APPARATUS FOR CONNECTING THE TRAILING END OF ONE METAL STRIP TO THE LEADING END OF A SUCCEEDING METAL STRIP

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ABSTRACT

In processing metal strips, the leading end of a succeeding strip is secured to the trailing end of a preceding strip by cutting the unuseable parts of the ends to be connected and applying an adhesive tape completely across the width of at least one of the ends. The ends are aligned in contacting relationship, preferably one overlaying the other and a pressure member secures them together. If necessary, heat can be applied with the pressure to effect the securement of the adhesive to the metal strips. The adhesive tape is placed across the width of the ends of the metal strips and is cut off before its application to the strip is completed so that it extends for exactly the width of the strip.

16 Claims, 10 Drawing Figures
APPARATUS FOR CONNECTING THE TRAILING END OF ONE METAL STRIP TO THE LEADING END OF A SUCCEEDING METAL STRIP

SUMMARY OF THE INVENTION

The invention is directed to connecting serially arranged metal strips together such as in processing operations where the strips are removed from coils and, more particularly, the invention concerns a method of and apparatus for securing the trailing end of one metal strip to the leading end of a succeeding metal strip where the ends secured are arranged in overlapping or butting relationship and an adhesive substance is placed between them for securing them together.

Machines which work continuously for the treatment of metal strips operate "from the coil" in comparison to machines in which the metal strip is taken from sheets. In continuously working the metal strip from the coil, it is necessary to maintain accurate treatment periods, that is, maintaining a rate of speed which depends on the dwelling time of the strip in a treatment station. The dwelling time is of importance in continuous annealing equipment, in zinc-coating and aluminum-coating equipment, in annealing and pickling equipment for alloy steels, in electrolytic tinning equipment and also in pickling equipment for carbon steels. In such equipment, means are provided for maintaining a reserve of the strip ahead of the treatment station so that any stoppage at the supply point when connecting the succeeding strips does not affect the continuous passage of the strips into the treatment station. Loop pits for maintaining a reserve of metal strips are an example of such a device. Depending upon the rate of travel of strip in the processing operation, a more or less sophisticated supply station and discharge station for the strip permits the attainment of the shortest down times.

Another type of equipment is known which is used with so-called endless strip. Such equipment can be stopped during coil changes and while connecting the strip ends because the down times have no influence upon the strip. In equipment of this type, a loop pit is not used and the strip is under tension between an unwinding machine and a rewinding machine. In certain types of this equipment S-shaped driving rollers are utilized for regulating the tension head of the rewinding machine or to exert, in a general manner, a certain tension effect at different locations in the treatment portion of the equipment. Consequently, the treatment portion of the equipment which operates continuously has a high balancing factor to assure constant operation. Similarly, high rates of strip travel or great tensional forces in the strip or bending forces at locations of deflection stress the strip to a corresponding extent. Therefore, the tensional force of the strip must be transmitted at the point where the strip is connected to the strip of the succeeding coil. It has been known to weld the trailing end of one strip to the leading end of another or to join them by means of hook forming apparatus, such as a combined press and bending apparatus. For various reasons, the shape-closing or integral connections are not suited for all strip thicknesses nor are they applicable to all types of equipment.

In such cases, a solution is provided by gluing the strips together since there are adhesives available for connecting the trailing end of one strip to the leading end of another so that considerable tension forces can be transmitted through the connection. Where a gluing method is utilized, both the application of the adhesive and the application of pressure represent problems which require solutions. It is the object of the present invention to improve the operation of gluing the strips together. On one hand, the quality of the connection is improved and on the other the time required for completing the connecting operation is kept as short as possible. In accordance with the present invention, the attachment of the strip ends can be accomplished without any manual labor which in the past caused qualitatively inadequate connections. Other difficulties experienced with manual labor are the inaccuracy of the application of the adhesive and the unsatisfactory positioning of the strip sections to be connected. For example, one notable deficiency where the glue is applied to the strip ends by hand is the development of gaps between metallic surfaces which are not filled by the adhesive. Another disadvantage occurs when the strip ends do not cover the adhesives supplied. Where gaps occur, they tend to carry the various liquids of the treatment baths through all of the treatment stations so that the chemical composition of the processing liquids are disadvantageously affected or else the strip is rendered useless over a considerable length adjacent the strip connections. Where the connection of the strips are not properly made, their ability to transmit great tensional forces is adversely affected and it is possible that no useable connection is attained depending on the thickness of the strips. Therefore, in accordance with the present invention, it is possible to overcome all of the deficiencies set forth above, taking into consideration such factors as the type of strip material used, its thickness and surface quality.

In accordance with the present invention, prior to locating the strip sections in overlapping or butting relationship, a metal-adhesive film is applied in an equally fast manner to one or both of the strip sections and then they are positioned properly for the connecting operation. With the edges of the strip sections in proper alignment, whether in overlapping or butting relationship, and with the adhesive film extending across the width of the connection, a substantially gap-free joint can be obtained. When the strip sections are being connected together they are located in a stationary position supported by a bearing surface to which heat can be supplied, if necessary. Where an overlapping connection is made, the serially arranged sections are exactly aligned so that the adhesive film portion or portions are properly and exactly juxtaposed at the strip ends to be connected. When the strip ends about one another and both ends are covered with the adhesive film, such as a fiber-glass-reinforced adhesive tape, the adhesive covers up the butt joint at the time connection is made. When the strip sections are correctly aligned, pressure can be applied for completing the connecting operation. The reaction of the adhesive with the metal takes place during the compressing step and during this step, care must be exercised to avoid any undesired shifting or displacement of the strip sections being connected.

To ensure the accuracy of the connecting operation unusable portions of the strip ends are cut away such
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as the wavy tail portion located at the inner end of a coil or the leading edge of a new coil. The trailing end of the preceding coil is removed and the preceding strip section is moved forwardly into the proper connecting position and then the unuseable leading end of the succeeding strip section is removed and the latter is gripped and moved forwardly into the proper connecting position relative to the previously positioned trailing end.

Another feature of the invention is the exact superposition or abutment of the strip sections to be connected. In feeding and positioning the strip sections, the use of flat strip sections having no bends at all is of considerable importance, as indicated above, where the trailing end or leading end of the sections are removed prior to the positioning and connecting operations. However, starting and stopping the strip sections for such operation may entail certain factors of instability. To assure accurate positioning of the strip sections the leading edge of the new or succeeding strip is clamped to a flat base at a position spaced from the point at which any unuseable portions are cut off and then is fed forwardly into the proper connecting position. By means of the clamping devices used, in holding the strip sections, the distance through which the sections move is defined precisely and exact positioning is possible. The extent to which the leading end is moved forwardly assures the proper overlap or abutment of the strip sections. When the strip ends are placed in abutment, they should not rest against each other too firmly for the purpose of closing the butt joint because an uneven or wavy configuration may develop in one of the strip section ends. If heat is applied to the strip ends during the connecting operation, it is particularly advantageous if the connection is cooled after it has been formed. This feature of the invention permits the connection to attain the greatest possible ability in transmitting tensile forces.

Another problem which the present invention solves is the uniform and exact application of the adhesive film to the strip sections to be connected. In accordance with the invention, an exact length of the adhesive tape is provided for application to the strip determined by the exact width of the strip. To achieve this end, the metal-adhesive film is provided by the combination of an adhesive tape and a paper tape formed on the one roll. Prior to its application the adhesive tape is separated from the paper tape or backing and the paper tape guides and leads the adhesive tape transversely across the width of the metal strip and before the adhesive tape is finally applied to the metal strip, it is cut and then its remaining length is pressed into place so that the cut end exactly aligns with a longitudinal edge of the metal strip.

To assure that the leading edge of the adhesive tape properly aligns with the longitudinally extending edge of the strip, the present invention provides an arrangement for such exact alignment. Therefore, in accordance with the invention, the adhesive tape is maintained under a tension so that the tensional forces employed in unwinding the paper tape and the adhesive tape leader effect a rotation of the pressure rolls guiding the tapes so that the leading edge of the adhesive tape is exactly positioned along one longitudinally extending edge of the metal strip as a pressure roll for applying the adhesive tape is lowered into position.

In implementing the present invention, the equipment employed comprises a pair of drive rollers which are height-adjustable and are located at the strip discharge side of the frame for the equipment. The driver rollers provide a clamping action for the trailing end of the metal strip at a position spaced forwardly from the end which is connected to the leading end of the succeeding strip. Located on the frame between the supply or inlet end of the metal strip and the discharge end a cutting member is provided followed in the direction of the travel strip by a pair of jaws for applying pressure and, if necessary, heat to the strip ends being connected. Between the cutting member and the jaws a device is arranged, movable in a direction across the direction of travel of the strip for applying the adhesive tape to the strip. The position of the cutting member employed in cutting off the unuseable portions of the strip ends provides an exact reference for feeding the strip sections forwardly into proper position for the overlapping or abutting connection. The positioning of the ends to be connected would be uncertain if the exact location of the trailing end and the leading ends of the strip sections could not be exactly determined.

The present invention eliminates this problem which was experienced in the past and, in addition, also overcomes the deficiency of any inadequate shape of the cut ends of the strips. Due to the coordination of the individual components forming the equipment, it is possible to carry out the entire connecting operation as a series of fully automatic steps.

Further, the equipment in accordance with the invention provides a carriage which serves as a table or support for the metal strip for moving it in proper relationship to the location of the connecting jaws and the cutting member. The carriage incorporates a clamping plate for securing the strip section in an exact position and a drive mechanism for moving the strip section forwardly into place for the cutting and connecting steps. The clamping plate is arranged to move forwardly with the carriage so that the leading end of the succeeding metal strip can be fed forwardly the precise distance for connecting the proper positioning of the ends to be connected. Located between the connecting jaws and the cutting member is an angularly adjustable intermediate table. Due to its adjustability, the table can be displaced for removing the cut off portions of the strip sections and, additionally, the table serves for supporting the strip as it is conveyed through the equipment.

Another feature of the equipment is the arrangement of the cutting member or shear which consists of single blades and the connecting jaws which are made up of a pair of individual jaws. In the operative condition, the blades and jaws move in opposite directions to perform the desired operation. The connecting jaws are operable only during the operation of attaching the strip ends together. When the equipment is switched over to "running through," the metal strip is fed through the equipment with the connecting jaws and the cutting blades disposed in the opened or spaced relationship.

A particular feature of the equipment embodying the invention is the device for the application of the adhesive tape to the metal strip. The tape applying device is actuated for applying and cutting the adhesive tape by means of cams or similar elements which afford the requisite adjustability for adapting to the width of the metal strip. Accordingly, the length of the section of
adhesive tape applied is determined by the width of the metal strip sections being connected.

The device for applying the tape is equipped with a friction wheel drive which serves as a payout drive for the adhesive tape, the wheels of the carriage run in tracks extending transversely to the direction of travel of the metal strip sections. The motion of the device automatically commences the unwinding of the adhesive tape so that the travel of the adhesive tape device is limited to the width of the metal strip.

Additionally, the torque of the friction wheel drive of the tape applying device is transmittable, by means of a pulling element, to one or more adhesive tape pressure rollers as well as to the paper tape rollers. Taking into consideration the respective transmission ratios both the paper and the adhesive tape rollers are driven synchronously.

The tape applying device, which acts as an essential element of the equipment is further characterized by a thrust piston drive system which is actuated by cams and embodies a lever with an eccentric. An adhesive tape guide roller is mounted on one part of the level and another part of the level, in combination with a housing for the adhesive tape reel, forms a friction wheel locking mechanism. The function of the friction wheel locking mechanism is to control the amount of the adhesive tape removed from its supply reel. When the braking action of the friction wheel locking mechanism is effective the adhesive tape guide roller is positioned so that it does not rest on the surface of the strip section to be connected.

In addition, an intermediate lever is attached to the lever of the friction wheel locking mechanism, and the intermediate lever is connected to a rocker member pivotally secured about an eccentric bushing on which a clamping roll is positioned for gripping the paper tape after it has been separated from the adhesive tape. Accordingly, the actuation of the thrust piston drive system operates not only the raising of the pressure roller or the engagement of the friction wheel locking mechanism, but also the motion of the intermediate lever secured to the rocker for releasing the clamping roll from the paper tape when the adhesive tape guide roller is lifted.

Furthermore, the rocker is preloaded by a helical spring acting counter to the support of the intermediate lever for biasing the clamping roller in the direction of a counter roller for gripping the paper tape. Therefore, the action of the spring tends to clamp the paper tape between the clamping roll and its counter roll until a release of the paper tape is effected due to the motion of the adhesive tape guide roller.

However, the intermediate lever is provided with an elongated hole at the point it is linked to the rocker so that, when the adhesive tape guide roller is lifted, a delayed release takes place in releasing the paper tape from between the clamping roll and its counter roll so that the paper tape remains taut when the adhesive tape guide roller is initially lifted causing only a slackening of the paper tape.

The slackening action on the paper tape is utilized to rewind a certain length of the adhesive tape onto its supply reel. This rewinding action is accomplished by means of a hub attached to the housing of the supply reel which is rotatably about a shaft in the housing and contains a mechanism for increasing the friction between the shaft and the reel housing. By increasing the resistance when unwinding the adhesive tape there is a tendency to maintain the combination of the adhesive tape and the paper tape in a taut condition. For example, a dish spring may act as the mechanism for increasing friction between the housing of the supply reel and the machine housing.

Advantageously, the supply reel of adhesive tape is pushed onto the hub over a ring concentric with it and a torsion spring is provided about the hub with one end anchored in the hub and the other in the ring secured about the hub. Accordingly, the tension in the adhesive tape preloads the torsion spring during the unwinding operation to an extent sufficient to store a certain amount of energy for maintaining the adhesive tape taut immediately when a slackening action is provided on the tape, that is, when the adhesive tape guide roller is lifted off the metal strip with the result that the adhesive tape and paper tape are rewound on the supply reel due to the energy stored in the torsion spring.

The adhesive tape device also incorporates a knife blade located behind the adhesive tape guide roller in the direction of travel of the tape and secured in a stationary position on the machine housing. The knife blade serves to cut the adhesive tape in a length corresponding exactly to the width of the metal strip. Furthermore, the knife blade cuts the adhesive tape before the adhesive tape is finally applied to the metal strip. Since several pressure rollers are utilized in addition to the adhesive tape guide roller and since the adhesive tape tightens tangentially when the adhesive tape guide roller if lifted from the metal strip, a cutting pressure is established in the tape against the knife blade which is positioned in the tangential path of the tape. As a result, with the continuous lifting of the adhesive tape guide roller the tape is cut without difficulty.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an elevational view, partly in section, of the overall arrangement of the equipment in accordance with the present invention;

FIGS. 2 to 7 show a portion of the equipment illustrated in FIG. 1 involved in the steps of connecting the ends of the serially arranged strip sections together;

FIG. 8 is a detailed elevational view, partly in section, of a device for applying adhesive tape as shown in FIG. 1, the section being taken transverse to the direction of travel of the strip through the equipment shown in FIG. 1;

FIG. 9 shows a portion of the elements illustrated in FIG. 8 at the termination of the operation of applying the adhesive tape across the width of the strip; and
FIG. 10 is a partial view of FIG. 9 displaying the arrangement of the elements of the tape applying device in position for commencing the application of the adhesive tape to the metal strip.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, equipment is shown for joining the trailing end of a metal strip to the leading end of a succeeding metal strip prior to passing the strip through a processing operation. As illustrated in FIG. 1, the equipment is in the "strip running through" condition, that is, a metal strip 2 is removed from a strip supply reel 3 and passes through the equipment leaving it at the discharge side 1 for subsequent passage through a processing station, not shown. At the strip supply side 4 of the equipment a pair of deflection rollers 5 and 6 are arranged to afford correct strip deflection for its passage into the equipment. The upper deflection roller 6 is of a larger diameter for conveying a greater bending stress of the metal strip 2.

At the discharge side or end of the equipment 1 a pair of driving rollers 7 and 8 are located, shown in FIG. 1 in spaced apart relationship. In reverse order to the direction of the travel of the strip 2 through the equipment are a pair of connecting jaws 9 for compressing and heating the ends of the strips to be connected, an intermediate table 10, an adhesive tape device 11 located above the strip as it passes over the intermediate table 10, a cutting member 12 located next to the intermediate table 10 and a carriage 13 which extends from the supply side of the equipment toward the cutting member 12.

The following is a detailed description of the main sub-assemblies of the equipment.

THE DRIVING ROLLERS 7 AND 8

At the discharge side of the equipment the driving rollers 7 and 8 are mounted on a frame 15a which is movably positionable in the vertical direction on a frame 15 which forms the common support for the various elements of the equipment. The frame 15a is adjustable similar to those used in milling machines. The driving roller 8 is supported in a bearing block 16 which is movably positionable in the upright direction. For adjusting the position of the driving roller 8, a cylinder 18 is mounted on the frame 15a and a piston rod extends upwardly and is attached to the bearing block 16 for selectively positioning the driving roller 8. As shown in FIG. 1, the driving rollers 7 and 8 are in the "strip running through" position. When the roller 8 is moved upwardly, it clamps the metal strip 2 between it and the upper roller 7 so that the metal strip 2 can be stopped or, by means of the gripping action provided by the rollers, the strip can be selectively moved through the equipment.

THE CONNECTING JAWS 9

The connecting jaws provide a pressing or compressing action for effecting various connecting processes where an adhesive has been applied to the metal strips to be connected. Mounted on the frame 15 above the path of the metal strip is a holder or bracket 19 and a similar bracket 20 is attached to the frame below the path of the travel of the strip. An upper press member 21 is fixed to the upper bracket 19. A lower press member 22 is mounted on the lower bracket 20 and is movable toward the upper press member 21 by means of a piston 23 mounted within a cylinder 24 aligned below the lower press member. At its lower end the housing 25 of the cylinder is linked to the frame 15. In effect, the lower press member 22 forms an extension of the piston 23 and is positioned for vertical movement upwardly toward the upper press member 21 within the tracks 26. The connecting jaws 9 can be provided with heating elements, however, such elements are not necessary for each connecting operation where an adhesive is used. When adhesives are employed which do not need heat to assist in the connecting operation, smooth or roughened jaws 27 are sufficient for the pressing operation and in such a case, the heating coils 28 are unscrewed and removed from the jaws. The upper press member 21 can be moved by relocating the fastening screws 29 in the holes provided in the frame 15. It is not necessary to provide any movability for the bracket 20 which supports the lower press member 22.

THE INTERMEDIATE TABLE 10

Below the path of travel of the strip through the equipment the intermediate table 10 is rotatably supported on a shaft 30 secured to the frame 15. In FIG. 1, the table 10 is shown in the horizontal position, however, various angular positions can be produced by means of the piston drive system 31 secured to the table and extending upwardly from it and secured at its upper end by means of a plug-in bolt joint 32 to the upper bracket 19. The lower end of the piston rod secured to the table is also provided with a similar type joint. In the position shown in FIG. 1, the table 10 rests on the adjacent lower member of the cutting member 12. When the lower knife member is raised, the table 10 is displaced upwardly into an upright position so that, on one hand, a discharge opening is provided for cut off portions of the strip section, and on the other hand, so that it will not interfere in the upward movement of the lower portion of the cutting member. It will be noted that the adhesive tape applying device 11 is located above the table 10 and the table acts as a bearing seat during the application of the tape when the lower portion of the cutting member 12 is in its retracted position.

THE ADHESIVE TAPE APPLYING DEVICE 11

The device 11 is composed primarily of a reservoir box 34 which slides in a vertical track 35 and a drive 36 is positioned above the box for moving it in the vertical direction. A thrust drive, that is, a hydraulically or pneumatically operated piston drive system, may be utilized as the drive 36. A rail arrangement 37 is rigidly attached to the frame 15 and extends transversely across the path of travel of the metal strip through the equipment. When the box 34 is lowered for applying tape, an adhesive tape guide roller 38, located in the lower end of the box, contacts the metal strip 2 and, in turn, provides the means for driving the friction wheel 39 which together with a rail 40 forms the drive for unwinding the adhesive tape from its supply reel. The drive for the transverse movement of the box 34 is pro-
vided by separate means. Above the rail 37, a box 41 having the dimensions of the rail is attached to the frame 15. The box 41 serves as a support and, at the same time, provides means for the entire adhesive tape applying device 11. Additionally, the box 41 represents a measure for the distance traversed by the device 11 across the width of the metal strip 2. To determine this transversely, impulse generators 42 are located on the box 41 and the impulse generators can be designed in the form of cams if instead of a hydraulic, a mechanical or electrical drive system is used. Various means of driving the adhesive tape applying device 11 are possible. One example of such drive means is an electric motor 43 which, by a chain transmission or a rack transmits its driving moment to the tape applying device 11. The specific means for driving the device 11 from the motor 43 are not illustrated. The manner in which the tape applying device operates and the construction in the interior of the reservoir box are described subsequently herein, (note the description with reference to FIGS. 8 to 10).

THE CUTTING MEMBER 12

The upper part of the cutting member 12 is attached to a bracket 44 secured to the frame 15. The bracket 44 supports the upper stationary knife element 45. Consequently, the cutting action is performed when the lower knife element 46 is moved upwardly relative to the upper knife element 45. The lower knife element 46 is positioned on a support 47 which is secured at its lower end to the upper end of a piston rod 48 which forms a part of a thrust drive piston 49 for the movement of the lower knife element. The piston drive system 49 is secured to a housing member 50 and is attached to the frame 15 by means of a quickly disconnectable plug-in bolt connection 51.

THE CARRIAGE 13

To the right of the cutting member 12, as viewed in FIG. 1, the carriage 13 provides the remainder of the equipment mounted on the frame 15. The carriage 13 serves as a support table for the metal strip 2. Primarily, the table is formed of a bearing surface 52 and rollers 53, 54 located at one end of the table and a roller 55 located at its other end, and all of the rollers are mounted on rigid shafts 56 secured in frame 15. A part of the bearing surface is formed by an angle plate 57 which serves as a counter plate for a movable clamping plate 58 located above the path of the metal strip as it passes through the equipment. When the clamping plate is moved downwardly, in combination with the angle plate 57, it clamps the metal strip 2 which passes between the two plates. Formed as a part of the angle plate 57 is a frame section 59 located vertically above the metal strip. Supported on the frame section 59 is a clamping drive 60, which, preferably, consists of a hydraulic piston drive system. The bearing surface 52, the angle plate 57 and the frame 59 which carries the clamping drive 60 for the clamping plate 58 all form part of the movable carriage 13. The drive for the carriage is provided by a lever transmission arrangement.

A link 61 is attached both to the angle plate 87 and to the upper end of a rocking lever 64 by pin members 62 and 63. The lower end of the rocking lever remote from the angle plate 57 is secured to the equipment by a pin member 65 and a hydraulic piston drive system 66 is secured to the rocking lever intermediate its ends and acts as the drive means for the carriage. The piston drive system 66 rests in a bracket 69 which forms a connection with the side legs of the frame 15 and contributes to the stiffness of the arrangement.

In addition to the moving parts of the equipment described above, a pair of nozzle tubes 70, 71 are provided on the opposite sides of the connecting jaws 9, see FIG. 1, and serve as a means for supplying cold gases to the space between the connecting jaws. In addition, between the driving rollers 7 and 8 and the connecting jaws 9, a table 73 is provided which is arranged in the horizontal position.

DESCRIPTION OF FIGURES 2 TO 7

In FIGS. 2 to 7, the elements of the equipment in FIG. 1 are shown isolated in the various steps involved in the preparation of and the connection of the trailing end and the leading end of the metal strip sections to be connected.

Initially, the last portion of the metal strip from a supply reel 3 enters the equipment and is supported on the carriage 13. As indicated in FIG. 2, the trailing end of the metal strip section has a wavy appearance and is not suitable for connection to the leading end of the next successive metal strip. The driving rollers 7 and 8, previously in the spaced apart position as indicated in FIG. 1, are moved into the clamping position 74, as indicated by the arrows in FIG. 2. To provide for the continuation of the processing operation ahead of the equipment a loop is formed forwardly of the driving rollers 7 and 8 of a sufficient size to prevent any disruption in the operations during the relatively rapid connecting operation. In this first step of the connecting operation the jaws 9 are in the opened position. As the lower knife element 46 moves upwardly the table 10 is swung about the shaft 30 into an upright position and the cutting member 12 removes the wavy trailing end 2a of the metal strip. All of the steps involved in the connecting operation are stored in a programming console and, if desired, can be run off automatically without any operator assistance.

As illustrated in FIG. 3, the driving rollers 7 and 8, controlled for example by an electrical motion initiator, are moved through an angular distance 75 pulling the strip 2 forwardly from the cutting member 12. The angular distance imparted to the metal strip moves its trailing end below the adhesive tape applying device 11 and the table 10 forms a support surface for the end of the strip below the device 11. The tape applying device is now in its lower position, note arrow 76, and the adhesive tape guide roller 38 rests on the upper surface of the metal strip 2. As the drive 70 moves transversely across the width of the strip, the friction wheel 39 provides the driving force for unwinding the combination adhesive tape 77-paper tape 87. For purposes of clarity, the manner in which the adhesive tape 77 is applied will be described with reference to the subsequent description of FIGS. 8 to 10.

After the adhesive tape has been applied to the metal strip, the driving rollers 7 and 8 perform another angular movement 78, note FIG. 4, moving the trailing end of the metal strip with the adhesive tape located at its end directly between the connecting jaws 9. Again the
table 10 swings about its shaft 30 as the cutting member operates to remove the unusable leading end 79 of the succeeding metal strip 80. As indicated in FIG. 4, the cut off portion of the strip drops out of the equipment without difficulty and is collected in a scrap bin, not shown. It is important to note at this point, that a definite length of the metal strip is determined by the clamping motion 81 of the deflection rollers 5 and 6, the accuracy of the metal strip length being increased by effecting the gripping action of the strip between the angle plate 57 and the clamping plate 58 effected by its clamping drive 60. In FIG. 5, it will be noted that the position of the driving rollers 7 and 8 remains unchanged so that the trailing end of the preceding metal strip remains in position. Meanwhile, the heating coils 28 have been heated electrically, such as by resistance heating, if such heating is necessary for the type of adhesive type 77 utilized. With the metal strip 80 gripped between the angle plate 57 and the clamping plate 58, the carriage 13 performs a feeding motion 82 which is precisely effected by means of the drive 66. This precise movement of the carriage locates the leading end 83 of the metal strip 80 directly above and overlapping the adhesive tape 77 applied to the trailing end of the metal strip 2. As the metal strip 80 is moved forwardly, the rollers 5 and 6 have released the strip so that they do not impede its movement. It is of particular note that the carriage 13 provides the advantage of moving the metal strip 80 across the lower knife element 46 of the cutting member 12. Furthermore, the arrangement of the table 10 is such that it does not interfere with the movement of the carriage 13. Additionally, the path of travel of the strip is arranged so that it is possible to use induction heating instead of resistance heating. The type of equipment employed permits an extensive change of all the elements involved.

As shown in FIG. 6, with the leading end of the succeeding strip in superimposed relationship to the trailing end of the preceding strip, the piston 23 pushes the lower connecting jaw upwardly against the upper connecting jaw with the metal strip ends between them. The connecting operation lasts only a few seconds and the strips 2 and 80 are united together. The advantages of this adhesive connection have been explained earlier.

In FIG. 7, the piston 23 retracts the lower connecting jaw 9 and the clamping drive 60 moves the clamping plate 58 releasing the gripping action on the strip 80. Cooling gas is supplied through the nozzle tubes 70, 71 for effecting a quick cooling of the strip connection and thereby bringing the connection to its highest degree of strength. This concludes the connection operation and the processing of the strip is continued as it is withdrawn from the succeeding supply reel.

The following is a detailed description of the steps involved in the application of the adhesive tape and of the various elements involved which make up the adhesive tape applying device. The operation and arrangement of the adhesive tape applying device is of particular importance to the invention since it assures the exact positioning of the adhesive tape across the surface of the metal strip so that the leading and trailing ends of the adhesive tape are in exact alignment with the longitudinally extending edges of the metal strip at its cut end.

DESCRIPTION OF FIGURE 8

Located within the reservoir box 34 are an adhesive tape-paper tape supply reel 84, clamping rollers 85 and 86 for the paper tape 87, a guide roller 38 for the adhesive tape 77 and two pressure rollers 88 and 89 disposed on the opposite sides of the guide roller 38 in the direction of travel of the tape applying device 11. Positioned on the exterior of the reservoir box is the friction wheel 39, shown in phantom, which has been described earlier. Also positioned on the exterior of the reservoir box are sprocket wheels 90, 91, 92, and 93 connected by shafts through the wall 94 of the box 34 to the friction wheel 39 (90), the clamping roller 86 (91), and the pressure rollers 88, 89 (93, 92). Accordingly, the traction of the friction wheel 39 on the rail 40 causes the chain 95 to be driven and in turn drives the clamping rollers 85, 86 for the paper tape 87 and the pressure rollers 88 and 89. While a chain 95 has been shown, it should be appreciated that other similar means could be employed for effecting the required driving action. The guide roller 38 is driven by the tensional forces developed in the combination adhesive tape 77-paper tape 87. The arrangement for supplying the adhesive tape is formed of a housing 96 containing a centrally arranged hub 97 formed of one piece of material. The hub 97 is mounted for rotation on a shaft 98 which is supported in the wall 94. Surrounding the hub 97 is a torsion spring 99 having one leg 100 anchored in a radial hole 101 in the hub and its other leg or end anchored in a hole 103 in a ring 104 which is disposed concentrically about the hub. The outer periphery of the ring 104 has a plurality of angularly spaced projections which afford a gripping action on a cardboard sleeve 106 of the type available commercially in rolls 107 of adhesive tape 77. The cardboard sleeve can be easily mounted on the ring 104 and securely held in place by the projections 105. When the adhesive tape and paper tape are unwound from the reel, the torsion spring 99 is tightened and stores energy.

Though not shown in FIG. 8, a dish spring is located on the outside diameter of the shaft 98 for increasing the friction between the shaft and the hub 97 so that the housing 96 can only be rotated under certain friction conditions.

Mounted on the exterior of the reservoir box 34 is a thrust piston drive system 108 whose piston rod 109 extends into the box and is secured by means of a lever 111 to an eccentric member 110. A lever member 112 is secured at one end to the eccentric 110 and at its other end supports the guide roller 38 so that it is rotatable about a shaft 113. Additionally, the lever member 112 adjacent the housing 96 has a curved configuration 114 juxtaposed to the outer surface 115 of the housing 96 which surfaces combine to form a friction wheel locking mechanism. An intermediate lever 116 is secured at its lower end to the lever body 112 and extends upwardly and is secured to one end of a rocker arm 117. At its other end, the rocker arm 117 supports the upper clamping roller 85. An eccentric bushing 118 is provided between the rocker 117 and the clamping roller so that one can turn within the other. A helical extension spring 119 is attached at one end to the rocker arm 117 and at its other end to the wall 94 of the reservoir box 34. The extension spring 119 biases the rocker 117 toward the intermediate
lever 116. The intermediate lever 116 has an elongated hole 120 at the point at which it is secured to the rocker arm.

In the lower portion of the reservoir box, between the pressure roller 89 and the guide roller 38, a fixed knife blade 121 is located for cutting off the desired lengths of the adhesive tape. After the adhesive tape 77 and paper tape 87 pass over the guide roller 38 the adhesive tape 77 is separated for application to the metal strip and the paper tape continues about the guide roller, passes upwardly through the reservoir box between the reverse clamping rollers 85 and 86 and passes between the sheet metal parts 122, 123 into a collecting bin 124 secured on the exterior of the reservoir box.

The following is a description of the manner in which the reservoir box operates, based on the assumption that it is driven transversely across the metal strip, and based on the showings provided in FIGS. 9 and 10.

FIGURE 9

The end of the step of applying the adhesive tape to the metal strip 2, as shown in FIG. 9, signifies the return of the reservoir box to the position required for initiating the next application of the tape. Specifically, FIG. 9 shows the termination of the tape applying operation. The impulse generator 42, see FIG. 1, actuates the activity of the thrust piston drive system 108, see FIG. 8, and raises the guide roller 38 from the position indicated in FIG. 8. As the guide roller moves upwardly, the adhesive tape also follows an upward path and intersects the position of the knife blade 21 and as the tape continues to move upwardly, the requisite length of the tape is cut for application to the end of the strip 2. After the tape is cut the pressure roller 89 completes the pressing of the tape onto the metal strip, the direction of application of the tape being indicated by the arrow 125. Accordingly, the cut off end of the adhesive tape coincides with the longitudinally extending edge of the metal strip at its cut off end and requires only the adjustment of the impulse generator 42 to afford the proper execution of the cutting and application of the tape.

When the adhesive tape is cut, the pre-loaded torsion spring 99 turns the adhesive tape supply reel assembly 84 or the reel 107 backwardly and winds a part of the adhesive tape 77 onto the paper tape 87. Accordingly, the adhesive tape is maintained taut. As the guide roller 38 is lifted by the lever 112 its curved configuration 114 moves into contact with the outside periphery 115 of the housing 196 and provides a braking action. As the lever member 112 and the guide roller 38 move upwardly so also does the intermediate lever 116. Due to the provision of the elongated hole 112 in the lever a certain delay is provided until the intermediate lever swivels the rocker arm so that the clamping rollers 85 and 86 become disengaged from the paper tape so that it no longer moves forwardly but instead moves in the reverse direction for a specific length, thereby affording a rewinding action of the adhesive tape and the paper tape together.

FIGURE 10

After the adhesive tape 77 and the paper tape 87 have been rewound a position is established, which, when the guide roller is again lowered, defines the start of the adhesive tape at the tangential point 126 on the periphery of the guide roller 38. By proper adjustment the tangential point 126 coincides exactly with the longitudinally extending edge of the metal strip passing under the tape applying device 11. When this starting position has been reached, the entire adhesive tape applying device 11, see FIG. 1, has been lifted by means of its vertical drive 36 so that the friction wheel 39 is disengaged from the rail 40, and accordingly, during the return movement of the device there is no movement of the adhesive tape 77. When the tape applying device is in position to repeat the application of the adhesive tape the guide roller 38 is in the position indicated in FIG. 10 with its tangential point 126 aligned directly above one of the longitudinally extending edges of the strip 2 and the friction wheel 39 is lowered into contact with the rail 40. To initiate the application of the tape the impulse generator 42, see FIG. 1, institutes the operation of the thrust piston drive system 108 and the guide roller is lowered into position by the lever member 112 and the downward movement of the lever member releases its curved configuration 114 from the outside periphery 115 of the housing 95. Since no tension prevails in the paper tape 87 at this point than in the adhesive tape 77, the guide roller unwinds in the manner described above. The purpose of the elongated hole in the intermediate lever 116 is to effect the discontinuance of the driving force of the clamping rollers 85, 86 on the paper tape 87, as the guide roller 38 is being lifted by the lever member 112, but before the friction wheel locking mechanism 114-115 comes into engagement. If the clamping rollers were not released the paper tape would remain under tension and would not permit the force of the torsion spring to become effective for rewinding the adhesive tape 77.

What is claimed is:

1. Apparatus for connecting the trailing end of a metal strip to the leading end of a succeeding metal strip comprising, in combination, a frame extending in the direction of travel of the metal strip from a supply source, said frame having a supply end where the strip enters said frame and a discharge end where the strip leaves said frame, and having a path of travel through the frame interconnecting the supply and discharge ends, means located at the discharge end of said frame for drawing a metal strip therefrom, strip cutting means positioned between the supply and discharge ends of said frame for cutting the metal strip, means positioned along the path of travel downstream relative to said cutting means for movement transversely of a metal strip and operable to apply an adhesive metal tape along the end of one metal strip in a direction transversely of the path of travel beginning at one longitudinal edge of the metal strip and terminating at the other longitudinal edge thereof, and clamping jaw means operable to press the end of another metal strip against the adhesive tape on the end of said one metal strip to interconnect the two metal strips.

2. Apparatus, as set forth in claim 1, wherein said clamping jaw means includes a pair of vertically aligned jaws one located above and the other located below the path of travel of the strip and positioned between the discharge and supply ends of said frame, said jaws being displaceable toward one other for clamping and applying pressure to the metal strips, said pair of
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aligned jaws being located between said metal tape applying means and the discharge end of said frame.

3. Apparatus, as set forth in claim 1, including carriage means located between said cutting means and the supply end of said frame, said carriage means comprising a clamping means for gripping the succeeding metal strip, said carriage means being moveably displaceable along said frame in the direction of the path of travel of the strip therebetween, and means for selectively displacing said carriage means along the path of travel for movement to a position where its end remote from the supply end of said frame is located adjacent said jaws and on the side thereof closer to said cutting means.

4. Apparatus, as set forth in claim 1, including means in operative communication with said tape applying means for moving said tape applying means transversely cross the width of the metal strip for exactly the width of the metal strip, so that on completing the movement across the width of the metal strip said tape applying means is returned to the position for initiating the application of the adhesive tape to the end of the next strip to be connected, a rail rigidly attached to said frame located above the path of travel of the strip and extending transversely of the direction of the path of travel, a friction rail secured to said rail for engagement with said tape applying means for feeding the adhesive tape to the strip, and a box secured to said frame above said rail, said box acting as a support for aid tape applying means and extending across the direction of the path of travel of the strip for guiding said tape applying means in applying the adhesive tape to the strip.

5. Apparatus for connecting the trailing end of a metal strip to the leading end of a succeeding metal strip comprising a frame extending in the direction of travel of the metal strip from a supply source, said frame having a supply end where the strip enters said frame and a discharge end where the strip leaves said frame and a path of travel across the frame interconnecting the supply end and the discharge end, means located at the discharge end of said frame for drawing a metal strip therefrom, a pair of aligned jaws one located above and one located below the path of travel of the strip and spaced between the discharge end and the supply end of said frame, said jaws being moveably to one another for clamping and applying pressure to the metal strips, a cutting means spaced from and located between said jaws and the supply end of said frame for cutting the metal strip, and means positioned along the path of travel between said cutting means and said pair of jaws for applying an adhesive tape to the metal strip in a direction extending across the path of travel of the strip, a table located between said jaws and said cutting means and positioned below the path of travel of the strip, said table being located below said tape applying means for acting as a support for the strip when the tape is being applied, and said table being pivotally mounted for movement between its normal horizontal position where it acts as a support for the tape applying means and a position where one end thereof moves upwardly into the path of travel of the strip through said frame.

6. Apparatus, as set forth in claim 5, wherein said cutting means comprising a stationary knife element secured in place and aligned above the path of travel of the strip, a movable knife element aligned below the path of travel of the strip and moveable upwards relative to the upper knife element for cutting the strip, means secured to the lower knife element for moving it upwardly, said lower knife element forming a support surface for said table located between said jaws and said cutting means so that when said lower knife element is moved upwardly it pivots said table upwardly into the path of travel of the strip, means attached to said frame for securing said jaw located above the path of travel in a stationary position, and means mounted on said frame for moving said lower jaw upwardly against said upper jaw.

7. Apparatus for connecting the trailing end of a metal strip to the leading end of a succeeding metal strip comprising a frame extending in the direction of travel of the metal strip from a supply source, said frame having a supply end where the strip enters the said frame and a discharge end where the strip leaves said frame and a path of travel across the frame interconnecting the supply end and the discharge end, means located at the discharge end of said frame for drawing a metal strip therefrom, a pair of aligned jaws one located above and one located below the path of travel of the strip and spaced between the discharge end and the supply end of said frame, said jaws being moveably to one another for clamping and applying pressure to the metal strips, a cutting means spaced from and located between said jaws and the supply end of said frame for cutting the metal strip, and means positioned along the path of travel between said cutting means and said pair of jaws for applying an adhesive tape to the metal strip in a direction extending across the path of travel of the strip, means in operative communication with said tape applying means for moving said tape applying means transversely across the width of the metal strip for exactly the width of the metal strip, so that on completing the movement across the width of the metal strip said tape applying means is returned to the position for initiating the application of the adhesive tape to the end of the next strip to be connected, a rail rigidly attached to said frame located above the path of travel of the strip and extending transversely of the direction of the path of travel, a friction rail secured to said rail for engagement with said tape applying means for feeding the adhesive tape to the strip, and a box secured to said frame above said rail, said box acting as a support for said tape applying means and extending across the direction of the path of travel of the strip, a table located between said jaws and said cutting means and positioned below the path of travel of the strip, said table being located below said tape applying means for acting as a support for the strip when the tape is being applied, and said table being pivotally mounted for movement between its normal horizontal position where it acts as a support for the tape applying means and a position where one end thereof moves upwardly into the path of travel of the strip through said frame.

8. Apparatus, as set forth in claim 7, wherein a pair of pressure rollers mounted in the lower end of said reservoir box for acting downwardly against said strip as said reservoir box moves transversely across the
width of the strip, a pair of clamping rollers located within said reservoir box and arranged to clamp the paper tape for pulling the paper tape and the adhesive tape from said supply reel, means operatively engaged with said friction wheel and said pressure rollers and clamping rollers for driving said pressure rollers and clamping rollers from said friction wheel.

9. Apparatus, as set forth in claim 8, wherein a thrust piston drive system operatively connected to said reservoir box, said thrust piston drive system being in operative communication with said means for moving said tape applying means, said thrust piston drive system comprising a piston rod extending inwardly into said reservoir box, a first lever connected at one end to the end of said piston rod within said reservoir box, a second lever, an eccentric pin secured in one end of said second lever and said first lever connected to the eccentric pin of said second lever, the end of said second lever remote from said eccentric pin being connected to said adhesive tape guide roller for moving said guide roller into and out of contact with the strip, and a portion of said second lever having a projection extending outwardly from its surface adjacent the exterior periphery of said adhesive tape-paper tape supply reel for contact therewith for effecting a braking action on said supply reel when said second lever lifts said adhesive tape guide roller out of contact with said strip.

10. Apparatus, as set forth in claim 9, wherein a link member attached to said second lever at a location spaced from its points of attachment to said adhesive tape guide roller and said first lever, a rocker arm secured to said link member at the end thereof remote from said second lever, an eccentric bushing mounted in said rocker arm at the end thereof remote from said link member, one of said clamping rollers secured upon said eccentric bushing for releasing the clamping action of said clamping rollers on the paper tape before the braking action of said projection on said second lever is effective against the outer periphery of said supply wheel.

11. Apparatus, as set forth in claim 10, wherein a tension spring secured at one end to said rocker arm and at said other end to said reservoir box for biasing said rocker arm in a position for maintaining the clamping action of said clamping rollers on the paper tape.

12. Apparatus, as set forth in claim 11, wherein the end of said link member secured to said rocking arm having an elongated hole so that the transmission of the upward movement of said second lever through said link member to said rocker arm is delayed by the extent of the length of the elongated hole.

13. Apparatus, as set forth in claim 12, wherein said supply reel having a hub therein for mounting a roll of adhesive tape-paper tape thereon, a shaft passing through said hub so that said hub is rotatable about said shaft and said shaft being supported by said reservoir box, a housing integral with said hub and enclosing said supply reel, and means disposed between said shaft and said housing for increasing the friction moment therebetween.

14. Apparatus, as set forth in claim 13, wherein an annular sleeve disposed concentrically about said hub and arranged to receive the supply roll of adhesive tape-paper tape, said sleeve being spaced outwardly from said hub and forming therewith an annular space, a torsion spring disposed about said hub in the annular space between said hub and said sleeve, one end of said torsion spring being secured within said hub and the other end thereof being secured within said sleeve for effecting energy storage when the adhesive tape-paper tape is unwound from said supply reel.

15. Apparatus, as set forth in claim 14, wherein a stationary knife element located in said reservoir box between said adhesive tape guide roller and one of said pressure rollers in a position so that said knife element is located above the adhesive tape as adhesive tape is being applied to the strip by said guide roller and so that as said guide roller is lifted upwardly the adhesive tape intersects the position of said knife element and is cut by said knife element to the exact width of the strip to which the adhesive tape is being applied.

16. Apparatus for connecting the trailing end of a metal strip to the leading end of a succeeding metal strip comprising a frame extending in the direction of travel of the metal strip from a supply source, said frame having a supply end where the strip enters the frame and a discharge end where the strip leaves the frame and a path of travel of the strip interconnecting the supply end and the discharge end, a support frame secured to said frame at the discharge end thereof and said support frame being movably adjustable in the upright direction, a pair of driving rollers located in said support frame one located above the path of travel of the strip from the discharge end of the frame and the other located below the path of travel of the strip, said lower driving roller being adjustable positionable in the upright direction for cooperating with said upper driving roller for gripping the strip and pulling the strip along its path of travel, a pair of connecting jaws mounted on said frame adjacent the discharge end thereof, one of said jaws being located above the path of travel of the strip and the other being located below the path of travel and aligned below the upper jaw, said upper jaw being stationarily affixed to said frame and said lower jaw being movably positionable in the upright direction for movement into engagement with the strip for pressing the strip against said upper jaw, heating means secured to said jaws for transferring heat to the ends of the strips to be connected, cutting means positioned between said jaws and the supply end of said frame, said cutting means mounted on said frame and comprising an upper knife element located above the path of travel of the strip and secured in a fixed position to said frame and a lower knife element located below the path of travel of the strip and movably displaceable upwardly toward said upper knife element for cutting the strip, a support table located between said lower jaw and said lower knife element and said support table being supported at one end by said lower knife element when said lower knife element is in its inoperative position, said support table being pivotally secured to said frame so that when said lower knife element is moved upwardly said support table is pivoted upwardly into the path of travel of the strip across the frame, an adhesive tape applying device mounted on said frame and located above the path of travel of the strip and between said upper jaw and said upper knife element so that said support table is located below said tape applying means and affords a support for said tape applying
means in its operative position, said tape applying means being vertically movable on said frame and being movable transversely across the direction of the path of travel of the strip for applying a length of adhesive tape across the width of the strip, means cooperating with said tape applying means for positioning said tape applying means for exactly placing the length of the adhesive tape so that it extends between the longitudinally extending edges of the strip, said tape applying means comprising rail means extending transversely across the direction of the path of travel for guiding said tape applying means, a friction wheel arranged to engage said rail in the operative position of said tape applying means for applying tape so that as the tape applying means moves transversely across the direction of the path of travel said friction wheel drives a length of adhesive tape for application to the strip, a knife for cutting off an exact length of the adhesive tape, and a carriage located on said frame between said cutting means and the supply end of the frame, said carriage comprising a support table located below the path of travel of the strip, said support table including an angle plate, a movable clamping plate aligned above said angle plate and movable downwardly for clamping the strip between said angle plate and said clamping plate, and means mounted on said frame and secured to said angle plate for moving said angle plate said clamping plate and said support table from a position spaced between said cutting means and said inlet end of said frame to a point where the end of the support table remote from the supply end is displaced toward the connecting jaws and moves the strip clamped between said clamping plate and said angle plate into a position between said jaws whereby the leading end of the succeeding strip can be positioned in overlapping relationship with the trailing end of the preceding strip which is held in place between the jaws by the driving rollers.

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