the Whitney foundry practice for the casting of car wheels, wherein the metal is tapped from three cupolas into an open reservoir of eight to ten tons' capacity, permitted to mix and even up in it, and the charges withdrawn to be cast into car wheels, the reservoir being maintained half full. The practice was to run the metal from the cupola furnaces into the reservoir ladle until it was nearly full, then to begin pouring out charges into the casting ladles, while [185 U.S. 403, 427] still continuing to pour metal into the ladle from the furnaces, the ladle being kept approximately full during the working day, when it was emptied and refilled on the following day. Aside from the fact that this process has only to do with cupola metal, uniformity in which was largely secured by a careful selection of the pig iron charged into the cupola furnaces, and had no reference whatever to the direct process of charging converters with the product of

blast furnaces, it appears that, while Whitney recognized the fact that the charges of iron from the cupolas, when run together into the ladle, would mix, it appears that with this running together of the different charges the mixing operation ended. The maintenance of a permanent pool, and the constant pouring in and out in ladlefuls,-the essence of the Jones invention,-had nothing to do with the process. Indeed, it may be doubted whether the mixing of the cupola metal was of any substantial value. Evidently it suggested to no one the Jones process. It is now too late to insist that it would have been suggested to any mechanic of ordinary skill and intelligence. But if the Whitney practice were primarily for the purpose of mixing, and were adequate for that purpose when applied to cupola metal carefully selected beforehand, it might be, and evidently would have been, wholly inefficient when used for the purpose of unifying the products of blast furnaces,-in other words, for the Jones process; and it might and did require invention to make such changes as were necessary to adapt it to such purpose. Doubtless there was such mixing as the carefully selected cupola metal required for the purpose of manufacturing car wheels, but the fact that the Whitney practice was used for cupola metal has but little tendency to prove that it was adaptable without change to metal tapped from blast furnaces, which varied so largely in chemical composition.

The following observations of the District Judge are illustrative of the distinction between the Whitney foundry practice and the Jones process:

'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; [185 U.S. 403, 428] Jones's 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.'
It should be borne in mind throughout the whole of this discussion that Jones never claimed to have succeeded in making a perfectly uniform product; that his object was to procure a uniformity which was adequate for the complete carrying on of the Bessemer process, or, as his second claim states, 'for further treatment,' and really to obviate the necessity of remelting the pigs, which had heretofore been regarded as preliminary to the further treatment by the Bessemer process.

Substantially the same remarks may be made with regard to the Kirk publication, which had to do only with the mixing of cupola metal. This publication was first held by the Patent Office to be an anticipation of the Jones process, the application for which was rejected upon that ground. Upon further consideration, however, and with some slight amendments, the application of Jones appears to have been reconsidered, and was finally granted. [185 U.S. 403, 429] An attempt was made to show that the Jones invention was anticipated by a practice, common in steel works prior thereto, of tapping iron from cupola furnaces into a receiving ladle, which became known as the Bassemer cupola ladle, from which it was poured into the converters. Molton iron was tapped from several cupolas into this ladle, from which a charge was drawn and delivered to the converter vessel. Of course, if the ladle were of greater capacity than was necessary to charge a single converter, a residuum of metal would be left in it; but this seems to have been merely an incident of the operation of the ladle, which was used primarily for storage, and to have been of no substantial benefit in securing uniformity of product, which can only be obtained by making the receiver of larger size, and retaining a considerable quantity of metal in it after each discharge. The witness Kennedy says of this process:

'The irons were carefully selected from the different piles to make up the cupola charges. . . . I have often seen the ladle drained in pouring into the converter. . . . It did not hold two full charges. . . . I never knew

of the ladle being used for mixing purposes. If such was the practice I would have known 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 . . . . Q. 18. When was this ladle drained, and when would there be some metal left in the handle?-A. There would be no regularity in the process. The rate at which the converters take the metal does not always correspond with the rate at which the cupolas are melting.'
It is true the Jones patent is a simple one, and in the light of present experience it seems strange that none of the expert steel makers, who approached so near the consummation of their desires, should have failed to take the final step which was needed to convert their experiments into an assured success. This, however, is but the common history of important inventions, the simplicity of which seems to the ordinary observer to preclude the possibility of their involving an exercise of the inventive faculty. The very fact that the attempt which had been made to secure a uniformity of product seems to have been abandoned [185 U.S. 403, 430] after the Jones invention came into popular notice is strong evidence tending to show that this patent contains something which was of great value to the manufacturers of steel, and which entitled Jones to the reward due to a successful inventor.

2. The phraseology of the patent and the amendments introduced in the Patent Office are made the subject of much criticism, apparently for the purpose of showing either that Jones did not understand what he had invented, or that the specification did not contain 'such full, clear, concise, and exact terms as to enable any person skilled in the art . . . to make, construct, compound, and use the same.' Rev. Stat. 4888. If these criticisms are not altogether clear, they are pressed upon our consideration with an earnestness which challenges a careful consideration of the history of this patent in the Patent Office.

In his first application the patentee stated that 'the primary object of the invention is to provide means for insuring uniformity in the product of a Bessemer steel works or a similar plant, in which the metal from more than one blast furnace is employed to charge the converters. The product of the different furnaces, or of the same furnace at different times, varies in quality, . . . so that . . . the manufactured steel lacks uniformity in grade. To avoid this I employ suitably constructed reservoirs or vessels, into which the molten metal from the blast furnaces is put, the vessels being of proper capacity to hold a considerable charge of metal from a single furnace, or from a number of furnaces, and being adapted to retain the metal in a molten state for sufficient time to enable the different charges to mix and become homogeneous. . . . Such apparatus possesses also an additional advantage in that it makes it possible to dispense with cupola furnaces for remelting the pigs preparatory to charging the converters. The metal may be tapped from the blast furnace into ladles or trucks, carried to and discharged into the mixing reservoir or vessel, and there retained in a molten state until sufficient metal has been accumulated to charge the converters.'

It is true that he subsequently states, as observed in the opinion of the court of appeals, that 'the main feature of my present [185 U.S. 403, 431] invention is the method of storing successive charges of molten metal in a receptacle before using it in converters or otherwise;' and hence it is insisted that the main feature of the invention was storage and not mixing; but the subsequent words of the same sentence, 'drawing portions of the metal from the receptacle without at any time removing the whole thereof, and from time to time replenishing the receptacle with fresh charges, which mingle with the residual molten metal already therein, for the purpose of rendering the successive tappings of metal uniform in quality,'-convey a wholly different impression, and show that the primary object was that of mixing different charges for the purpose of securing uniformity in the metal when discharged into the converters. This appears still plainer in the claim appended to this specification: 'The process hereinbefore described, which consists in storing charges of molten metal in a covered receptacle provided with a heat-retaining lining, removing portions only of the molten contents of the said receptacle, without entirely draining or emptying the same, and successively replenishing the receptacle with fresh additions of molten metal, whereby the character of the several charges of metal so treated is equalized; substantially as described.' The word 'storing' was evidently used in the sense of pouring the metal into the reservoir or mixer, as essential to the maintenance of a dominant pool therein. The application was evidently considered as not sufficiently differentiating this from former patents, and was rejected upon reference to the Witherow patents and to Kirk's Founding of Metals. Certain slight amendments were then made in the specification, the claim verbally changed, and an argument submitted to the effect that the purpose of the Witherow patent was 'to receive and store the molten metal for the purpose of preventing the detention, incident to

the necessity of discharging the contents of the blast furnace when there is no converter ready to receive it;' whereas the distinctive idea of the Jones patent was 'to have a receptacle capable of holding metal in a molten condition into which metal, it may be from several blast furnaces, is run from time to time, and from which metal is drawn for treatment in the converters, or otherwise as required.' [185 U.S. 403, 432] This was evidently considered as still too indefinite, and the application was thought to be fully met by the description in Kirk's Founding of Metals, and was rejected.

Thereupon the application was again amended, its present phraseology adopted, and the distinguishing feature of the invention more clearly set forth. Without further suggestion the application was allowed, and the patent issued.

It is true the process is described in the second claim as a 'method of mixing molten metal,' from which we are asked to infer that it was intended to include the products of cupola as well as of blast furnaces, whereas in the very first sentence of the specification it is stated that 'in practice it is found that metal tapped from different blast furnaces is apt to vary considerably in chemical composition. . . . Especially is this so in the process of refining crude iron 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 practised.' The first claim of the patent is expressly for an improvement in the art of refining iron directly from the smelting furnace. The second claim apparently extends to the art of mixing all molten metals, but the specification, taken in connection with the disclaimer, which describes a process designed to dispense with the use of cupolas, shows that it was intended to include metal tapped from blast furnaces, and was probably intended to be limited to that. Whether the claim would be void if construed to include cupola metal it is unnecessary to consider. It clearly includes metal from blast furnaces, and is not rendered void by the possibility of its including cupola metal. The claim of a patent must always be explained by and read in connection with the specification, and as this claim clearly includes metal taken from blast furnaces, the question whether it includes every molten metal is as much eliminated from our consideration in this case as if it were sought to show that the word 'metal' might include other metals than iron. Were infringement charged in the use of an apparatus for mixing cupola metal, the question would be squarely presented whether the claim had been illegally expanded beyond the specification. [185 U.S. 403, 433] Much ingenuity and many words have been expended in an endeavor to prove that the plaintiff and defendant, as well as the courts, differed widely in their construction of the patent and of what Jones was trying to accomplish. Upon the theory of the defendant the circuit court 'did not attempt to construe the patent in any proper sense, but bent all its energies to wrest and torture the plain English of the patent into a meaning diametrically opposed to that which it bears on its face,' and to make it appear that the great trouble at the time Mr. Jones conceived his invention arose, not from any lack of uniformity in the percentages of silicon and sulphur, but were solely the natural difficulties incident to abrupt variations in the percentage of silicon present; and that his statement that the trouble in the Bessemerizing operation, which was the thing Jones had in mind to obviate, was absolutely irreconciable with the specification of the patent, because the sole object stated by Jones was to secure products, whether of Bessemer steel or otherwise, which would be practically homogeneous and substantially uniform in their contained sulphur and silicon,-results which can only be obtained by mixing the iron to a substantial uniformity. Defendant further states its view of the case as follows:

'If, as a matter of fact, Mr. Jones, at the time he applied for his patent, had in view not only the process described by him for securing uniformity in the admixture of silicon and sulphur, but also another process, similar to that now used by the plaintiff and defendant, and by means of which the operation of Bessemerizing iron was made, . . . without securing uniformity in the product, then . . . it is manifestly clear from his patent and from all the surrounding facts that he deliberately and carefully suppressed any disclosure of this invention in his specification.'
One of the arguments that this was the case was that if Jones 'believed the method of use by which abrupt variations in silicon could be avoided without securing uniformity in product to be a patentable invention, there was even more reason for carefully suppressing all suggestion of such a mode of use in the patent for the manipulation to obtain uniform products, because the two processes are obviously alternative and inconsistent with [185 U.S. 403, 434] each other, incapable of being claimed in one application, and therefore disclosure might have worked a loss of a possible grant of the patent for the alternative mode of use.'

It is true that its construction of the patent was pressed upon the courts by the defendant with great earnestness and elaborateness of detail, and appears to have created an impression of its soundness upon the circuit court of appeals, but the circuit court did not seem to look upon it as the turning point of the case, nor do we regard it as at all decisive. It seems to assume that the second claim can only be met by evidence of absolute uniformity of product, whereas all that is claimed is a uniformity in the constituent parts of molten metal preparatory to further treatment; in other words, to make it fit for further treatment in the converters, without the necessity of remelting in the cupolar furnaces. Or, as stated by the district judge: 'It is therefore plain that with a mixer thus operated it is possible to have wide variations in the composition of the blastfurnace 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.'

With regard to this portion of the opinion, counsel for defendant observes:

'The judge of circuit court, having lost sight of the statutory requirements as to a full, clear, and concise statement of the invention, and having persuaded himself that it was his judicial duty to find a way if possible to protect the Carnegie Company in his monopoly of what Mr. Gayley and his colleagues claim ought to have been the invention described in the patent, adopted the ingenious view that the patent was to be construed as though it disclosed and covered two inventions, one having for its object to obtain a product substantially uniform in its contained silicon and sulphur, and the other having for its object the improvement in the operation of Bessemerizing iron which is incident to an avoidance in the successive charges of abrupt variations in contained silicon.' [185 U.S. 403, 435] We have not, however, been able to persuade ourselves that the two processes are so alternative and inconsistent with each other as to render them mutually destructive, or to justify counsel in charging the district judge with an abdication of his judicial duty of deciding the case according to what he believed to be the law and the facts. We dismiss the subject with the simple observation that much more seems to have been made of it than it deserves, and that a reference to the second claim shows its object was to secure uniformity of the molten metal in its constituent parts preparatory to its further treatment, by which further treatment we are to understand the Bessemerizing process of converting metal into steel, and that any step in that direction would necessarily lead to an avoidance of abrupt variations in silicon and sulphur, while such avoidance of abrupt variations would in their turn only tend toward a greater uniformity of product.
Some criticism was made upon the action of the court in permitting a disclaimer of certain clauses in the specification, printed above in italics, which was made after the argument and upon the petition of the plaintiff, 'that at the hearing of this cause it was taken by surprise by the argument of the defendant that the portions of the specification now disclaimed enlarged the scope of the invention of the said letters patent beyond what your petitioner believes to be the import of the claims thereof.' Upon the hearing defendant seems to have insisted that certain portions of the specifications were broader than the second claim. Those parts of the specification therefore were disclaimed. As we had occasion to observe in Sessions v. Romadka, 145 U.S. 29 , 36 L. ed. 609, 12 Sup. Ct. Rep. 799, '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.' In that case the plaintiff was permitted to enter a disclaimer of all the claims but the one in suit, the patentee having included in the patent more devices than properly could be the subject of a single patent. In the case under consideration the disclaimer was not of a claim but of certain statements in the specification, which if retained might be construed to have the effect of illegally broadening the second claim. The first statement disclaimed [185 U.S. 403, 436] was that the invention might be practised by merely receiving a number of small portions of metal taken from different ladles, the mixing being performed merely by the act of pouring into the charging ladle. The use of the word 'merely' ignored the steps embodied in the second claim, where the mixing is not performed by merely pouring together the several charges into a ladle, but by maintaining a permanent quantity of metal in the reservoir, to which charges were alternately added and from which they were withdrawn. The other clauses were intended to disclaim the casting of the metal into pigs. We think there is no force in the criticism that a disclaimer may not extend to a part of the specification, as well as to a distinct claim. Hurlbut v. Schillinger, 130 U.S. 456 , 32 L. ed. 1011, 9 Sup. Ct. Rep. 584; Schillinger v. Gunther, 17 Blatchf. 66, Fed. Cas. No. 12,458; Schwartzwalder v. New York Filter Co. 13 C. C. A. 380, 26 U. S. App. 547, 66 Fed. 152. Had the purpose of the disclaimer been to reform or alter the description of the invention, or convert the claim from one thing

into something else, it might have been objectionable, as patents can only be amended for mistakes of this kind by a reissue. But the disclaimer in this case appears to have been made to obviate an ambiguity in the specification, and with no idea of obtaining the benefit of a reissue. If the clauses had the effect of broadening the patent the disclaimer removes the objection. If they did not, the disclaimer could do no harm, and cannot be made the subject of criticism.

It is insisted, too, that there is no mention in the second claim of a dominant pool, and that the words '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,' are satisfied by leaving a quantity of iron, however small, in the reservoir, and that it really includes nothing that was not well known before. It is true that neither the size of the reservoir nor the amount of metal to be left therein, after each discharge is made into the converter, is specified; but it is stated in the specification that this reservoir may be of any convenient size, 'holding, say, 100 tons of metal (more or less),' with the bottom of the discharge spout some distance above the bottom [185 U.S. 403, 437] of the vessel, 'say, 2 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.' Though the size of the reservoir and the considerable quantity left therein as a dominant pool might have been described more definitely (but perhaps at the risk of an infringement being avoided by one using a receiver of a different size containing a different quantity), we think it is impossible to read this patent without gathering from it the dominant idea of Jones not to describe a reservoir for storage, with or without incidental mixing, but to provide a receptacle the main, if not the sole, object of which is to preserve therein a large and constant quantity of molten iron as a basis for a gradual unification of the product of several blast furnaces, or of several casts from the same furnace, and herein distinguishing it from all prior inventions. The specification of the patent is not addressed to lawyers, or even to the public generally, but to the manufacturers of steel; and any description which is sufficient to apprise them in the language of the art of the definite feature of the invention, and to serve as a warning to others of what the patent claims as a monopoly, is sufficiently definite to sustain the patent. He may assume that what was already known in the art of manufacturing steel was known to them, and, as observed by Mr. Justice Bradley in Webster Loom Co. v. Higgins, 105 U.S. 580, 586 , 26 S. L. ed. 1177, 1179, 'he may begin at the point where his invention begins, and describe what he has made that is new, and what it replaces of the old. That which is common and well known is as if it were written out in the patent and delineated in the drawings.' We think this second claim not only describes with sufficient clearness the purpose of the patent to secure uniformity of the molten metal in its constituent parts preparatory to further treatment, but, read with the specification, sufficiently describes the process by which this uniformity may be secured by always preserving in the reservoir a sufficient quantity of molten metal to secure such uniformity [185 U.S. 403, 438] of product. It is undoubtedly true that the storage feature appeared more prominently in the specification which was first rejected upon the ground that it was not sufficiently differentiated from prior patents than in that which was finally accepted, but there is nothing to indicate that Jones did not understand from the first that the distinguishing feature of his invention was the preservation of a considerable quantity of iron in the reservoir.

3. The question of infringement only remains to be considered, and, in the view we have taken of the prior devices, presents no serious difficulty. The court of appeals was of opinion that 'the defendant's reservoir, or accumulating ladle, complained of, is the same in principle as one which has been in use at the Cambria works ever since Bessemer steel was first manufactured there, with only this difference, that at first it was used at cupola, now at furnace.' If such were the fact, of course defendant would not be open to the charge of infringement. Undoubtedly it has the right to make use of all prior devices, and particularly such as had been used at its own manufactory. In order to understand the device made use of by the defendant prior to the Jones invention, we reproduce herewith with two small but easily understood cuts, taken from its brief, showing the character of the ladle known as the Bessemer intermediate ladle, used by it and generally by all American mills manufacturing steel by the Bessemer process.

It appears elsewhere in the testimony that the intermediate reservoir or ladle was from fifteen to eighteen tons' capacity, and the converter from six to eight tons; that the molten metal [185 U.S. 403, 439] was tapped from the cupolas into the reservoir, and withdrawn for the converter, and as the intermediate ladle

held considerably more than the amount of metal necessary to charge a converter, there was some incidental mixing; but the main and perhaps the only purpose of the reservoir was for storage, and that if any quantity of metal were left in the reservoir it was by accident rather than by design. It will be noticed, too, that the reservoir was open at the top. It does not appear to have been made use of in carrying out what is known as the direct process, the difference being that the cupola practice furnished a metal for the Bessemer converter that was uniform in composition, or practically so, while the direct metal was largely variable in composition.

The testimony further shows that, after the installaton of the Jones mixer at the Edgar Thomson works, Mr. Morgan, the defendant's mechanical engineer, visited and inspected these works, and obtained information as to their practical operation, and was advised by the superintendent as to the location and proper size of the mixer and its contiguity to the converters. Mr. Morgan does not deny this conversation, although he qualifies it by saying that he thought the Jones apparatus had grave defects. Shortly after this visit, and in the latter part of 1895, defendant installed an apparatus of its own for the operation of the direct process, which is herewith produced upon a small scale and in comparison with the Jones process. It consisted of a covered refractory lined and turtle-shaped vessel of about

300 tons' capacity, arranged to tilt, and having a spout at either side for receiving and pouring out the metal. The metal was brought to the mixer and poured in at one end, and, [185 U.S. 403, 440] through a spout on the other side, was poured into a ladle, which supplied the Bessemer converters. The metal was supplied both from blast furnaces and cupolas, the former furnishing about two thirds, the latter about one third, of the metal used; but the metal from the cupola system was delivered by a ladle to the converter direct and not through the reservoir. The metal from the blast furnace entered the reservoir in about fifteen- ton ladle lots, and was withdrawn in approximately twelve-ton lots. The chief engineer of the company states that, 'in accordance with the natural way of using the reservoir, it is ordinarily kept well filled up.' That in the practical operation of the mixer or reservoir a large quantity of iron was retained for mixing purposes is evident from the fact that a chalk mark was made on the side of the mixer, which was not allowed to run below the floor, as a guide to the men who rotated or tilted the mixer, since, if the mark went below the floor and out of sight, they could not tell how much iron was left in the mixer. Under these instructions not to allow the chalk mark to go below the floor there was retained in the mixer about 175 tons of molten metal, amply sufficient for the purposes stated in the Jones patent. Its principle of construction was similar to that of the Jones mixer, and its operation identical. Indeed, defendant's engineer 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' of the Jones patent. We agree, in the opinion of the circuit court, that '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.'

If the contents of the mixer used by defendant were allowed [185 U.S. 403, 441] habitually to become empty in carrying out its process, there would be no infringement; but all the evidence contradicts this. In the Jones practice this cannot be done, since the mixer cannot be tilted beyond a certain point. In the defendant's mixer it can be done, but is not, since the operator is not allowed to tilt it beyond a certain point gauged by a chalk mark. This seems to be the only foundation for the charge so frequently reiterated, and in varying language, that the methods in use before the Jones process deprived that process of all novelty, and if novelty existed it was by reason of the varying modes of executing such methods; the inference from this being that, as the Jones method was old, it could only be treated as new because of the conduct of individuals in applying the method and their intentions, and that this reduces itself to the proposition that the Jones patent rests upon the mere intention of minds of persons. If we understand this argument correctly, it is that the prior method contemplated storing only, and the mixing was but an incident, while the Jones patent contemplates mixing as its main object and storage only as an incident.

This proposition that the application of this patent depends upon the individual intent of the operator overlooks the essential nature of a process patent. The directions and specifications of such a patent are addressed to those engaged and skilled in the art. It professes to disclose a method of procedure, not the particular instrumentality that may be employed. It may be, as suggested, that one person may, and in ignorance of the patented method, make use of a reservoir merely as such, and without any desire to avail himself of the patented process; but such a fact would not deprive the discoverer of the process of the protection of his patent. Such a supposed case might present a question of fact for a court or jury, and if it were made to appear that the party charged with infringement had, as in this case, changed the instrumentalities used by him after a new method had been disclosed, and particularly if he had for the first time used a special device necessary to that process, a jury might well refuse to believe and find that the defendant was only following the old methods of procedure, and not seeking to avail himself of the plaintiff's invention. [185 U.S. 403, 442] But we think the difference in the two processes may be illustrated by a very simple example: Let us imagine a reservoir containing, say, three quarts, and filled with one quart each of three liquids of different constituent parts, and withdrawn for further treatment at the rate of one or two quarts at a time. Necessarily there would be some incidental mixing, but it would occur at once that the main object of the reservoir was a retention of a sufficient quantity of the mixture to supply the receptacle for further treatment, and if no necessity existed for a longer retention of the liquid in the reservoir, it could be very quickly emptied by two discharges into the receiving vessel. Now, let us substitute for this reservoir a cask of, say, sixty quarts, into which the liquids of different constituent parts are poured in at one end from a multitude of receptacles, and discharged at the other end after remaining a certain time in the cask, and that this cask could not be tilted so far but what a quantity of liquid would be left within it amounting, say, to half its capacity. Now, if there be no distinction between these two operations there would be little left to the Jones process, the very vitality of which consists in the size of the cask relative to the ladles and the mixing of the various liquids poured into it before they are withdrawn.

If, as insisted by the defendant and found by the court of appeals, the reservoir now used is the same in principle as the one which had been in use at the Cambria Iron Works ever since the Bessemer steel was first manufactured there, and the same were adequate for the purposes of the direct process, why was any change made? Therein we think the court of appeals made its most serious error. The defendant had an unquestioned right to manufacture steel as it had been accustomed to do; but instead of that it abandons the Bessemer uncovered ladle of twelve to eighteen tons, and adopts a covered refractory lined reservoir of 300 tons' capacity, and makes use of it, not as before, for the storage of cupola metal, but for the mixing of Blast-furnace metal according to the direct process. This, too, was done immediately after Mr. Morgan's visit to plaintiff's works.

It is true that with the growth of the production of furnaces [185 U.S. 403, 443] from fifty tons a day in 1872 to four or five hundred tons in 1895 all apparatus would naturally be increased in size; but why was the open reservoir theretofore used for cupola metal provided with a cover and enlarged in its capacity from fifteen to three hundred tons-twentyfold- while the converter was little more than doubled in size? Why was it so operated that 175 tons were left in the mixer as a dominant pool, if no infringement were contemplated? In the face of these facts the question so earnestly pressed by the defendant, whether the 'method of mixing molten metal,' covered by the second claim, was one for securing a substantial homogeneous composition of metal, to the end of getting a practically uniform product, or was one simply for the purpose of preventing sudden variations in the compositions of successive small portions drawn from the reservoir, without attaining substantial uniformity, loses most of its significance. We do not know how the process can be better described than in the specification itself: 'To provide means for rendering the product of steel works uniform in chemical composition.' The variations in such composition are said to be 'particularly in silicon and sulphur,' and the process to be one of mixing, whereby the particles of metal 'are diffused or commingled thoroughly among each other, and the entire charge is practically homogeneous in composition, representing in each part 'an average of a variety of uniform constituent parts, all the charges of the converter from time to time will be substantially uniform.' This, denuded of all hypercriticism, is the object of the Jones invention, which seems to be the only one yet devised for carrying on what is known as the direct process. If it be true that this process cannot be carried on without infringing the Jones patent, he is certainly entitled to a monopoly of the invention. If it can be, then every method theretofore known for carrying on such process was open to the defendant. But

we think the change from the Bessemer intermediate ladle to the Jones mixer was a radical one, and was made for a purpose. That purpose was clearly the adoption of the Jones process.

It is true that before the facts were fully ascertained a stipulation was signed to the effect that the 'amount of molten [185 U.S. 403, 444] metal in said mixer (defendant's) varies from nothing to its full capacity, depending on the supply and demand, the supply being generally sufficient to keep the mixer more than half full of molten metal, which metal remains molten therein.' It appears, however, that upon the facts being more fully ascertained, notice was given that, in so far as the stipulation varied from the facts appearing in the testimony of defendant's expert, it would be repudiated, and particularly that portion wherein it was said 'that the amount of the molten metal in the mixer varies from nothing to its full capacity.' As it clearly appears from the mouths of defendant's own witnesses (notably Mr. Morgan) that, in the usual operation of the mixer, the ordinary amount of metal kept in the reservoir was more than one half its capacity, we think that plaintiff's case should not be prejudiced by this stipulation. Stipulations are ordinarily entered into for the purpose of saving time, trouble, or expense, and in this case it recites that 'as defendant's counsel is expected to sail for Europe in a few days, and may not be back for about four months, it is therefore stipulated by counsel for both parties, to save delay, as follows.' But while the stipulation is undoubtedly admissible in evidence it ought not to be used as a pitfall, and where the facts subsequently developed show, with respect to a particular matter, that it was inadvertently signed, we think that, upon giving notice in sufficient time to prevent prejudice to the opposite party, counsel may repudiate any fact inadvertently incorporated therein. This practice has been frequently upheld in this and other courts. The Hiram, 1 Wheat. 440, 4 L. ed. 131; Hurt v. Hollingsworth, 100 U.S. 100, 103 , 25 S. L. ed. 569, 570; Malin v. Kinney, 1 Cai. 117; Barry v. New York Mut. L. Ins. Co. 53 N. Y. 236.

In short, we are clearly of opinion that the reservoir now in use is used for entirely different purposes from the intermediate Bessemer ladle formerly employed; that the process carried on with it is identical with the Jones invention; and that its primary, if not its sole, use, is for mixing purposes, with necessarily incidental storage, while the Bessemer intermediate ladle was solely used for storage, with little, if any, thought of the advantages to be gained by an incidental mixing. [185 U.S. 403, 445] Discarding now all that does not bear directly upon the validity of the Jones patent, and dropping all superfluity of words, let us determine exactly what Jones has contributed, if anything, to the art of making steel. He undoubtedly found reservoirs of small size in use, in which were poured from receiving ladles enough molten metal to fill them, and from which a sufficient amount was discharged to supply a converter, usually about half the size of the reservoir. But in all these cases the fact whether any particular amount of metal was left in the reservoir was treated as a matter of indifference or accident, although there must have been necessarily some incidental mixing; and probably the metal as it ran into the converters approximated more nearly to uniformity than when it ran into the reservoir. The former methods were adequate for cupola metal, uniformity in which had been largely secured by a careful selection and breaking up of the pigs, but it had not proved a success for blast-furnace metal, except that it had been used to a very limited extent in foreign countries where the peculiar character of the iron ore had rendered it possible to carry on a direct process, although apparently by methods quite other than those employed by Jones. The principal step employed by Jones was to magnify the capacity of the reservoir about twentyfold, provide it with a cover, and to arrange that it should not be tilted beyond a certain point, in order that a 'considerable quantity' of molten metal might be retained in it for a sufficient time to accomplish a pretty thorough mixing, but little change having been made in the meantime in the size of the receiving ladles and converters. As the reservoir was designed to hold a large quantity of metal for a considerable time it must have been covered to obviate the contents being crusted over or sculled.

As soon as this method had proven to be successful by employment at the Edgar Thomson works, and had become so well known as to attract the attention of other manufacturers of steel, if found a ready sale, was adopted by all the leading manufacturers in this country, and was sold for use abroad for about $50,000.

It should be borne in mind that this process was one not [185 U.S. 403, 446] accidentally discovered, but was the result of a long search for the very purpose. The surprise is that the manufacturers of steel, having felt the want for so many years, should never have discovered from the multiplicity of patents and of processes introduced into this suit, and well known to the manufacturers of steel, that it was but a step from what they already knew to that which they had spent years in endeavoring to find out. It only

remains now for the wisdom which comes after the fact to teach us that Jones discovered nothing, invented nothing, accomplished nothing.

We cannot better conclude this opinion than by the following extract from the opinion of Mr. Justice Bradley in Webster Loom Co. v. Higgins, 105 U.S. 580, 591 , 26 S. L. ed. 1177, 1181: 'But it is plain from the evidence, and from the very fact that it was not sooner adopted and used, that it did not, for years, occur in this light to even the most skilful persons. It may have been under their very eyes; they may almost be said to have stumbled over it; but they certainly failed to see it, to estimate its value, and to bring it into notice. . . . Now that it has succeeded, it may seem very plain to anyone that he could have done it as well. This is often the case with inventions of the greatest merit. It may be laid down as a general rule, though perhaps not an invariable one, that if a new combination and arrangement of known elements produce a new and beneficial result, never attained before, it is evidence of invention.'

The decree of the Circuit Court of Appeals is therefore reversed, and the case remanded to the Circuit Court for the Western District of Pennsylvania for further proceedings consistent with this opinion.

Mr. Justice White, with whom concurs Mr. Chief Justice Fuller, Mr. Justice Harlan, and Mr. Justice Brewer, dissenting:

To elucidate the reasons which constrain me to dissent, it is deemed essential to give a mere outline of the processes by which iron and steel were made prior to June 4, 1889, when the patent in suit was issued, in so far as such processes in some aspects concern [185 U.S. 403, 447] the manufacture of steel by what is known as the Bessemer method, to which the court now declares the patent in suit solely relates.

Into the stack of a smelting furnace iron ore, with suitable fluxing material and fuel, was introduced. In the operation of the furnace the ore was reduced to a metallic state by the oxidizing action of carbon or gas containing carbon. This metallic iron melted in the lower part of the furnace, taking up a proportion of carbon and other ingredients, dropping to the bottom of the hearth as molten pig iron. The earthy impurities combined with the flux, and were also melted and descended into the hearth, resting upon the top of the molten metal. The molten metal was drawn from the hearth from time to time by tapping, and the molten impurities, combined with the flux, forming a cinder, were also drawn from the hearth at a higher level. As the molten iron was tapped it was run out into molds, and came to be known as pig iron or pigs. These pigs were not of uniform composition, because of the varying quantity of the constituents contained in the ore and the chemical changes wrought by irregularities incidental to the operation of the furnace.

To make foundry castings, pigs were selected, broken up, charged into a cupola furnace, reduced to a molten state, and the liquid was drawn off into a receiving ladle. From this the quantity desired was tipped into a smaller vessel known as a casting ladle, and was poured into the molds. Where more than one cupola furnace was employed, each was tapped, and the metal poured through a groove into a receiving ladle, common to the furnaces, where it was held for use, and drawn as required into a advantages may be obtained by casting already mentioned.

In 1855 and 1856 Sir Henry Bessmer obtained various patents covering his discovery for producing malleable iron and steel by forcing currents of air through molten iron. The appliance described was a refractory lined vessel, called by Bessmer a converting vessel, which came to be designated as the converter or the vessel. Without going into detail, it suffices to say that, for various reasons, the method of Sir Henry Bessemer [185 U.S. 403, 448] proved not to be as advantageous as had been expected. Indeed, it was not until Mushet patented a method of decarbonizing iron by completely blowing it and adding ferromanganese or speigel-eisen in a molten state that the difficulty of producing steel was solved and the process of Sir Henry Bessemer was rendered practical. Despite, however, the fact that Mushet's discovery was of immense value and rendered Bessemer's conceptions a commercial success, Mushet allowed his patent right to lapse through neglect to pay the requisite fees in the third year; and (to quote the language of the author of the article on Iron, contained in Encyclopoedia Britannica, 9th ed. vol. 13, p. 342) 'in consequence his name is all but forgotten in connection with his improvement on Bessemer's own process, the combination being ordinarily termed 'Bessemerizing."

In the manufacture of steel by the Bessemer-Mushet process two methods were followed, one termed the indirect, the other the direct. In the indirect, pigs were charged into a reverbatory furnace, for which, at a later date, a cupola furnace was substituted. In such furnace the pigs were melted and run into ladles or reservoirs, and thence the molten iron was conveyed to the converter for the necessary treatment. Without attempting to give accurately the variations in the size and consequent capacity of cupola furnaces and converters, it is unquestioned that the quantity of molten metal which could be drawn at a single tapping from the cupola was usually not adequate to supply a full charge to the converter. It followed that ordinarily more than one cupola furnace was used to supply a converter, and that the tappings from such cupolas were drawn into a common reservoir or ladle, and there stored until required to be carried to the converter. Indeed, irrespective of the necessity of storing the tappings, growing out of the difference between the capacities of the vessels in question, such storage was additionally required in order that the operation might be continuous, in case of delay resulting from accident to the converter or otherwise.

In the direct process the capacity of blast furnaces greatly exceeded that of cupola furnaces. The molten iron was tapped directly from the blast furnace into a number of receiving reservoirs or ladles, and carried for treatment to the converter. [185 U.S. 403, 449] On October 31, 1888, William R. Jones made application for two letters patent, one stated to be for a new and useful improvement in apparatus 'for mixing molten pig metal,' the other for a process declared to be 'a new and useful improvement in methods of mixing molten pig metal.' The application for the first or apparatus patent was several times rejected, and, after various amendments, was finally allowed. This patent may be dismissed from view, as it is not involved in this controversy. The first application for the process patent-which is the patent under consideration in this case-was rejected. Thereupon a new and amended application was presented. This was also rejected, when a second amendment was made, and the application was finally allowed.

As the opinion of the court has reproduced the specifications and claims of the patent, it is unnecessary to repeat them in detail, and therefore a mere outline of them is now given. The patent was entitled 'Method of Mixing Molten Pig Metal.' The primary object of the invention was stated to be 'to provide means for rendering the product of steel works uniform in chemical composition.' It was also stated that: 'My invention is not limited to its use in connection with converters, since similar advantages may be obtained by casting the metal from the mixing vessels into pigs for use in converters, puddling furnaces, or for any other uses to which pig iron may be put in the art.' It was further stated that: 'My invention may be practised with a variety of forms of apparatus,- for example, by merely receiving in a charging ladle a number of small portions of metal taken from several ladles or receiving vessels containing crude metal obtained at different times or from different furnaces, mixing being performed merely by the act of pouring into the charging ladle, and other like means may be employed.'

It was, however, declared that it was preferable to use the device covered by the apparatus patent, and a description of the same was set out. That device may be thus described: It consisted of a covered tilting tank of large size, 'holding, say, 100 tons of metal [more or less],' lined so as 'to retain the heat of the molten contents of the vessel and to pre- [185 U.S. 403, 450] vent chilling thereof,'with receiving and charging spouts, a gas-heating appliance contained in the discharging spout, and so constructed that, after being fully charged with molten metal, drawn from the furnaces into ladles and poured into the reservoir, as the metal was poured out for use a considerable residue would remain in the reservoir to mix with an incoming charge.

The patent embodied two claims which read as follows:

'1. In the art of refining iron directly from the smelting furnace, the process of equalizing the chemical composition of the crude metal by thoroughly commingling or mixing together the liquid metal charge and subsequently refining the mixed and equalized charge, substantially as and for the purposes described.
'2. 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 constitutents (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.'
On December 2, 1895, the Carnegie Steel Company, Limited, which had acquired full title to the Jones patents, commenced the present suit against the Cambria Iron Company for an alleged infringement of the foregoing process patent. The defenses made by the answer were substantially a denial of infringement and an averment of want of patentable novelty.

After the evidence for the defendant was all in and several witnesses had been examined in rebuttal, the complainant, on March 30, 1897, stated 'that at the hearing of the cause he will urge infringement of the second claim only of the patent in suit.' At the close of all the evidence the complainant filed what is termed a 'petition for disclaimer,' praying that the court would receive in evidence a certified copy of a disclaimer of portions of the specifications, which on that day had been sent to the Patent Office for filing. The trial court admitted the disclaimer in evidence. The portions of the specifications [185 U.S. 403, 451] covered by the disclaimer are printed in italics in the patent as reproduced in the opinion of the court. The disclaimer need not be further noticed at this time.

It was shown beyond question that in November, 1895, the defendant had erected at its works a reservoir of the capacity of about 300 tons, for the storage of molten metal drawn from its blast furnaces, the metal so stored being held in the reservoir for the purpose of treatment in the converters. This reservoir was described by a witness in the following condensed manner: 'It was cylindrical in shape, with slightly convex ends, and in turning [for the purpose of pouring out the metal] it revolves upon the center of the cylinder. It is supported upon cradles of rollers, and the motion is imparted to the reservoir by hydraulic cylinders.' As this cause, as already stated, does not involve the Jones apparatus patent, no question of infringement of the mechanical device embraced in such patent can possibly arise. In this reservoir the molten metal as tapped from the furnaces was stored continuously, and the reservoir was drawn upon with like continuity to supply molten metal for treatment in the converters. While it is not asserted that the use of the reservoir, as just stated, caused the metal stored therein to become uniform in its chemical constituents, it is conceded that the method pursued counteracted the inconvenience of sudden variations in the metal as drawn for converter purposes.

There is controversy, however, whether the defendant, in reservoiring its molten metal, irrespective of the supply and demand, intentionally retained in the reservoir a considerable residuum. From the view taken by me, however, it is unnecessary to pass on this contention, since the principles deemed by me applicable to the cause will be wholly unaffected, even if it be conceded that the defendant, in operating its reservoir, in filling it with molten metal, and in drawing the same off for use in the converter, designedly held in the reservoir a considerable residuum of molten metal in order that the metal which was subsequently charged into the reservoir might commingle with that retained.

The cause was decided by the circuit court in favor of the [185 U.S. 403, 452] complainant. The court held that the second claim of the patent referred alone to metal direct from the blast furnace intended to be Bessemerized in a converter, and that the object was, not the obtaining, by mixing, a molten metal substantially uniform in its chemical constituents, but the avoidance of abrupt variations between the various charges supplied to the converter. The patent was construed as not contemplating the mixing of batches of metal; that is, the filling up of the apparatus and a drawing down to a 'residue' before replenishing. The gist of the Jones idea was stated to be 'the creation and maintenance of a great pool of metal between the blast furnaces and converters, through which all the incoming and outgoing metal must pass,' by which means abrupt variations were prevented, although neither a uniform molten metal nor a uniform product was thereby obtainable. Indeed, the court said: 'In Jones, uniformity is a nonessential-in fact, a nonattainable-attribute of product, and is a necessary nonsequence of material used.'

While the court found that reservoiring was well known in the art at the time the Jones patent was obtained, and that mixing necessarily resulted from such reservoiring, it held that the Jones method was patentable, because the reservoiring known to the art contemplated storage, and not the prevention of abrupt variations; that although a mixing of the metals was of course the inevitable result of the reservoiring, such fact did not preclude the validity of the Jones patent, because prior to its grant the

mixing arising from reservoiring was incidental to storage, while under the Jones method the storage was incidental to the mixing. The court said:

'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.'

A decree was entered reciting that the patent in question was valid as to the second claim thereof; that the defendant, [185 U.S. 403, 453] 'by reason of the use of a certain method of mixing molten pig metal, as in the said complainant's bill set forth, has infringed the said recited letters patent as to the second claim thereof, and has violated the exclusive rights of the said complainant thereunder.' It was adjudged that recovery be had of the gains and profits made by the defendant and the damages sustained by complainant, and a master was appointed to ascertain the amount of such gains, profits, and damages. The defendant was, in general terms, enjoined from any further infringement of the second claim of the letters patent and of the exclusive rights of complainant thereunder.

An appeal was taken to the circuit court of appeals. That court held that the second claim of the patent did not cover the retention in reservoiring of a considerable residuum, even though the same was designated as a dominant pool, and if it did that the method was not patentable in view of the state of the art, and that the proceedings in the Patent Office demonstrated that this was in effect conceded by Jones. It was decided that the defendant had the right to reservoir its molten metal, and that its method of doing so did not infringe the patent. The court decided that the disclaimer was not warranted by the statute, but that in any event it was ineffective to alter the true meaning of the patent. Thereupon the decree of the circuit court was reversed.

This court now reverses the decree of the circuit court of appeals, adopts the views of the circuit court, and in effect affirms the decree of that court. The court expressly upholds the theory of a dominant pool, and decides that the Jones patent related, not to the obtaining of uniform molten metal by mixing in a reservoir, and a resultant uniform product, but solely to the procuring, by means of reservoiring, molten metal which would not abruptly vary in its chemical constituents when drawn from the reservoir for use in a converter. The opinion of this court now, as did that of the circuit court, expressly concedes that reservoiring of molten metal was well known in the art at the time the Jones patent was applied for, and that mixing was the inevitable result of such reservoiring; but it is decided that this fact did not operate to deprive the Jones [185 U.S. 403, 454] method of novelty or to relieve the defendant from the charge of infringement.

My mind is unable to assent to the construction which the court affixes to the patent, and as it is conceded that the method used by the defendant does not infringe unless the patent has the import which the court has given to it, the reasons for my dissent would perhaps be most directly made manifest by stating what seems to me to be the true construction of the patent. Doing so, however, is for the moment pretermitted, for two reasons: 1. Because to my mind it seems that even if it be granted, arguendo, that the patent is susceptible of the construction which the court has placed upon it, on the face of the opinion, the conclusion reached is wrong; in other words, the opinion of the court to me seems self-destructive. 2. Because if the concession of the court be accepted, that reservoiring and mixing were well known in the art, then it follows, from a consideration of the record, that the patent, as construed by the court, was wanting in patentable novelty. That is to say, if the admissions of fact made in the opinion of the court are right, its conclusion is demonstrated by the record to be unsound.

Let me briefly advert to the opinions of this court and of the circuit court, to point out the reasons which constrain to the first proposition just stated. The circuit court concluded that the reservoiring of molten metal from cupola and blast furnaces for use in casting or in converters was well known to the art at the time the Jones patent was applied for. It also declared as follows: '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 this was held not to establish that at the time the Jones method was patented that method as now construed was known to the art or had been anticipated, because, in the prior practice, the mixing

'was accidental, eccentric, and nonsystematic, and therefore not of a systematic, regular, functional type, or for a systematic, functional purpose;' that such mixing was incidental to storage, while in [185 U.S. 403, 455] the Jones method storage was incidental to mixing. This court approvingly adopts and elaborately restates these views.

Now, my reason does not enable me to conceive how, consistently with the view of the prior state of the art as to mixing and reservoiring which is admitted, the conclusion as to the patentability of the Jones method as construed can be sustained.

It would seem to be beyond question that, as it is held that the mixing resulting from the storage as practised prior to the grant of the Jones patent was the resultant, as stated, of a well-known law of nature, it must follow that the qualifying words 'accidental, eccentric, nonsystematic, and functional type or purpose' could only relate to the conduct of the persons who practised the method prior to the Jones patent. This must be unless it can be said that a well-known law of nature was accidental, eccentric, nonsystematic, and nonfunctional. The qualifications, then, applying, not to the law of nature, but to the conduct of parties, the reasoning must come to this: Although the method attributed to the Jones patent was well known to the art at the time that patent was issued, and hence it was intrinsically wanting in patentable novelty, nevertheless such method must be held to have embodied invention because the well-known practice was carried out by individuals in a varying and irregular manner. But this is only to say that while the Jones method was old, it must be treated as new because of the conduct of individuals in applying the method and their intentions. And this reduces itself to the proposition that the Jones patent as construed covered the mere intention or mind of persons. The reasoning is equally applicable to the distinction which is asserted to exist between storing and the mixing incidental thereto, and mixing with incidental storage. The mere form of expression cannot create a distinction where none exists, or destroy a law of nature. As by me it cannot be conceived that various charges of molten metal can be stored in a common reservoir without resulting mixing, it follows necessarily, by the law of diffusion of fluids, the mixing is the secondary result arising from and created by the primary act of storage. It is impossible that the secondary force can be caused to become [185 U.S. 403, 456] the first and creating power by a mere collocation of words. If, then, the distinction has significance, as of course it must have, since the court makes it the basis of its decision, it can only mean this, that those who practised the reservoiring of molten metal before the grant of the Jones patent mainly contemplated storage, and did not in their minds take into view the inevitable mixing which would arise therefrom by a law of nature; therefore, in the minds of the person so reservoiring, the storage was the primary, and the mixing the incidental, consequence. But, on the contrary, as those reservoiring metal after the Jones patent must be considered to have contemplated, first, the advantages resulting from mixing, therefore, in their minds, the mixing is the principal and the storage the accessory. But this is only again to say that while the Jones method was old it is to be treated as new because it covered the intention of those who stored metal for the purpose of use.

Aside from this, it seems to me the concession that the placing of molten metal in a reservoir for use as required was well known at the time the Jones patent was issued is inconsistent with the ruling now made, that the Jones patent validly embraced the retention in a reservoir of a mass of such metal, now described by the court as a dominant pool. The elementary import of the right to reservoir, as applied, not only to molten metal, but other fluids, is the storing of the fluid for use as required, and this implies the drawing off as desired, the replenishing at will, and the keeping of such residuum or reserve supply as may be deemed best. It may not be doubted that to say that one who stores fluid for use is obliged, whenever he draws any off, to draw all off before replenishing, is to say that such party has not the right to reservoir. If it be meant by the court that the right to reservoir carries with it the right to draw off or to retain at will, unless the person reservoiring intends to retain a residuum for a particular purpose, the reasoning redeces itself again to the proposition that the Jones patent covers, not the process described therein, but the mind and intention of the individual who may exercise the right to reservoir molten metal. That is to say, my reason does not enable me to understand how the right to reservoir can be admitted, [185 U.S. 403, 457] and yet such right be at once denied by a construction of the patent which imposes qualifications on the right to reservoir, which, in effect, renders its beneficial exercise impossible. In other words, I fail to see how the exclusive right can be conferred to do the very thing which the court admits was well known at the time the patent to Jones was issued. The conflict which my mind perceives between the facts admitted upon the face of the opinion and its conclusion is expressly pointed out by the

opinion itself, where it is said: 'If the contents of the mixer used by the defendant were allowed habitually to become empty in carrying out its process there would be no infringement.' That is, if in the use of its reservoir the defendant did not habitually retain a residuum there would be no infringement. But the admission that the occasional use of a residue would be no infringement concedes that the patent did not embrace the right to use a residue, for if it was covered by the patent it would be an infringement to avail of it even occasionally. Thus it must follow that the exclusive right which the court upholds is expressly declared to relate, not to the process, but to the mere habit of the defendant.

For the purpose of demonstrating the second proposition previously adverted to, let me now recur to the state of the art as depicted by the record, in order to point out that even if the Jones patent embodied the process which the court now attributes to it, that process was wanting in patentable novelty. In doing this, for convenience, the subject is thus divided: (a) The use of molten metal drawn from cupolas for foundry purposes, before the invention of Bessemer, as well as the foundry practice and the Bessemerizing practice by the indirect process after such invention and before the grant of the Jones patent; (b) the direct process of making steel from blast-furnace metal prior to the grant of the Jones patent.

Foundry and Indirect Bessemer Practice Before the Grant of the Jones Patent.

1. The Whitney-Car-Wheel Practice: At the Whitney car-wheel works in Philadelphia, commencing in 1847, remelted pig metal from several cupola furnaces was tapped at intervals [185 U.S. 403, 458] into a large reservoir ladle having a capacity of from twelve to fifteen tons. From this the molten metal was poured into charging ladles having a capacity of but 600 pounds. A considerable residue was always maintained in the reservoir ladle. The principal purpose, as testified to by witnesses having personal knowledge of the subject, was to secure, as a consequence of the mixing resulting from the reservoiring, the production of a practically uniform product. Excerpts from the testimony of John R. Whitney contain a clear statement on the subject:

'When the [large] 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 size wheel it held 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 in 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 molten state in the large ladle. ... * *

'As the mixture [of selected iron] 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 wheel 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.'

2. The Wheeling Foundry Practice: Kirk on Founding of Metals, 1875, thus described a foundry practice (italics not in original): [185 U.S. 403, 459] 'In melting iron I should recommend melting it hot, and as fast as possible. 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 a large ladle. I think this is a good way of mixing iron. See alloys.'

3. The Altoona Practice: At the Altoona wheel works of the Pennsylvania railroad, from 1871, the cupola metal was designedly stored and mixed. The early reservoir ladle, of seven tons' capacity, received the metal from two cupolas, and we thus described:

'A. The ladle turns on two trunnions, and has chains leading from these trunnions down to the hydraulic cylinder shown on the drawing, one chain being wound in one direction on one trunnion and other being would in the other direction on the other trunnion, and the two chains being connected at opposite ends of the piston rod.'
In describing the regular way of working each day the witness said (italics not in original):

'It the first place each cupola is charged with about forty tons of metal. We charged about forty tons in each cupola; then after we have this done we put the blast on and begin to melt, and as soon as ever the bed in the cupola is filled up with molten metal we tap it out into the receiving ladle or reservoir, which fills the reservoir about one-half full, then we stop the cupolas up again until the iron raises to the eyeholes, then they are tapped again, and this second tap generally fills the reservoir; then after the reservoir is full, we begin to pour the metal out into smaller ladles, then send it around to the molders for pouring into the wheel molds.
... * *

'The custom was to empty the receiving ladle about one half; then hold the remainder of iron in the reservoir until the cupolas [185 U.S. 403, 460] were ready to be tapped again; and after the reservoir is full we start and pour out into the smaller ladles again. The receiving ladle at all times is kept about one-half full, and it is this full when we tap the metal into it from the cupola.'
In the London Engineering for 1877, describing the practice pursued at Altoona, when a ten-ton receiving ladle was used, it was said: 'It was found advisable to employ a ladle of so large a capacity, because by doing so a more complete mixture of the different irons is effected than would be the case if a smaller vessel were employed.'

And the methods of using cupola metal for foundry purposes above described were early applied to making Bessemer steel by the indirect process. The following excerpt from the testimony of a witness clearly states the subject:

'A. L. Holley, who built the Troy works, and made his first conversion in 1865, introduced into this original plant tipping accumulating ladle resting on scales. This ladle was patented by Bessemer in 1869, English patent 566, alluded to in the previous answer, but apparently was an American invention. It was introduced in some form or other in all the American works, and was used almost always in duplicate, holding about two heats each, or many cupola tappings. In the last works built in St. Louis by Holley, in 1876, there were three of these ladles. In all American works these ladles were turning or tipping ladles, and were placed on scales to weigh the converter charges.'
In 1877, describing the Vulcan works, a plant designed and erected under Mr. Holley's supervision, that gentleman said (London Engineering, vol. 23, 1877):

'The cupola ladles ff facilitate the distribution of metal to the vessels. They form reservoirs which make the smelting department and the converting department independent of each other, within limits. This advantage was not appreciated fully until the large productions of the last few years were attempted. Should any delay occur in casting, in preparing a vessel, or from any cause, the melting department keeps right on, for those 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, [185 U.S. 403, 461] when covered with charcoal, for several hours. But it is necessary to put these ladles upon weighing machines, so that either uniform vessel charges may be run out, or so that spiegel charges may be proportioned to such charges as are run out.'
These ladles were variously named. Holley called them cupola ladles, interposed ladles, and reservoirs. Hunt described them as 'intermediate accumulating ladles.'

A witness thus testified respecting the extent of use in this country of the receiving ladle as follows:

'Early American steel works, commencing with Troy in 1864, Pennsylvania in 1867, Cleveland in 1868, Cambria and Union in 1871, North Chicago in 1872, Joliet and Bethlehem in 1873, Edgar Thomson and Lackawanna in 1875, and Vulcan in 1876, used receiving ladles, two in number, holding about two heats each, with the exception of Bethlehem, which used a single ladle on a car to mix taps from four cupolas,

and Vulcan, which used three receiving ladles, holding two heats each. These ladles were used for storing and measuring the heats.'
It is shown that from 1879 to 1888 the capacity of the accumulating ladle used at the works of the defendant was 28,000 pounds, and the converter charge 15,500 pounds, leaving 12,500 pounds in the ladle after a charge was supplied to the converter. The cupola taps of from 4,000 to 6, 000 pounds passed into and filled such ladle.

Describing the mode of use of the ladle, Price, a witness, said:

'It was the custom to leave in the ladle an amount of metal equal to the difference between the converter charge and the full ladle capacity . . . . This ladle was again filled to its full capacity by retapping the cupolas. . . .
'The metal from the several cupolas necessarily varied from time to time considerably, both in chemical and physical conditions; at times the metal being such from one or two of the cupolas that in themselves they would be unfit for converter use. But by the means which was afforded by the intermediate ladle the metal from this one, or the two, cupolas, would be averaged with the better adapted metal for converting from the others.' [185 U.S. 403, 462] Speaking of the beneficial effects resulting from the use of the accumulating ladle at the works of the defendant, another witness (Cabot) said:
'The mixing of cupola metal at Cambria was accomplished by the tapping of a number of cupola furnaces into one large receiving ladle, from which converter charges were poured off, and the supply in this ladle again increased by further tapping. The practice at the Bellaire steel works was similar to that. The purpose was to obtain a supply of metal for the converters to equalize the different streams of metal from the different cupolas, and that was its effect. It accomplished that.'
Yet another witness (Hunt) declared 'it was recognized as one of the great features of the intermediate ladle, that it made the work so much more uniform in results from mixture or evening up of the various grades of pig iron used.'

What distinction can be drawn between these methods and the patent as now construed? This court and the circuit court did put aside the Whitney method on the ground that it provided for obtaining absolute uniformity of product, while the Jones method was held to provide simply for avoidance of abrupt variations. While it is clear that a method which had for its purpose merely the prevention of abrupt variations would not necessarily include one for the obtaining of a uniform product, how a method of reservoiring molten metal as such metal is produced in the furnace and drawing it off from the reservoir for use, which produced uniformity of product as the result of the reservoiring, can be said not to have embraced the prevention of abrupt variations, is to my mind absolutely unthinkable, since the greater must necessarily include the lesser. For, of course, as there cannot be abrupt variations in the constituent elements of a molten metal which is uniform, it must follow that a process of reservoiring which in the continuous operation of a plant will obtain a uniform metal must necessarily exclude abrupt variations in the quality of the metal.

The court now, in addition, disposes, not only of the Whitney practice, but of the others to which reference has just been made, by certain general considerations which it is held applies to them all. These considerations are, first, an assertion that although [185 U.S. 403, 463] all such practices included reservoiring and the incidental mixing arising therefrom, none of them contemplated mixing as a necessary and inherent attribute, and none of them embraced the retention in the reservoir of a considerable mass of metal, a dominant pool, as a part of the process of reservoiring; and, second, as the practices in question related to molten metal drawn from cupolas, therefore they did not establish that reservoiring and mixing were known to the art so far as concerns the molten metal drawn directly from blast furnaces.

The first proposition, it is submitted, is absolutely in conflict with the express and uncontroverted proof in the record, as manifested by the references which I have already made. Let me recur to the practices under consideration to show that this is the case. Take the Whitney practice as testified to by Whitney. After saying that withdrawals were not made from the reservoir until 'it was nearly full,' and describing the drawing off of the molten metal from the reservoir, he said:

'And [as] the iron continued to melt [in the cupolas] the ladle was constantly being filled from the cupolas, and it was kept full until all the iron charged in the three cupolas was melted and the bottoms dropped.' The witness thus clearly showed, not only the constant retention of molten metal in the reservoir, but that such retention was recognized in the practice as essential to secure 'desired uniformity of molten metal.' I cannot see how there can be doubt on this subject, in view of the fact that the witness added:

'If we had drawn it [the molten metal] directly from the cupola into the smaller ladles from which we pour the wheels, one wheel might have been poured out of very hard iron, and another wheel 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.'
Take the wheel foundry practice as portrayed in Kirk's publication. The statement is made that 'a quantity of molten iron should be kept in the cupola, or in a large ladle, so as to [185 U.S. 403, 464] give the different brands of iron a chance to mix.' Again: 'The iron is all run out of the cupola as fast as it is melted, and is mixed in a large ladle.' The publication thus clearly pointed out the advisability of retaining a residuum in the cupola or in the reservoir, for the purpose of better mixing.

Recurring to the Altoona practice, doubt on the subject seems to me to be in reason impossible. It is not gainsaid that such practice embraced reservoiring and mixing. It cannot, it is submitted, be affirmed that it did not embrace the retaining in the reservoir of a large residuum of metal for the express and necessary purpose of making the mixing more perfect, if the proof as to the practice pursued is not wholly disregarded. What was that practice? When the metal in the cupolas began to melt, it was drawn off into the reservoir until the reservoir was half full; then the withdrawals from the cupolas were stopped. But the metal in the half- full reservoir was not, however, then made use of. Why was it not so used, although already in the reservoir? The answer is because it was deemed best, in order to obtain beneficial results from mixing, to hold the half- full reservoir for a subsequent tapping therein from the furnace, of a quantity of molten metal sufficient to fill the reservoir. Only when the reservoir was thus filled did they commence to draw the metal therefrom, and when by such use the quantity in the reservoir was reduced to about one half, then the drawing off was stopped, so as to retain about the one half until there was a further replenishing from the furnace, and thus the operation continued. How, by a mere affirmation, it can be held that the process which has just been described did not contemplate the constant retention of a considerable residuum in the reservoir is to my mind inexplicable. Let me quote again from the record the uncontradicted testimony as to the practice in question:

'The custom was to empty the receiving ladle about one half; then hold the remainder of iron in the reservior until the cupolas were ready to be tapped again; and after the reservoir is full we start and pour out into the smaller ladles again. The receiving ladle at all times is kept about one-half full, and it is this full when we tap the metal into it from the cupola.' [185 U.S. 403, 465] The irresistible conclusion thus arising from this proof is, it seems to me, rendered if possible clearer, when it is recalled that as early as 1877 the London Engineering, in a reference to this practice, declared:
'It was found advisable to employ a ladle of so large a capacity, because by doing so a more complete mixture of the different irons is effected than would be the case if a smaller vessel were employed.'
And what has just been said applies equally to the practice of making Bessemer steel from cupola furnaces. That the excerpts which I have given on this subject clearly show that mixing by the use of a residue was the result of the employment of the accumulating ladle, and a result that was well known and intended, it seems to me cannot be gainsaid. How the Jones method, as construed, can be declared to have been novel-because in cupola metal there was no variation requiring mixing-in face of the fact that the very patent which is sustained, in various forms of expression, expressly declares that such variation exists, is not by me comprehended.

Besides, the proposition involves an unsound deduction, since it in effect not only disregards the fact that the practices in question were availed of with the avowed purpose of correcting the inequalities found to exist in cupola metal, but also the erroneous assumption that there could be patentable novelty in merely applying to blast furnaces the well-known practices as to cupola metal.

It may well be conceded, without affecting the case, that the variation is greater in metal drawn from blast furnaces than in that drawn from cupolas, but this mere difference in the degree of variations between the

two affords no ground for construing the Jones patent in such a way as to cause it to cover the well-known prior methods.

Nor does the example given in the opinion of the court for the purpose of illustrating the difference which is found to exist between the practices to which I have referred and the Jones patent, as now construed, enable my mind to discover the difference. The court says (italics mine):

'Let us imagine a reservoir containing, say, three quarts, and [185 U.S. 403, 466] filled with one quart each of three liquids of different constituent parts, and withdrawn for further treatment at the rate of one or two quarts at a time. Necessarily there would be some incidental mixing, but it would occur at once that the main object of the reservoir was a retention of a sufficient quantity of the mixture to supply the receptacle for further treatment, and if no necessity existed for a longer retention of the liquid in the reservoir, it could be very quickly emptied by two discharges into the receiving vessel. Now, let us substitute for this reservoir a cask of, say, sixty quarts, into which the liquids of different constituent parts are poured in at one end from a multitude of receptacles, and discharged at the other end after remaining a certain time in the cask, and that this cask could not be tilted so far but what a quantity of liquid would be left within it amounting, say, to half its capacity. Now, if there be no distinction between these two operations there would be little left to the Jones process, the very vitality of which consists in the size of the cask relative to the ladles and the mixing of the various liquids poured into it before they are withdrawn.'
In the first place, this example fails to notice the fact that in the accumulating ladle the metal was received from several-in some instances as many as four or five-cupolas; and that in practice a residue was constantly maintained, and for the purpose of mixing, and that these ladles could not be drained of metal unless there was an intention to do so. The only distinction afforded by the example is that resulting from the difference in sizes of the two supposed receptacles in which the mixing was accomplished. But this would reduce the patentable novelty in the Jones process to the size of the reservoir. Indeed, it is so expressly stated, since in the opinion it is declared that 'there would be little left to the Jones process, the very vitality of which consists in the size of the cask relative to the ladles and the mixing of the various liquids passed into it before they are withdrawn.' The mixing having been disposed of by what I have already said, it follows that the 'very vitality' of the patent is found to be the size of the cask relative to the ladles, which in reason is a direct abandonment of the whole theory of a dominant pool previously expounded as the source of vitality [185 U.S. 403, 467] in the patent. But the size of the reservoir-called by the court a cask- relative to the capacity of the plant is clearly shown not to have been novel by what has been previously said, and will be further demonstrated beyond peradventure by the consideration which it is now proposed to give to-- The Manufacture of Bessemer Steel by the Direct Process.

The use of the direct process for Bessemerizing, it would seem, was at once resorted to on the continent of Europe, and there is testimony in the record giving rise to the inference that the greater uniformity of the ores used in the blast furnaces on the continent caused such processes to be there at once quite successful. However, it may not be doubted that on the continent the use of a reservoir or accumulating ladle sometimes obtained, and the advantages which it afforded of bringing about a desirable mixture of the metals from several furnaces was known. Thus Kohn, in the Journal of the Iron and Steel Institute, 1871, speaking of the practice at Terre-Noire, in France, said:

'The iron is first run into a ladle, as explained by Mr. Menelaus, and so taken to the converter. The ladle is brought to the back of one furnace, and half filled; it is then run to the next furnace and filled up. In this way the Terre-Noire Company always obtain a mixture of the metals, and therefore the greatest regularity is secured through the rest of the work. The furnaces are kept in regular working order, and by carefully managing the charges of the blast furnaces, and watching them as much as possible, the practical result is that there is no inconvenience as regards the furnaces themselves in tapping frequently. The same thing is done at Mr. Schneider's place at Creuzot, but he believed they do not there go so far as to mix the iron.'
In England the direct process was not made use of until about 1877, and it is shown that this largely resulted from the fact that the Bessemer plants in the early use of the process were not connected with blast furnaces.

In this country, though the manufacture of Bessemer steel was commenced in the early sixties, and in one or two of the [185 U.S. 403, 468] early experimental plants a brief use was made of direct metal, the

indirect process was in general use until the year 1882, when the first large plant equipped for direct use of blast-furnace metal began operations at the new South Chicago works of the Illinois Steel Company, and later in the same year the Edgar Thomson works (the Carnegie Company), with five new furnaces, also commenced such work. These plants were still producing steel by the direct process, with the use of the accumulating ladle, when the Jones patent was granted in 1889, and it was not until the year 1892 that a large storage tank was installed at the South Chicago works.

A number of patents having relation to the making of steel by the Bessemer direct process were from time to time granted before the Jones patent was issued, and I shall now notice the most important of such inventions, as also some other publications embodied in the literature of the art.

In the British patent to Deighton of 1873 the purpose of the inventor, among others, was declared in the specifications to be to keep a steel- works plant or apparatus in nearly uninterrupted work, thus very considerably increasing the production of such plant. It was said:

'Instead of manufacturing Bessemer iron or steel from pig iron which has to be 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 a 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 apparatus was then described in detail, and consisted of blast furnaces, arranged in a line, with channels from each furnace to a common reservoir or mixer, and with a connection from the mixer to a converter, so that the molten metal in running from the blast furnaces might go into the reservoir and be mixed, and might be drawn off as desired to the converter. [185 U.S. 403, 469] It was stated that the receiving vessel '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 metal from two or more of the smelting furnaces. From the receiver m the mixed molten metal is tapped and flows down the swivel through 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.'

In 1885, a few years prior to the grant of the Jones patent, two United States patents were issued to James P. Witherow (1) for apparatus for the manufacture of iron and steel; and (2) steel-plant appliance, which patent showed a blast furnace, an intermediate storage vessel of large size, and a converter. In brief, the purpose of the Witherow reservoir apparatus was to receive and store the molten metal for the purpose of preventing the detention incident to the necessity of discharging the contents of the blast furnaces when there is no converter ready to receive it. The advantages of the large storage receptacle was thus stated in the specification of one of the patents:

"The metal is usually tapped from a blast furnace once in every six hours, and the quantity thus cast is many times in excess of the charge of a converter. . . . The charge of a converter is from one to five tons, and in the case of a blast furnace usually runs from ten to fifty tons. . . . The time between charges of the converter is usually twenty minutes and upward, and the metal from the furnace must be kept in condition to be tapped from time to time into the converter as needed."
The evidence establishes that the Deighton and Witherow reservoirs were each of a capacity of 100 tons.

Commenting, in June, 1877, upon the merits and demerits of the use, then just commenced in England, of direct metal,-that is, the conversion of molten metal direct from the blast furnace, without remelting in a cupola or storing it in a large reservoir,-A. L. Holley said (italics mine):

'It has not yet been practicable to work the blast furnace with sufficient regularity to realize approximately the theoretical advantages of the direct process. [185 U.S. 403, 470] 'Fourth. The obvious remedy is to mix a number of blast-furnace charges, so as to reduce the irregularity to a minimum. Two systems of doing this are on the eve of trial: The one is simply mixing so few charges in a tank that the metal will be drawn out before it chills; the other is to store a larger number of charges in a heated tank,-that is to say, in an immense open-hearth furnace.'

The first of these two systems of mixing would seem to be that embodied in the following portion of Mr. Holley's description of the West Cumberland practice:

'In order to get a more uniform metal, Mr. Snelus is about trying the experiment of placing a twenty-ton ladle on a hydraulic lift at the 'A' pit, so arranged as to store, mix, and pour, say, three six-ton to seven-ton blast-furnace taps, or to mix blast furnace and cupola metal. No doubt this body of metal will 'live' if the ladle is thickly lined and well covered. Mr. Snelus has another object also: tapping half or a third of a vessel heat out of the blast furnace-in other words, tapping so often- wears out the tap hole more rapidly; slag gets into the walls and weakens them. It is preferable in every way, as blast-furnace men well understand, to tap a full hearth. At the same time improvements in working the furnace are gradually developing. More care is taken 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.
'. . . 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.'
The second of the two systems of mixing is undoubtedly the one then being erected at Moss Bay, England, viz., a sixty-ton reverberatory coal- fired furnace or two forty-ton furnaces. The ladles of blast-furnace metal were to be 'tapped out into the large reverberatory furnace,' in which 'it is the intention to store and keep hot some sixty tons of iron from all the blast furnaces.' This method, for some reason not stated, perhaps an economical one, was not successful. Mr. Holley, in the article just noticed, referring to the arrangements in connection with[185 U.S. 403, 471] the use of this 'large furnace,' said: 'The complex manipulations due to the arrangement described seem likely to take unnecessary amount of time and labor.'

After reviewing the practice in the various English and continental steel works using direct metal, Mr. Holley summed up his conclusions, and recommended the American works to continue for the present to select and remelt the pig metal, and confine their efforts for some time 'to the preliminary department of the direct process,-to increasing our uniformity of blast-furnace working and product.' We excerpt the following passages from the Conclusions contained in the report:

'Fourth. But if the storage of a large quantity of iron in a reverberatory furnace or other reservoir should prove successful, then a few blast furnaces making even an irregular product, and, if necessary, working in connection with cupolas, would largely economize the Bessemer manufacture.
'In fact, this mixing of irregular irons on a very large scale, thus avoiding the expensive niceties of ore selection and the necessity of many furnaces, is the theroetical key to the situation. 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 and part cupola metal can result in any substantial saving.
'But the mixing problem is not such a difficult one. A small amount of flame spread over a large surface of metal should certainly keep it hot for a long time, seeing that the metal will keep hot in a ladle exposed to air for an hour or more. And should there be any trouble about stopping the tap hole in a large storing furnace, it would not be a very difficult or expensive matter (considering the Pernot revolving-hearth experience) to tip the whole hearth to pour a charge.'
Without stopping to comment in detail upon all the matters just referred to, there can be no question that they demonstrate that if the vitality of the Jones patent depends upon the size of the reservoir, it was clearly anticipated. They also further [185 U.S. 403, 472] establish that the advisability of the use of a large reservoir for the purposes of storage and mixing was well known; and that it was deemed to be an obvious and desirable expedient is also apparent.

It is not denied that the Deighton and Witherow patents each provided for a reservoir, the former (Deighton) laying stress upon the advantages resulting from the mixing in such reservoir. Both patents, it seems to me, in effect contemplating as they did the continuous operation of the plant, and, in view of the relative capacities of the furnace or furnaces, the reservoir and the converters, necessarily embraced the presence in the reservoir of a considerable residuum, without which residue the proposed continuity was impossible. As it is to me apparent, I do not stop to refer to the testimony showing that this must necessarily be the case. The argument that the Deighton reservoir had no cover, and therefore it is not the Jones process, ignores the fact that Jones in his process patent does not provide for the operation of his

method in a covered receptacle, but, on the contrary, in the specifications of that patent, it is declared that the process may be carried on in a charging ladle, an uncovered receptacle. Further, it is to be borne in mind that the record overwhelmingly establishes that it was a well-known expedient to cover a ladle or other receptacle for molten metal when the metal was required to be retained longer than the customary time. The inappositeness of the suggestion that the Deighton patent ought not to be given any weight as showing the state of the art, because the patentee allowed the patent to lapse for the nonpayment of fees, cannot be better illustrated than by this case, when it is recalled that the patent to Mushet, which made Bessemerizing commercially practicable, was allowed to lapse because the Patent Office fees were not paid.

The demonstration of want of novelty in the patent as construed, which arises from the previous considerations, entirely disposes of the case, as it is, as already observed, conceded that, unless the patent means what it is now held to mean, there was no infringement by the defendant. It is to me equally clear, however, that even if the state of the art be, arguendo, put out of view, the patent cannot be held to signify what it is now decided [185 U.S. 403, 473] to mean (a) without repudiating the true meaning of the patent, which is- properly deducible from the proceedings in the Patent Office, that is, the filewrapper and contents, and without refusing to give effect to the express declarations and admissions of the patentee (Jones) as to the significance of the patent, which is also shown by the proceedings in question; and (b) without misconceiving and misconstruing the patent. Let me briefly demonstrate these propositions.

As I have said at the outset, the application for the patent in suit when first made was rejected by the Patent Office, on the ground of the prior state of the art, as evidenced by the Witherow patents and the Kirk publication. An amended application was thereupon filed, which beyond all question eliminated from the patent all claim to an exclusive right to reservoir or store the molten metal. When this amendment was presented to the Patent Office, counsel for the applicant submitted a written argument to demonstrate the patentability of the method covered by the amended application, in which no reference whatever was made to the importance of a residue, whether of small or considerable size, but the purpose of the inventor was thus declared (italics mine) 'to have a receptacle capable of holding metal in a molten condition, into which metal, it may be, from several blast furnaces, is run from time to time, and from which metal is drawn for treatment in the converters, or otherwise, as required. This continuous pouring into and drawing out of a common receptacle produces such a mixture of the charges as results in an uniform average quality of metal, whether treated in the converters or used for casting without such treatment, as is very desirable, but has hitherto been found unattainable.' But the amended application was rejected, and the examiner-evidently having in mind the statement in the argument of counsel above referred to- called the attention of the applicant to the fact that the continual pouring into and drawing out of the molten metal to produce a mixture was anticipated by the Kirk publication. The examiner said (italics mine):

'The process, as now claimed, seems to be fully met by the description in Kirk's Metal Founding, heretofore referred to, [185 U.S. 403, 474] which states that the metal is run continuously from the cupola and mixed in the ladlc, from which it is tapped into the smaller ladle. See also the additional references of British patents No. 859, Broman, March 23, 1866, page 5, lines 25-35, and No. 2382, Stewart, May 10, 1883, page 5, lines 9 and 10.'
When it is borne in mind that the Kirk publication thus referred to provided expressly for a continuous inflowing and outdrawing of the metal, and besides expressly said 'a quantity of molten metal should be kept . . . so as to give the different brands of iron a chance to mix,' the conclusion cannot by me be escaped that the examiner pointed out to Jones that the conception of a continuous inflow and outflow, and the keeping of a residue for the purpose of mixing, was not patentable.

The presumption cannot be indulged in that the amendment was not intended to obviate the objection on account of which the Patent Office had rejected the application, and, moreover, it cannot be assumed that the Patent Office issued the patent for a method which it declared was not patentable. But now the patent is construed by the court as covering the continuous flowing into and withdrawal from a reservoir of molten metal, and as alone referring to the prevention of abrupt variations in the metal drawn from the reservoir for use in a converter, while Jones himself declared to the Patent Office that the patent as amended related to metal drawn (from a reservoir for treatment in a converter, or otherwise, as required. Besides, it was expressly stated that what the patent contemplated was the production of a uniform

quality of metal, intended for further treatment in the converters, or to be used for casting without such treatment. It is submitted that this demonstrates that the construction now given by the court to the patent is directly repugnant to the meaning which Jones affixed to it, and besides is in conflict with the ruling of the Patent Office, in which Jones acquiesced, and upon which the patent was issued; and therefore that the construction which the patent now receives amounts, it seems to me, to a grant by judicial decision of a new and different patent from that which the Patent Office allowed.

Conclusive as is the view just stated, it is made, if possible, [185 U.S. 403, 475] more so if the correct construction of the patent be ascertained. This it is proposed to demonstrate by an analysis of the patent as originally applied for, by a consideration of the amendments made to it, and by its text in its final form. Considering these matters, it will, I think, appear that the patent was not, as now held to be, solely one for the prevention of abrupt variations in the metal drawn from the receptacle for use in a converter. On the contrary, the true purport of the patent was this, and this only: The selection of separate portions of molten metal, pouring the same into a reservoir, mixing such aggregated portions of molten metal thoroughly until it, the commingled metal, became uniform, so that the equalized metal might be used, not alone in the making of steel in a converter, but in any other process of making steel, in a foundry, or in any other mode where a uniform product was desired. Having thus provided for equalizing the contents of the reservoir when filled with selected metal and mixing had been accomplished, the patent contemplated that this equalized molten metal present in the reservoir should be drawn off for any desirable purpose down to an undetermined residue, so that when a fresh supply of selected metal was charged into the reservoir the metal thus newly supplied might be mixed with the residuum, and thus not only a further supply of equalized metal might be obtained, but also, as a result, abrupt variations between the freshly equalized metal and that of the preceding batch discharged from the reservoir would be avoided.

To demonstrate the correctness of this construction, which, as already shown, was undoubtedly the view taken by the Patent Office, let me come to consider the application for the patent, the amendments, and the patent as granted.

The application, as originally filed, contained a statement of the primary object of the invention, which is excerpted in the margin.

'The primary object of the invention is to provide means for insuring uniformity in the product of a Bessemer steel works or similar plant, in which the metal from more than one (subsequently amended to read 'one or more') blast furnaces is employed to charge the converters. The product of the different furnaces, or of the same furnace at different times, varies [185 U.S. 403, 476] This was followed by a statement of the secondary objects designed to be attained as follows:
'My invention, however, is not limited to its use in connection with converters, since similar advantages may be obtained by casting the metal from the mixing vessel into pigs for use in converters, puddling furnaces, or for any other uses to which pig iron may be put in the art.'
A description was then given of the apparatus, which it was previously stated had been invented 'for practising my invention,' and the mode of operation of such apparatus was stated. The claim read as follows:

'The process hereinbefore described, which consists in storing charges of molten metal in a covered receptacle provided with a heat- retaining lining, removing portions only of the molten contents of the said receptacle without entirely draining or emptying the same, and successively replenishing the receptacle with fresh additions of molten metal, whereby the character of the several charges of metal so treated is equalized; substantially as described.'
Considering the application as thus made, what support does it lend to the theory now announced that it was the purpose of

____ in quality, the variation depending on the kind of ore employed, and on many other conditions well known to those skilled in the art, so that when the converters are charged at one time with the output from one furnace, and at another time with the output from another furnace or furnaces, the manufactured steel lacks uniformity in grade. To avoid this I employ suitably constructed reservoirs or vessels, into which the molten metal from the blast furnaces is put, the vessels being of proper capacity to hold a considerable charge of metal from a single furnace, or from a number of furnaces, and being

adapted to retain the metal in a molten state for sufficient time to enable the different charges to mix and become homogeneous. The advantage which I thus obtain in securing uniformity and homogeneity in the total product will be readily understood by those familiar with the operations of a steel works and the frequent loss which is caused by the lack of such uniformity. Such apparatus possesses also an additional advantage in that it makes it possible to dispense with cupola furnaces for remelting the pigs preparatory to charging the converters. The metal may be tapped from the blast furnaces into ladles or trucks, carried to and discharged into the mixing reservoir or vessel, and there retained in a molten state until sufficient metal has been accumulated to charge the converters.' [185 U.S. 403, 477] the Jones invention merely to prevent abrupt variations between each charge of metal drawn from a reservoir for treatment in a converter? Such purpose is nowhere declared, unless it be inferred from certain statements in the patent descriptive of the mode of operation of the appliance covered by the apparatus patent, to which, hereafter, I shall more particularly advert. The conception that the patent solely related to abrupt variations in metal drawn from a reservoir and supplied to a converter is absolutely excluded by the fact that the secondary object is pointed out to be to secure a pig metal so uniform in its chemical constituents that it might be used 'in puddling furnaces or for any other use to which pig iron might be put in the art.' It cannot be conceived that the patent provided for making the metal uniform in the reservoir, and, by the same language, provided merely against the occurrence of abrupt variations in the equalized metal when drawn off to a converter. If made uniform, there could not, in the nature of things, be abrupt variations. It being, then, certain that the process patent, as originally filed, in and of itself not only contained even no intimation of the claim which the court now attributes to the patent, it must follow that if the patent covered such a claim it was one not in the mind of Jones, but must have been in some way evolved in the passage of the application through the Patent Office.

This original application, as I have said, was rejected by the Patent Office as being 'completely anticipated' by the Witherow patents, and reference was made to the Kirk publication.

To meet this objection a change was made by which the assertion of an exclusive right to store charges of molten metal was eliminated, the amendment being as follows:

'The process hereinbefore described, which consists in running successive charges of molten metal into a covered receptacle provided with a heat-retaining lining, removing from time to time from said receptacle for subsequent treatment a portion only of its molten contents, and successively replenishing such receptacle with fresh additions of molten metal, for the purpose of equalizing the character of the several charges of metal drawn therefrom, substantially as described.' [185 U.S. 403, 478] Accompanying this paper was the argument of the attorney, already referred to, in which it was expressly declared, as has been seen, that the patent related to uniformity of molten metal for further treatment in converters, or otheruise; that is, as declared in the argument, the obtaining of a metal of such uniform quality that it might not alone be used in converters, but might be 'used for casting without such treatment.'
As the application, as amended, was asserted to embody a claim for the continuous operation of a plant by reservoiring metal, by inflowing and outflowing, with mixing,-a method construed by the Patent Office as identical with that described in the Kirk publication,-the patent, as already stated, was again rejected. It was again amended, and, as thus finally amended, the patent was allowed. The new amendments consisted, first, of a substituted statement of the primary object of the invention, which is excerpted in the margin. It will be observed,

'The primary object of my invention is to provide means for rendering the product of steel works uniform in chemical composition. In practice it is found that metal tapped from different blast furnaces is apt to vary considerably in chemical composition, particularly in silicon and sulphur; and such lack of uniformity is observable in different portions of the same cast, and even in different portions of the same pig. [Here follows table of analyses said to have been made of metal contained in different ladle charges from one cast of a blast furnace.] . . . 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 often 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 practised.

'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 and segregated elements of silicon and sulphur originally contained in each [185 U.S. 403, 479] from the concluding sentence in the first paragraph, that it was clearly implied that the applicant deemed that inequalities were present in cupola metal as well as in blast-furnace metal.
There was substituted for the single claim as originally presented and amended the two claims embodied in the patent as finally issued, and which have been previously set out.

It plainly results from the amendment that it was drawn to meet the objection of the examiner and to make clear the fact that the character of the mixing contemplated by the Jones process was not that resulting from a continuous operation of a reservoir by the inflowing and outdrawing of metal with the constant retention of a residuum, but was a distinct character of mixing by thorough commingling of batches of metal, in order to produce in a reservoir a molten metal which would be homogeneous and uniform, of a character deemed to be unattainable by the continuous process; the purpose of securing this reservoir of uniform metal being to obtain a mixed metal so uniform in its chemical constituents that it might be, with greater advantage than theretofore, subjected to further treatment in the converters or be run into pigs, which, by reason of the uniform quality of the metal, might then be used for any purpose where such a metal was desired. In other words, the amendment was drawn for the purpose of satisfying the Patent [185 U.S. 403, 480] Office that the method which was claimed should not be rejected because the prior art provided against the mere variations in the metal drawn from the reservoir, as the patent went further and described a process of mixing which would bring about the greater result of a uniform molten metal and consequent uniform product.

This conclusion is rendered clear by the fact that the amended application not only retained in substance all the prior declarations as to the purpose of obtaining a uniform mixed molten metal, and as to the use of such uniform metal in converters, or otherwise, but emphasized the same by adding the following:

'To this end my invention may be practised with a variety of forms of apparatus. For example, by merely receiving in a charging ladle a number of small portions of metal taken from several ladles or receiving vessels containing crude metal obtained at different times or from different furnaces, the mixing being performed merely by the act of pouring into the charging ladle, and other like means may be employed.' And to make the object of the amendment perfectly clear, the prior description of the method was supplemented by stating that 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.'

True it is that on the trial below the complainant presented a disclaimer, which the court now upholds, by which he sought to eliminate from the patent the amendments which had been inserted to meet the objections of the Patent Office examiner, and which indubitably fixes the meaning of the patent. I do not deem it necessary, however, to stop to refer to authorities to show that a disclaimer which, in effect, has for its object the making of a new patent by striking out the essential representations upon which the patent was granted, is without legal warrant. This, it is submitted, is the obvious result of the authorities to which the opinion of the court refers.

But even if the patent as it is now made over, as I think, by the effect which is given by the court to the disclaimer, be alone considered, it plainly results that the patent as so changed did not contemplate, as now decided, solely the prevention of [185 U.S. 403, 481] abrupt variations in the metal drawn from the reservoir for use in the converter, since the patent yet provides: 'Instead of discharging the metal into the cars 12, and carrying it in the cars to the converters or casting house, the vessel 2 may be so situate relative to the other parts of a furnace plant as to deliver its contents immediately to the converters or other place where it is to be utilized.' I fail to see how it can be held, even giving the fullest effect to the disclaimer, that the patent provides only for metal to be supplied to a converter, when it expressly points out that the metal may be used 'in the casting house, in the converters, or other place where it is to be utilized.'

I come now to the statements found in the patent to which I have previously alluded, which the court thinks give support to the claim that the patent had reference merely to the avoidance of abrupt variations in metal supplied to the converters. The statements thus relied upon are contained in that portion of the patent where the mode of operation of the appliance covered by the apparatus patent is described. These passages are excerpted in the margin.

When the passages in question are properly considered, it becomes, I submit, incontrovertible that, instead of sustaining,

'Referring now to the drawings, 2 represents the resevoir before mentioned. It consists of a covered hollow vessel having an outer casing 3 of iron or steel, which is suitably braced and strengthened by interior beams and tie-rods, as shown in the drawings. The whole exterior of the vessel is lined with fire brick or other refractory lining, which should be of sufficient thickness to retain the heat of the molten contents of the vessel and to prevent chilling thereof. The vessel is strongly braced and supported by braces and tie-rods, and may be of any convenient size, holding, say, 100 tons of metal (more or less), and its shape is preferably such as shown in the drawings, being rectangular, or nearly so, in cross section, and an irregular trapezium in longitudinal section, one end being considerably deeper than the other. At the top of the deeper end, which I call the 'rear' end, is a hopper 5, into which the molten metal employed in charging the vessel is poured, and at the front end is a discharge spout 6, which is so located that the bottom of the spout is some distance above the bottom of the vessel,-say 2 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 [185 U.S. 403, 482] they are antagonistic to, the construction which has been given by the court to the patent, and hence sustain the construction which has been presented in this dissent.
Referring to the excerpted matter in the margin, it will be [185 U.S. 403, 483] seen that in the second paragraph is described the mode of filling the reservoir. Various portions of metal, termed 'charges,' are drawn 'either from a number of furnaces or at different times from a single furnace,' and such charges are introduced into the reservoir until the vessel is full; that is, to use the language of the patent, until a 'sufficient charge' has been supplied to the reservoir, the result being, as stated in the patent, that the charges of metal thus accumulated in the reservoir '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 of the charges.' Thus it appears that the patentee had in mind the cure of the inequalities or variations present in the 'charges' of metal poured into the reservoir to make up the 'sufficient charge,' and thereby to cause such sufficient charge 'to 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.' And the production of this homogeneous mass, it is further observed, 'may be aided by the agitation of the vessel on its trunnions, so as to cause the stirring or shaking of its liquid contents.' Manifestly, not only the obtaining of the homogeneous molten mass is absolutely incompatible with the theory that the patent related to mere variations, but the statement about the agitation of the vessel on its trunnions is likewise a negation that the conception of the patent related to the continuous inflowing and outflowing of molten metal from the reservoir. The construction now put upon the patent by the court disregards the provision that the variation which was to be cured was that existing between the 'charges' as they were poured in, and assumes- contrary to the language of the patent-that the purpose was to cure variations which would exist in the mass of molten metal, when, by a sufficient charge, the reservoir had been filled. And this, although it is expressly declared in the patent that by the operation of the reservoir, in the mode described, the variations existing in the metal before the pouring in would be destroyed by the mixing, which would cause the mass from which withdrawals were to be made to become homogeneous.[185 U.S. 403, 484] The error becomes more manifest upon an examination of the last of the excerpted paragraphs, wherein is contained directions as to the withdrawals of the equalized metal from the sufficient charge; that is, the filled reservoir of equalized metal and the replenishing of the reservoir with new charges to make another sufficient charge. It will be seen that the patent contemplated the discharge of the mass of homogeneous metal by tilting the tank down to a residue, and that no reference is made to replenishing the reservoir until provision is made for the retention of a residue. Then the reservoir is to be replenished by the addition of new charges which mix with these parts of previous charges, which have been equalized and which remain in the reservoir as a residue. Obviously, in this subsequent addition of charges it was intended that a 'sufficient charge' of metal should be contained in

the reservoir, which, when thoroughly mixed, would form another homogeneous mass of molten metal, it being declared 'by which means any sudden variations in the quality of the metal supplied to the converter is avoided.' 'By which means' is clearly meant the bringing into existence of the homogeneous mass referred to in the patent. In other words, the patent points out that by making all the 'constituent charges' of a 'sufficient charge' homogeneous there would be no variations in the withdrawals from that equalized mass. And this is, besides, made more manifest by the following sentence in which attention is called to the fact that the equalized metal thus drawn off might be carried to the converters or be cast into pigs without treatment in the converters.

Moreover, turning to the first paragraph in the excerpt, it will be perceived that it is stated that the operation of the mixer as described will 'secure, as much as possible, uniformity in the character of the metal which is fed to and discharged from the tank [meaning the equalized mass], and cause the fluctuations in the quality of the successive tappings to be very gradual.' That is to say, the patent contemplated that each distinct full reservoir or sufficient charge, constituting a batch of metal, would be homogeneous in itself and substantially uniform in its chemical constituents, and the successive 'sufficient charges' or 'full reservoirs' would, by means of the residuum, vary but [185 U.S. 403, 485] slightly between each other. The words 'successive tappings' can have no other meaning than successive batches, for it is impossible to conceive that they could refer to the separate withdrawals of metal taken from one full reservoir or sufficient charge, because it had been declared that the 'constituent charges' of each full reservoir of metal by the operation described would become homogeneous; that is, practically uniform.

Certainly, this construction of the patent gives effect to all of its provisions, and harmonizes with its plain letter, while the contrary construction, now approved by the court, reads out of the patent the repeated statements as to the purpose of the patent being to secure a uniform molten metal, and disregards the fact that the patent expressly provides that what it aims to secure is such uniform metal as is fit, not only for use in converters, but for castings and any other mode by which such a metal can be utilized. Certainly, what has been previously stated is a demonstration that the construction previously given by me accords with the express declaration made by the patentee when he applied for his patent, and is strictly in harmony with the action of the Patent Office in allowing the patent. It is equally clear that the construction of the patent, which has been by me elucidated, is, besides, in accord with the conception entertained by the Patent Office of the meaning of the patent long after it had been issued. Thus, the Commissioner of Patents, in a report bearing date January 1, 1896, reviewing the advance in the industrial arts, said (italics mine):

'A process now commonly used in steel manufacture is that of patent No. 404,414, January 4, 1889, to Jones, in which he described a means of getting a uniform product of metal by mixing together in a suitable receptacle batches of metal from different furnaces, so that the mixture when drawn off will be the average of the different charges.'

As the views hereinbefore expressed sufficiently make manifest the reasons for my dissent, it is unnecessary to stop to notice many matters considered in the opinion of the court. Lest, however, if they are not referred to, it may be assumed that assent is given to them, the more important of such statements [185 U.S. 403, 486] are briefly adverted to. First, it is said that the making of steel by the direct process was commercially impracticable before the grant of the Jones patent, and that that patent operated a revolution in the art. The proposition, in my opinion, finds no support in the record. On the contrary, it is affirmatively established that not only on the continent, but in England and in this country, long prior to the grant of the Jones patent, Bessemer steel was made by the direct process, upon a large scale, continuously and successfully. So far as revolution in the art is concerned by the alleged enormous saving rendered possible by the use of the Jones method, it is not perceived how such a statement is compatible with the unquestioned proof in the record that, although the complainants at their Edgar Thomson works erected several of the Jones mixers about the time of the grant of the Jones patent, they did not introduce them into their other works until more than seven years afterwards. Indeed, to my mind it is established by the record that the Jones method, when put into practical operation by the complainant, proved not to be a commercial success, and the apparatus was continued in use despite this fact because of the means which it afforded of securing on a larger scale the benefits of storage hitherto well known in practice, and that the use of this larger storage vessel became more and more advantageous

as the capacity of blast furnaces was enlarged and improvements took place in the mode of their operation.

The statement that upon the grant of the Jones patent the so-called mixer was at once adopted by steel works generally in this country is also unwarranted by the facts in evidence, which establish without any conflict that storage reservoirs of like capacity to that of the Jones apparatus were in use at the time of the hearing of this cause in but three steel works in the United States outside of those operated by the complainant, and that their introduction long after the grant of the Jones patent in such outside works is shown to have been coincident with the increase in blast-furnace output and the necessity which had thus arisen for greater reservoir capacity to hold the enormous supply of molten metal which was then being produced by the operation of blast furnaces. The record, moreover, establishes [185 U.S. 403, 487] that in the works in question, where, long after the grant of the Jones patent, large reservoirs were first employed, this was done, not because better results were secured by means of mixing than had been obtained by the mixing theretofore resorted to, but because the larger output of blast furnaces pointed to the necessity for the construction of a larger reservoir than those previously employed.

The effect of the decision now rendered, it seems to me, is, therefore, to put the patentee in a position where, without invention on his part, and without the possession by him of lawful letters patent, he is allowed to exact tribute from the steel and iron-making industry, whenever those engaged in such industry desire to increase their plants or to more conveniently and satisfactorily conduct their operations so as to keep pace with the natural evolution of modern industrial development.

I am authorized to say that the CHIEF JUSTICE, Mr. Justice Harlan, and Mr. Justice Brewer concur in this dissent.

Footnotes

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 uniform constituent parts, all the charges of the converter from time to time will be substantially uniform, and the products of all will be homogeneous. To this end my invention may be practised with a variety of forms of apparatus,-for example, by merely receiving in a charging ladle a number of small portions of metal taken from several ladles or receiving vessels containing crude metal obtained at different times or from different furnaces, the mixing being performed merely by the act of pouring into the charging ladle, and other like means may be employed. I prefer, however, to employ to apparatus shown in the accompanying drawings, and have made it the subject of a separate patent application, serial No. 289,673, and, without intending to limit the invention to the use of that specific apparatus, I shall describe it particularly, so that others skilled in the art may intelligently employ the same.'
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 fluctuations 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 vessels 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 cars 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 vessel, 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.'

'After the vessel is properly charged, the metal is drawn off into the cars 15 from time to time, as it is needed, by opening the door or cover 16 of the spout 6 and driving the engine 12, so as to elevate the rear end of the vessel and tilt it forward, and thus to discharge any required amount of its contents in the manner before explained into the cars 15, which are transported to the converters, or the metal is cast into pigs or otherwise used. 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, by which means any sudden variations in the quality of the metal supplied to the converter is avoided. Instead of discharging the metal into the cars 12, and carrying it in the cars to the converters or casting house, the vessel 2 may be so situate relatively to the other parts of a furnace plant as to deliver its contents immediately to the converters or other place where it is to be utilized.'