United States Patent Office

3,188,776

Patented June 15, 1965

3,188,776

SURFACE TREATMENT OF STEEL

Gilbert D. Dill, Mishawaka, Ind., assignor, by mesne assignments, to The Wheelabrator Corporation, Mishawaka, Ind., a corporation of Delaware

No Drawing. Filed Aug. 20, 1962, Ser. No. 218,166
5 Claims. (Cl. 51—320)

This invention relates to a process for the surface treatment of steel and, in particular, to the treatment of hot worked steel having mill scale thereon.

It is well-known that hot worked steel products acquire a substantial amount of mill scale which must be removed prior to most cold working operations. It has been the practice of the art to remove this mill scale by acid pickling, hot caustic salt bath treatment, abrasive blasting techniques or a combination of abrasive blasting followed by acid pickling. Some hot formed steels can be satisfactorily cleaned of mill scale by abrasive blasting only, providing subsequent cold forming operations are not too drastic. Other steels such as stainless steel require acid treatment even when blasted, to render its surface passive to corrosion as well as to clean the surface. In the case of hot formed plain carbon steels which are to be subjected to more drastic cold working operations such as cold rolling, abrasive blasting alone has not been satisfactory.

Specifically, when plain carbon steels cleaned by abrasive blasting alone are cold rolled, a heavy black "smut" has appeared on the surface, and this is an intolerable surface condition. This smut is believed to be caused by small particles of embedded mill scale, work hardened surface metal and amorphous iron on the surface breaking loose from said surface of the steel during the cold rolling operation and mixing with the rolling lubricants as hereinafter more fully described. To overcome this situation, the prior art has resorted to a pickling operation following the blast cleaning. This pickling treatment, which is ordinarily applied for about fifteen seconds, effects the removal of these three surface defects whereby the appearance of smut during the cold rolling operation is essentially eliminated.

The necessity for two cleaning operations of such a diverse nature is highly undesirable, and it is an object of this invention to provide a cleaning technique which eliminates the need for separate blasting and pickling operations.

It is a further object of this invention to provide an improved blasting technique for the surface cleaning of hot worked steel which eliminates the appearance of smut in cold rolled products.

It is an additional object of this invention to provide an improved blasting technique which eliminates the need for expensive acid pickling with its subsequent acid disposal problem which finds particular application in the surface treatment of hot worked steel sheet and strip which is to be subsequently cold rolled.

These and other objects of this invention will appear hereinafter, and it will be understood that the specific examples to be described are provided solely for purposes of illustration and not by way of limitation.

The process of the present invention is designed for the treatment of hot worked steel in preparation for a subsequent cold working operation such as cold rolling. The process generally comprises subjecting the hot worked steel to a first blast operation while utilizing steel shot for the blasting material. This is followed by a second blasting operation wherein steel grit is employed as the blasting material. By this double blasting technique, undesirable surface conditions are removed from the steel which, if not removed, would cause formation of smut on the surface during cold rolling.

It is believed that several conditions contribute to smut

formation, and the procedure of this invention serves to overcome these conditions. It will be understood, however, that applicant does not wish to be limited to any particular theory of operation. It is believed that the formation of smut is caused by at least three contributing surface conditions. Thus, it has been observed that a flat hot rolled steel surface, when blast cleaned with a steel abrasive, will be contaminated with microscopic particles of mill scale due to the impingement force of the abrasive particles. In the cold rolling operation, there is a tendency for these microscopic particles to be liberated and, upon mixing with the rolling lubricants, smut will be formed.

A second condition observed relates to the nature of the surface resulting from blast cleaning. Blast cleaning results in a surface composed of numerous hills and valleys, portions of which surface become work hardened during the blast cleaning operation. These portions, particularly the hill or peak portions which are further work hardened during cold rolling, tend to disintegrate in the cold rolling operation and they mix with the rolling lubricants to form smut.

A third condition observed concerns the effects of the coiling operation at the end of the hot mill. It is believed that the scale on the steel surface during the coiling is affected by the temperature of the strip at this time. Coiling temperatures above about 1150° F. create a tougher scale as well as a deposit of molecular iron on the virgin metal surface beneath the scale layer. This deposit results from the reversal of the reaction which forms the FeO. This type of iron, which is sometimes referred to as amorphous iron, becomes chemically bonded to the virgin steel surface. It appears to work harden to a great degree, and a good deal of this iron can be removed by the single application of blast cleaning. However, the portion which remains will break down during cold reduction, mix with the rolling lubricants and form smut.

The first blasting operation is designed to remove substantially all of the mill scale by the mass-velocity impact shattering and abrasion action of the round steel shot. The second blasting operation serves to remove the more tenacious embedded scale, particles of work hardened metal and amorphous iron from the surface of the steel by a cutting and scouring cleaning action of the angular sharp edged steel grit. This combined blasting operation has been found to eliminate the need for pickling hot formed steel so that the subsequent cold rolling operation can be successfully carried out without the appearance of detrimental amounts of smut on the surface.

In the practice of this invention, strip cleaners of the type employing centrifugal blasting means are utilized when the concepts of this invention are applied to the treatment of sheet and strip. The Dill Patent Number 2,434,881 issued October 28, 1947, describes a strip cleaner of this type. A pair of strip cleaners, one utilizing shot and the other utilizing grit, can be arranged in tandem and the cleaning operation carried out in a highly efficient continuous manner.

In a preferred form of this invention, the steel grit employed in the second blasting operation is heat treated to the extent that it will be harder than the shot employed in the first blasting operation. It is also preferred to employ shot having a diameter which exceeds the largest dimensions of the steel grit.

As used herein, the term "steel grit" is to be distinguished from shot in that the shot generally exists in the form of pellets of rounded or curvilinear shape. On the other hand, grit is formed of steel particles of small dimension having irregular shapes and with edges that are relatively sharp by comparison with the generally rounded surfaces of shot.

The Cline Patent Number 2,895,816, issued July 21, 1959, provides an illustration of a typical procedure involving the preparation of steel shot and grit.

Centrifugal blasting equipment has been found particularly suitable for use in conjunction with the concepts of this invention. Where sheet and strip are being cleaned, the steel is adapted to be passed through a first cleaner having centrifugal wheels directing shot onto both surfaces of the steel. This operation will serve to remove substantially all of the mill scale through the mass-velocity impact of the round shot and its shattering and abrasion action. A second cleaner is located tandem the first cleaner, and the centrifugal wheels therein direct grit onto the surfaces of the steel sheet or strip in order to remove the remnants of the mill scale, work hardened surface metal and amorphous iron. Greater than 95 percent of the scale should be removed by the shot blasting operation, while the grit blasting attacks the remainder of the smut forming materials.

As previously indicated, it is preferred that the largest dimensions of the grit particles be smaller than the largest dimensions of the shot. The steel shot may vary in size up to about 0.111 inch in diameter, while the grit particles ordinarily have largest dimensions of less than 0.1 inch. I prefer to use the smallest diameter steel shot that will insure shattering and breaking up the mill scale upon impact. By so doing, greater surface coverage is achieved per pound of abrasive thrown by the blasting units, less work hardening of the surface is done and the surface is not given as deep an etch which facilitates rolling out of the etch to a relatively smooth surface in subsequent operations. In a typical operation in accordance with the practice of this invention, the shot may have an average diameter between 0.017 and 0.039 inch, while the grit particles may have largest dimensions between 0.007 and 0.017 inch.

It is also preferred to have grit particles which are harder than the shot employed; however, exceptionally hard grit particles are not necessary, and this adds to the economy of the process, since grit particles drawn back or tempered to a lower hardness have a longer life. Shot which has been found suitable for the practice of this invention ranges in hardness between 45 and 55 Rockwell C, and preferably between 48 and 55 Rockwell C. The grit employed has a hardness ranging between 55 and 65 Rockwell C, and preferably between 58 and 64 Rockwell C. The use of grit having the lower of these values provides a particularly economical process.

As an example of a procedure involving the process of this invention, 18 inch wide 12 gauge low carbon steel is hot rolled and then introduced into a first strip cleaner employing centrifugal blasting wheels. The strip is then passed through the cleaner at a rate between 80 and 100 feet per minute, and the steel shot is directed at the strip at a rate of about 1800 pounds per minute on each side of the strip. The steel shot employed is characterized by a hardness of 50 Rockwell C and an average diameter between 0.017 and 0.039 inch.

The strip is then immediately passed to a second strip cleaner employing centrifugal blasting wheels. Steel grit with largest dimensions between 0.007 and 0.017 inch and having a hardness of about 60 Rockwell C is employed at the same abrasive flow rate for this second surface treatment. Upon cold rolling of the steel the appearance of smut is substantially eliminated.

In the preferred form, both the first and the second blasting operations are performed with steel abrasives in the dry state for reasons of simplicity and economy. However, the second blasting operation may be performed in a wet state by using a hard grit suspended in a liquid. Hard, non-ferrous or non-metallic grits such as sand or aluminum oxide may be substituted for the steel grit.

In view of the results achieved by the practice of this invention, it is believed apparent that the combination of the shot and grit blast cleaning removes the detrimental

surface conditions which are present when shot blast cleaning only is employed. The production of steel coming from a cold rolling operation without generation of excess smut can, therefore, be accomplished by cleaning the hot rolled steel using mechanical means only without restorting to an acid pickle.

In considering the concepts of this invention, it is apparent that various alterations of the specific description provided can be conceived. Thus, the size and types of abrasive used, the method of applying the blast and the cleaning rates can vary while still realizing the results of this invention. It will also be apparent that various other modifications can be made in the treatment described which provide the characteristics of this invention without departing from the spirit thereof, particularly as defined in the following claims.

I claim:

1. A process for treating hot worked steel in preparation for cold working comprising projecting hardened steel shot, having smooth surfaces, at high velocity onto the surface of the steel to disintegrate scale and remove surface scale, and then projecting hardened steel grit, having sharp edges, onto the previously treated surface of the steel to remove substantially all of the remaining scale and other smut forming conditions remaining in the surface of the steel, and in which the steel grit is of variable dimension with the average diameter of the steel shot exceeding the average of the large dimensions of the steel grit, and moving one of the elements including the surface of the hot worked steel and the source of the projection of the steel shot and grit in relative linear movement during projection of the steel shot and grit onto the surface.

2. The process as claimed in claim 1 in which the steel grit is harder than the steel shot.

3. A process in accordance with claim 1 wherein the diameters of said steel shot range between 0.017 and 0.039 inch and wherein the large dimensions of the particles of the steel grit range between 0.007 and 0.017 inch.

4. A process in accordance with claim 1 wherein the hardness of said steel shot ranges between 45 and 55 Rockwell C and the hardness of said steel grit ranges between 55 and 65 Rockwell C.

5. A process for treating hot worked steel in preparation for cold working comprising projecting hardened steel shot, having smooth surfaces, at high velocity onto the surface of the steel to disintegrate scale and remove surface scale, projecting hardened steel grit, having sharp edges, onto the previously treated surface of the steel to remove substantially all of the remaining scale and other smut forming conditions remaining in the surface of the steel, in which the steel shot has a diameter within the range of 0.017 to 0.039 inch and the steel grit has its large dimension within the range of 0.007 to 0.017 inch and in which the steel shot has a hardness within the range of 45–55 Rockwell C and the steel grit has a hardness within the range of 55–65 Rockwell C.

References Cited by the Examiner

UNITED STATES PATENTS

777,178	12/04	Boley.	
1,116,776	11/14	Wilcox	51—318
1,568,958	1/26	Carter	51—14
2,038,204	4/36	Bidle.	
2,077,639	4/37	Minich	148—4
2,239,044	4/41	Leighton.	
2,703,550	3/55	Bell.	
2,913,354	11/59	Bell.	

FOREIGN PATENTS

626,704	9/61	Canada.
709,869	6/54	Great Britain.
789,513	1/58	Great Britain.

LESTER M. SWINGLE, *Primary Examiner.*

FRANK H. BRONAUGH, *Examiner.*