

BELL SYSTEM PRACTICES
Motor Vehicles and
Construction Apparatus

SECTION J6.404
Issue 1, January, 1944
AT&T Co Standard

BURIED CABLE

ROOTING AND PREPARATORY WORK

Contents	Page
1. Type and Assembly of Equipment	2
1.01 Rooting Train	2
(a) Equipment of Main Tractor	2
(b) Equipment of Auxiliary Tractor	3
(c) Equipment of C48 Plow for Rooting	3
(d) Planks for Use Under Tracks	4
(e) Skid for Supporting Rooter Tongue	4
1.02 Plow Coupling	5
1.03 Use of Pusher Tractor	5
2. Rooting Procedures, also Trenching and Crossing Streams	5
2.01 General	5
(a) to (g) incl.—Types of Obstructions	5
2.02 When to Root or Trench	6
(a) When Rooting Can Be Omitted	6
(b) When to Root and Plow in Single Train	6
(c) Rooting in Advance of Plowing	6
(d) Trenching Where Plowing is Impracticable ..	6
2.03 Precautions When Train is in Motion	7
2.04 Following the Markers	7
2.05 Depth of Rooting	7
(a) General	7
(b) Range of Depths	7
(c) Locking Share at Desired Depth	8
(d) Conditions Determining Depths	9
(1) 10 or 14-Inch Depth	9
(2) 18, 22, 24, 26-Inch Depths	9

Contents—(Cont'd.)	Page
(3) 30-Inch Depth	9
(4) 34-Inch Depth	9
(5) 38-Inch Depth	9
(6) 46 and 50-Inch Depths	10
(7) Future Maintenance Considerations.....	10
(8) Use of Lightning Shield Wires Affects Coverage	10
2.06 Crossing Washes, Streams, Ditches	10
2.07 Procedures on Hills	11
2.08 Rooting on Side Hills	14
2.09 Hazards Due to Rooted Trench	15
2.10 Procedures at Obstacles	15
2.11 Replacement of Wearing Plow Parts.....	15
(a) Plow Points	15
(b) Shear Pins	17
(c) Welding Worn Sections	17
3. Obstacles in Right of Way	19
3.01 Removing Obstacles Left in Rooting	19
3.02 If Obstacles Cannot Be Removed	19
3.03 Trenching	19
4. Additional Grading	20
5. Spotting Reels	20

1. TYPE AND ASSEMBLY OF EQUIPMENT

1.01 The rooting equipment generally consists of two or more caterpillar type tractors of at least 100 horse-power and weighing about 40,000 pounds each, connected to a rooter plow such as the Type C48 with share equipped for rooting.

(a) The equipment required for the main tractor (the one attached directly to the plow) is:

- (1) A suitable two-drum or four-drum control winch for use in adjusting plowshare depths. (Two drums are used when rooting, four when plowing.)
- (2) 100 feet of 1/2-inch cast steel rope with independent wire rope center on each drum.
- (3) Adequate protection screen at rear of driver's seat.
- (4) Tarpaulin for covering tractor when not in use.
- (5) Signal whistle or horn.

- (6) Tool box on right running board of tractor.
- (7) Standard tools for tractor maintenance.
- (8) Standard set of tools for C48 plow maintenance.
See 1.01 (c).

(b) The equipment required for the auxiliary tractor is :

- (1) Heavy duty winch 70,000# single line, low gear capacity.
- (2) 800-foot winch rope. 3/4-inch improved plow steel with independent wire rope center.
- (3) Snatch block (Boston and Lockport #326C).
- (4) Wire rope towing line. 30 feet to 50 feet, 1-1/8 inch cast steel with independent wire rope center, with eye in each end.
- (5) Adequate protection screen at rear of driver's seat.
- (6) Tarpaulin for covering tractor when not in use.
- (7) Tool box on right running board.
- (8) Standard tools for tractor maintenance.
- (9) Trail-blazer or bull-dozer blade on one tractor with each plow train.

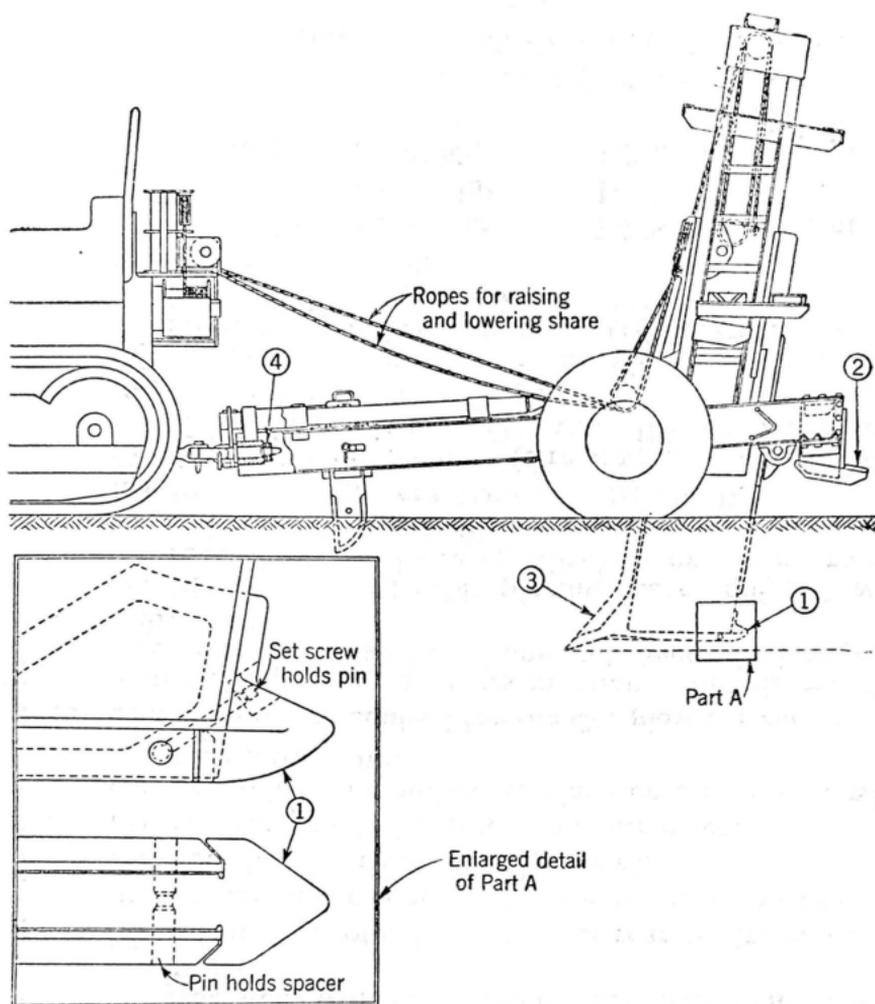
(c) The equipment required for the C48 plow for rooting is :

Note: All drawing numbers mentioned in this practice refer to American Telephone and Telegraph Company drawings.

- (1) Either standard cable placing share equipped with rooter spacer (Drawing 216-A-7) or special rooter share (Drawing 100-R-60).
- (2) Pusher attachment (Drawing 216-A-20).
- (3) Two extra plow points (Drawing 211-A-53) if cable placing share is used, (Drawing 100-R-64), if special rooter share is used.
- (4) 24 extra shear pins to fit plow. 3/4-inch high strength or 1 inch mild steel. (Drawing 111-S-8 for 3/4" Pin.) (Drawing 117-S-61, for 1" Pin.)
- (5) Wrenches. 2 each

7/16" for 1/4" Nut	1-1/8" for 3/4" Nut
5/8" for 3/8" Nut	1-1/2" for 1" Nut
13/16" for 1/2" Nut	1-7/8" for 1-1/4" Nut
1" for 5/8" Nut	
One 2-1/2" for 1-5/8" Nut	

Note: Items listed under (4) and (5) to be carried in main tractor tool box.



C48 PLOW EQUIPPED FOR ROOTING
 Numbers in circles refer to corresponding parts of paragraph 1.01 (c)

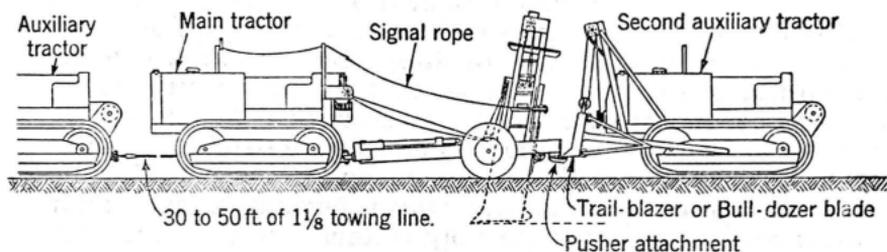
(d) **Planks may be required on the job to place under tractor and trailer tracks and under plow wheels at night to prevent their freezing in the mud during winter season. They also may be of assistance in crossing ditches and road shoulders.**

(e) **A large steel skid (Drawings PR319 and PR320) is used to support the roter plow tongue when pulling roter over soft or marshy ground where it is necessary to pull it alone by means of the winch line, without the usual tractor**

attached to the tongue. Ground may be too soft to support the tractor and skid is required to support front end of tongue to prevent it from "digging in."

1.02 Plow Coupling: The plow should be coupled directly to the draw bar of the main tractor, the auxiliary tractor being connected ahead of this tractor by a 3/4" winch line (preferably 2 to 1 pull) or 1-1/8" towing line (single line pull). In general, the auxiliary tractor will precede the tractor to which the plow is connected, by 25 to 50 feet; however, this distance will vary depending on the terrain.

1.03 If a third tractor is needed on the job, it should be equipped with the trail-blazer or bull-dozer blade. When the ground is hard and dry this blade can be rested on the roter plow pusher attachment and its tractor used to push the roter in addition to the pull of the other tractors.



2. ROOTING PROCEDURES, ALSO TRENCHING AND CROSSING STREAMS

2.01 General: When soil and other conditions are favorable, a rooting speed of about 2-1/2 miles per hour is desirable (generally third speed in the tractor transmission). However, it is often necessary to use second speed or even low gear (about 2 or 1-1/2 miles per hour) because of adverse conditions. Experience soon indicates the desirable speeds for various conditions encountered. The only purpose of rooting or exploring ahead of the actual cable laying is to be sure that the cable plow can pass without meeting obstructions of various types such as:

- Ground too hard to permit plowing to desired depth in one cut with the available equipment.
- Extra depths at road crossings.
- Large stones requiring removal or detours.
- Large roots that would stall the train.
- Small roots gathering on plowshare requiring frequent removal.

BURIED
CABLE
ROOTING
AND
PREPARATORY
WORK

- (f) Other obstructions requiring backing the plow or rooter to disengage the point.
- (g) Ditches, banks or slopes requiring special attention.

2.02 When to Root, or Trench.

(a) If soil conditions are good and such that none of the above-mentioned obstructions are expected, it is not necessary to root. In many instances rooting in swamps or marshy land will disturb the ground to such an extent that the cable placing is made more difficult. In such instances rooting should be omitted unless subsurface obstructions are suspected. If the expectancy of such obstructions is less than about two per mile, consideration might be given to plowing without previously rooting.

(b) If the expectancy of obstructions is slightly more than in (a), some saving in man-hours and possibly in number of tractors may be realized by coupling the cable placing train directly back of the rooting train. See Section J6.406 second cut.

(c) In general, rooting should be done just ahead of placing the cable. If done too long in advance, as over a winter, the ground may settle sufficiently to require rooting again before placing cable. However, in territory where numerous obstructions of the above-mentioned types are expected, the rooting should be done sufficiently in advance of the placing operations so that time will be allowed for clearing away obstructions before the arrival of the placing train. Rooting in very stony soil proceeds at a slower pace than the placing operation and ordinarily should be started well in advance of the placing operations.

(d) Trenching, Where Plowing is Impracticable.

(1) Rooting (or cable plowing) should not be attempted where sharp changes in grade are encountered. Operations become rather difficult on grades above about 25 per cent. Where soil conditions are favorable, grades up to 50 per cent. can be negotiated and about 65 per cent. is the limit even under best conditions. In some cases, particularly on short grades, satisfactory conditions can be obtained by preliminary grading. If this cannot be done, it may be necessary to place the cable by hand trenching. Hand trenching may also be necessary in instances where rock is encountered near the surface and reduced coverage is used as outlined in Paragraph 2.05 (d) (1). Hand or machine trenching may be found more economical where the run is short and a plow train is not readily available.

(2) Trenching may be found desirable where the type of terrain encountered is such that it is difficult or impossible to traverse with the equipment. Very rocky soil or quicksand would be examples of this. Shoring of the trench walls may be required under some conditions. Whenever it is necessary to enter such a trench, arrangements shall be made for an employee to be stationed above the excavation during the time anyone is in the trench, keeping the person working in the trench within sight at all times.

2.03 Precautions When Train is in Motion: In the rooting operation special precautions shall be taken that no person is within falling radius of the plow during the period the plow is in motion. In event the plow point should strike a boulder or rock ledge and the wheels on one side a soft spot in the earth, there would be danger of the plow upsetting quickly. **UNDER NO CIRCUMSTANCES SHOULD WORKMEN OR OTHER PERSONS BE ALLOWED TO RIDE THE PLOW, OR TO WALK BESIDE THE PLOW OR AHEAD OF THE TRAIN, OR BETWEEN THE UNITS OF THE TRAIN WHEN THE TRAIN IS IN MOTION.**

2.04 Following the Markers: In carrying out this work the tractor operator, in normal position, keeps the equipment in line with the markers previously placed, as the train advances. The inside of the left tractor track should almost contact the markers, if they are placed as required (two feet to the left of the proposed trench location).

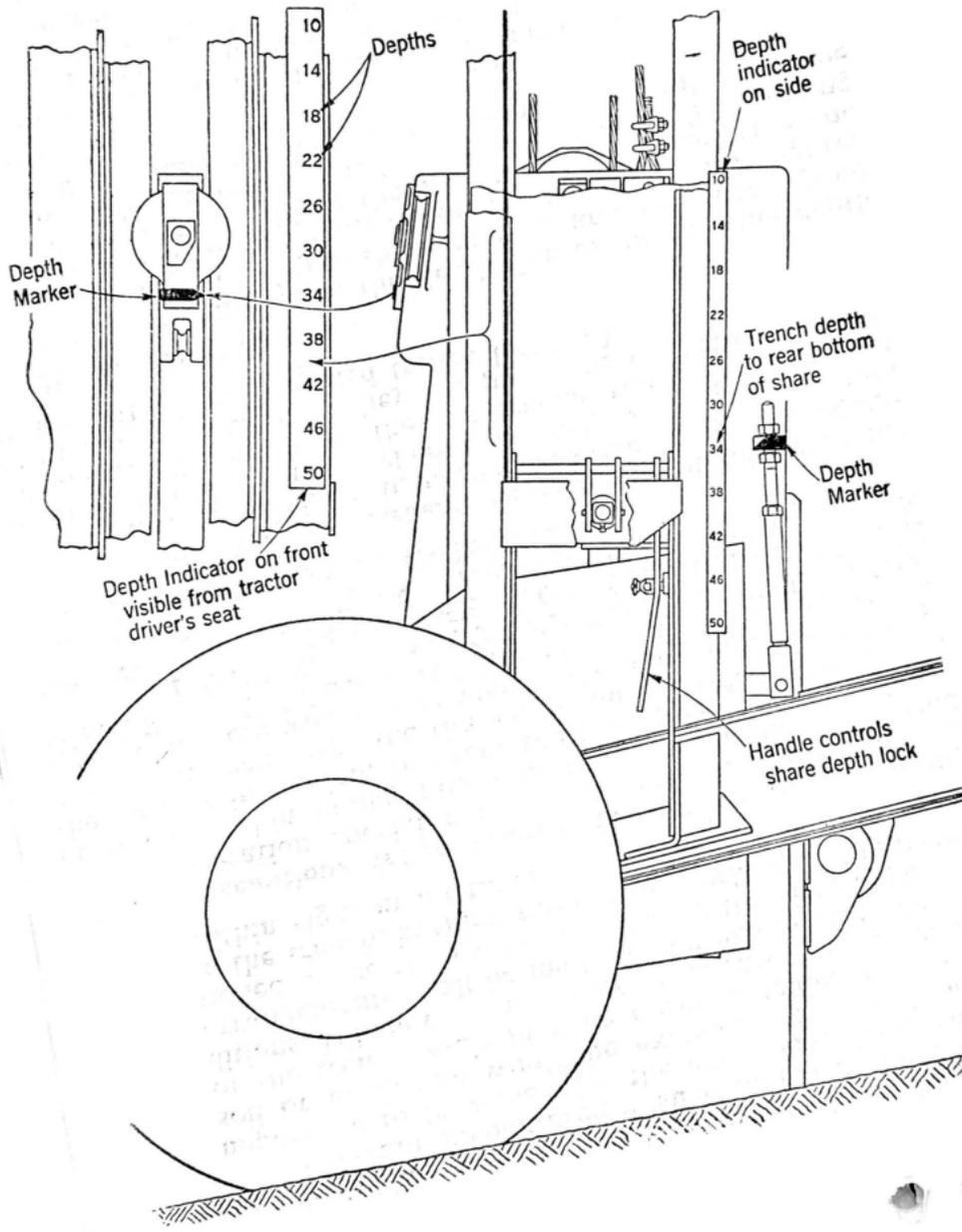
2.05 Depth of Rooting.

(a) In this discussion the depth figures indicate the depth to bottom of plowshare at rear and they correspond with the depth markings on the latest plows. These figures represent what will be the sum of the cable coverage and the cable slot opening at bottom of plowshare. The rooting shall be done to the depth at which the cable is to be placed.

(b) **The range of 18 inches to 50 inches in depth** covers practically all conditions encountered in burying cable with the plow. If a 10-inch depth is required, it is apt to be where hand or compressed air digging, or blasting is necessary. Under unusual conditions the 10 and 14-inch depth settings on the plow may be used for placing cable in a temporary location, pending clearance work on the right of way, preparatory to later moving the cable to its permanent location. Also these shallow depths may be used at a location where fills will later be made above the cable.

BURIED
CABLE
ROOTING
AND
PREPARATORY
WORK

(c) The plowshare can be locked at any depth from 10 to 50 inches, the variation being at four-inch intervals, i.e., 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50 inches. Convenient markings on the plow indicate the depth.



(d) While the desired depths are indicated on the detail plans, local conditions encountered in rooting may indicate a change in depths. The following discussion will be helpful in analyzing these conditions.

(1) **10 or 14-Inch Depth:** Generally desired in rock where trench is made with assistance of compressed air tools or blasting and cable will be protected by a covering suitable for the conditions.

(2) **18, 22, 24, 26-Inch Depths** are desired for a combination of the following conditions:

(a) Where soil contains many rocks or tree roots.

(b) Ground will not be disturbed by farming or other operations.

(c) Soil will not wash away tending to uncover cable because of grades or soil composition.

(d) Conditions generally are such that cost of plowing deeper would be considerable. A C48 plow with roter attachment and pulled by two 40,000-pound tractors should reach one of these depths in one to three passes. The last pass should always be in the direction in which the plowing train will proceed.

(3) **30-Inch Depth** is desired for a combination of the following conditions:

(a) Ground fairly level.

(b) Soil does not readily wash.

(c) Where usual farming or other surface operations occur and do not disturb ground below 8 or 10 inches.

(d) Where "Panbreaker" plows do not disturb below 18 inches.

(4) **34-Inch Depth** is desired where one or more of following conditions exist:

(a) Ground is hilly and erosion at hill tops might reduce coverage protection, thus requiring this depth to maintain coverage.

(b) Dust storms are prevalent.

(c) "Panbreakers" may cut to a maximum depth of 22 inches.

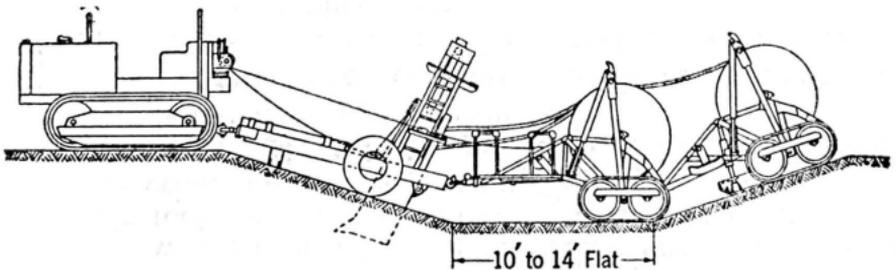
(5) **38-Inch Depth** is desired under conditions similar to those for 34-inch depth except:

(a) Where "Panbreakers" may cut to a maximum depth of 22 to 30 inches.

- (6) **46 and 50-Inch Depths** are desired where one or more of the following conditions exist:
- (a) Under highway ditches and highways.
 - (b) Under ditches or soft bottom streams where the cable might be washed out.
 - (c) Where ground levels may be changed by later improvements.
- (7) In any of the above mentioned ground conditions, where underground structures such as farm drain tile, present or future, may be involved, a depth should be selected to protect the cable as far as practicable, from future subsurface maintenance or construction. The prevailing practices followed in any particular area in respect to placing such foreign subsurface structures, can be used as a guide.
- (8) If lightning shield wires (see Section J6.408) are to be used, the desired coverage of the wires as well as the desired coverage of the cable determine the depth of rooter plowshare setting. The top wire or wires leave the share 19 inches above the bottom. Thus with a 34-inch depth setting the top wire or wires would be laid 15 inches deep. They may settle 3 or 4 inches as the ground settles. While it is desirable that these wires be not disturbed by plowing or other operations, it is not serious if occasionally wires are actually broken as they still provide protection.

2.06 Crossing Washes, Streams, Irrigation Ditches, Etc.

- (a) If washes or creeks with steep sides and with narrow bottoms are encountered, it will be necessary to grade the sides and provide a bottom width of at least 10 feet before rooting is attempted.



Gradual slopes desirable to keep plowing depths uniform at slope changes.
 Cable reel trailers added in cut to illustrate need for grading. Trailers are omitted while rooting.

(b) The procedure outlined in (a) may be objectionable, particularly at irrigation ditches, as infiltration of the irrigation water might result. At such locations the buried cable or, if necessary, wire armored cable, placed by hand trenching with specially tamped backfill, or pipe crossings may be used. In the latter case protection against freezing may be essential. This can be provided by placing the pipe below the frost line, or by opening the pipe at the low point and providing proper drainage if it can be obtained. If pipe is used, either plain lead covered or the buried type of cable is satisfactory.

(c) In crossing the larger creeks and small rivers where conditions permit, a trench should be rooted across by pulling the rooter plow with the winch line and later pulling the cable plow with the loaded trailers along the same trench by locating the winch at the same position as when rooting.

(d) Where this construction is not practicable because of rocks or quicksand in the stream bed, or where the cable in the stream may be exposed to damage, it may be necessary to specify wire armored cable. This should be covered in the detail plans.

(e) If found desirable, wire armored cable can be fed through the plow. However, since wire armored cable is larger than the same cable when jute or tape armor is used, it may be necessary to change the plowshare shims. See Section J6.406. With the larger cables it is possible that a jute or tape armored cable can be plowed but not the corresponding wire armored cable which might be too large to pass through the share.

2.07 Procedures on Steep Hills.

(a) On steep hills the power required to move the tractor without its load up the hill may use practically all the available engine power. Under such conditions the auxiliary tractor or tractors are disconnected from the train and located up the hill. If the hill is long, these tractors must be placed part way up the hill, the rear auxiliary tractor being not more than one-half the length of its winch line from the main tractor in order to permit a 2 to 1 winch pull. The second auxiliary tractor may be ahead as an anchor holding on the front hook of the rear auxiliary with its winch line. This operation is repeated as necessary.

(b) If the slope is such that the auxiliary tractors can proceed in a forward direction up the slope straddling the proposed cable location, the block can be attached to the main tractor's front towing hook, the winch line

BURIED
CABLE
ROOTING
AND
PREPARATORY
WORK

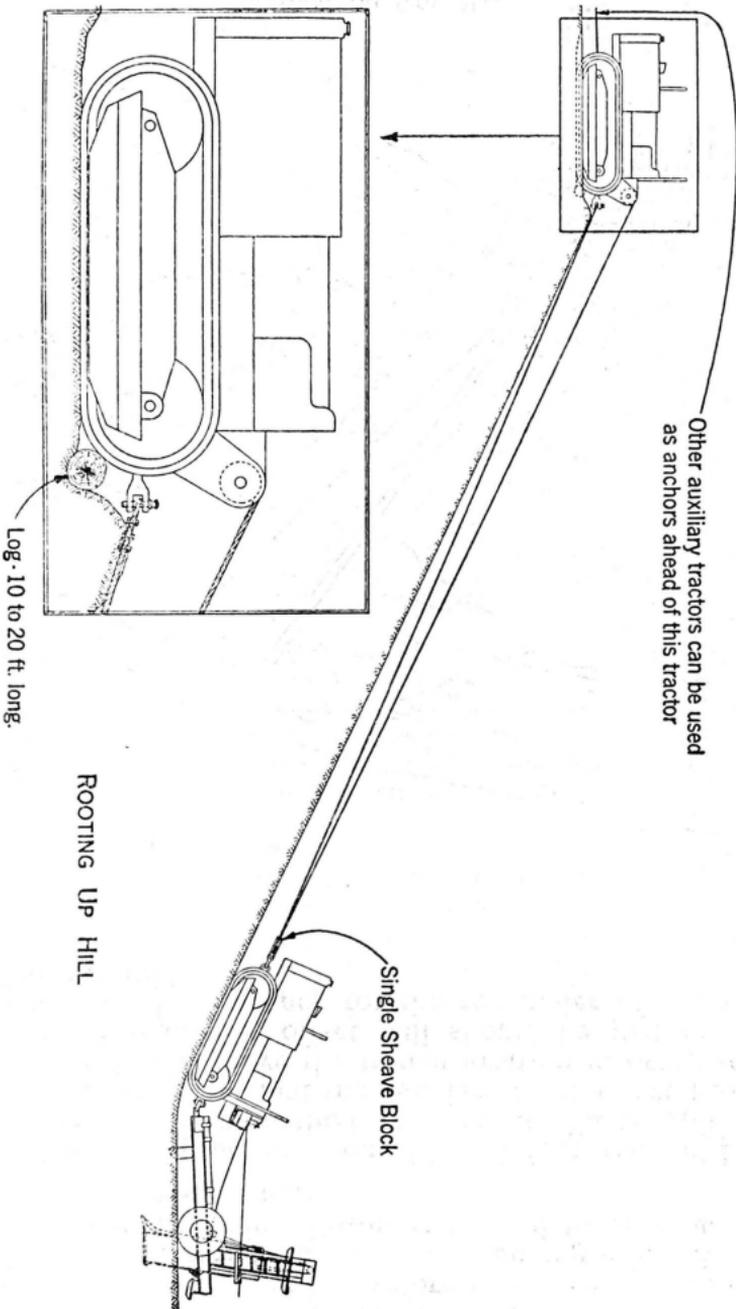
threaded through the block and attached to the rear towing hook of the first auxiliary tractor. Then in locating the tractors the winch line will pay out as the auxiliary tractor proceeds up the hill.

If conditions are such as to require frequent use of the winch line and block from auxiliary tractor to main tractor, the winch line should be left in place and used instead of the towing line. When the winch line is not required, the towing line should be used since its lower connection on the auxiliary tractor results in better pulling performance with the tracks of the front tractor.

(c) If the slope is such that auxiliary tractors must detour to reach the top of the hill, it will be necessary to pull the rope down the hill to the main tractor. Leave the block at the bottom of the hill before moving the auxiliary tractor. After threading the end of the winch rope through the block, the end is carried up the hill and attached to the auxiliary tractor towing hook.

(d) Under some conditions a winch equipped tractor can be backed up a steep hill that cannot be negotiated in a forward direction. In this case the rope can be threaded through the snatch block and attached to the auxiliary tractor towing hook before it proceeds up the hill. The winch rope will pay out under the tractor as it moves. The tractor is turned around at the top of the hill before making a winch pull.

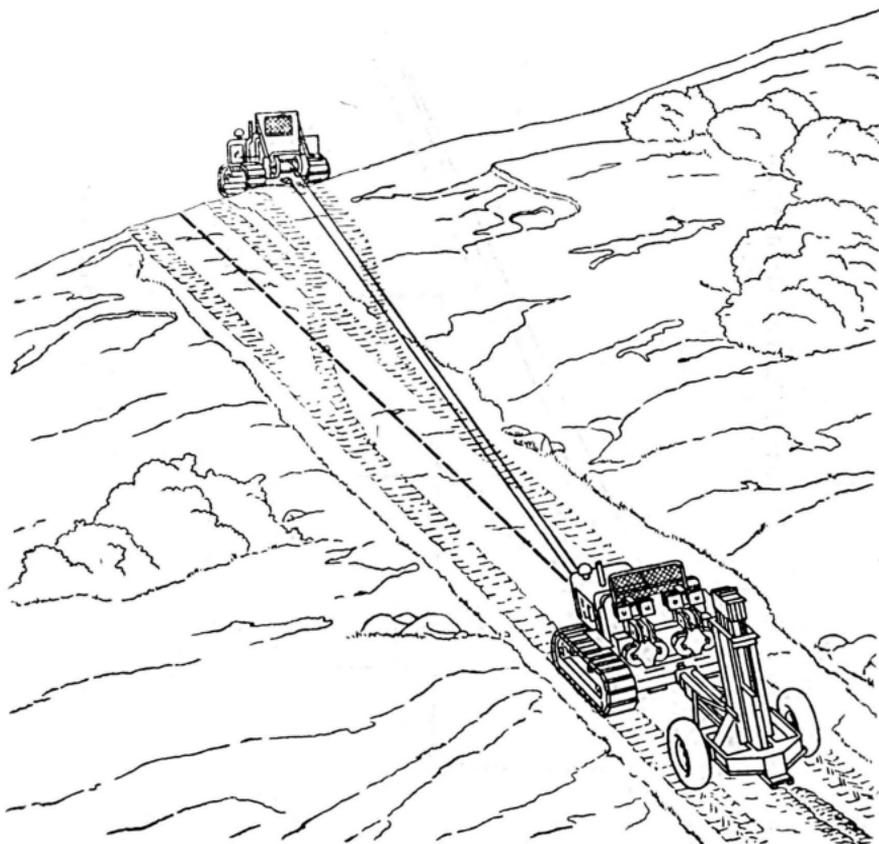
(e) After the tractor is in position take up the slack in the winch line. If only two tractors are being used in the train, it is usually necessary to anchor the auxiliary tractor before the maximum pull can be made with the winch line. This is accomplished by setting the brakes on the main tractor and churning the tracks on the auxiliary tractor pulling against the winch line (with winch drum brake set), until a depression is cut under the tracks. In some cases it is desirable to chock the auxiliary tractor tracks with a log, railroad tie or pole stub. If more than one auxiliary tractor is available, it is sometimes necessary to dig in each of them connected in series ahead of the main tractor with their towing lines or winch lines.



**BURIED
CABLE
ROOTING
AND
PREPARATORY
WORK**

2.08 **Rooting on side hills** where the grade is appreciable, is generally accomplished by winching the train. The tractors have a tendency to slide down a side hill when power is applied to the tracks and therefore it is necessary to do considerable steering with resulting loss of pulling effort if traction is used to pull the train. (Power is applied to only one of the two tracks when steering.)

(a) On grades up to about 10% (1-foot rise in 10 feet) the winching method outlined in Paragraph 2.07(e) can be used except that the auxiliary tractors are positioned on the side hill above the trench location in order to make an offset pull. The offset pull should be just enough to counteract the tendency for the remainder of the train to slide downhill.



ROOTING ON SIDE HILL

(b) On grades of about 10% or more it is generally necessary to cut a road, 10 feet wide and approximately level, in the side hill. Ground composition, length of side hill location and traction available, determine to some extent the grade upon which a road is necessary.

(c) In general when winching a train on side hill the main tractor is used in neutral or using only enough power to steer, merely serving as a support for the plow tongue. Less sidewise displacement of the auxiliary tractors is necessary if power is not used on the main tractor tracks.

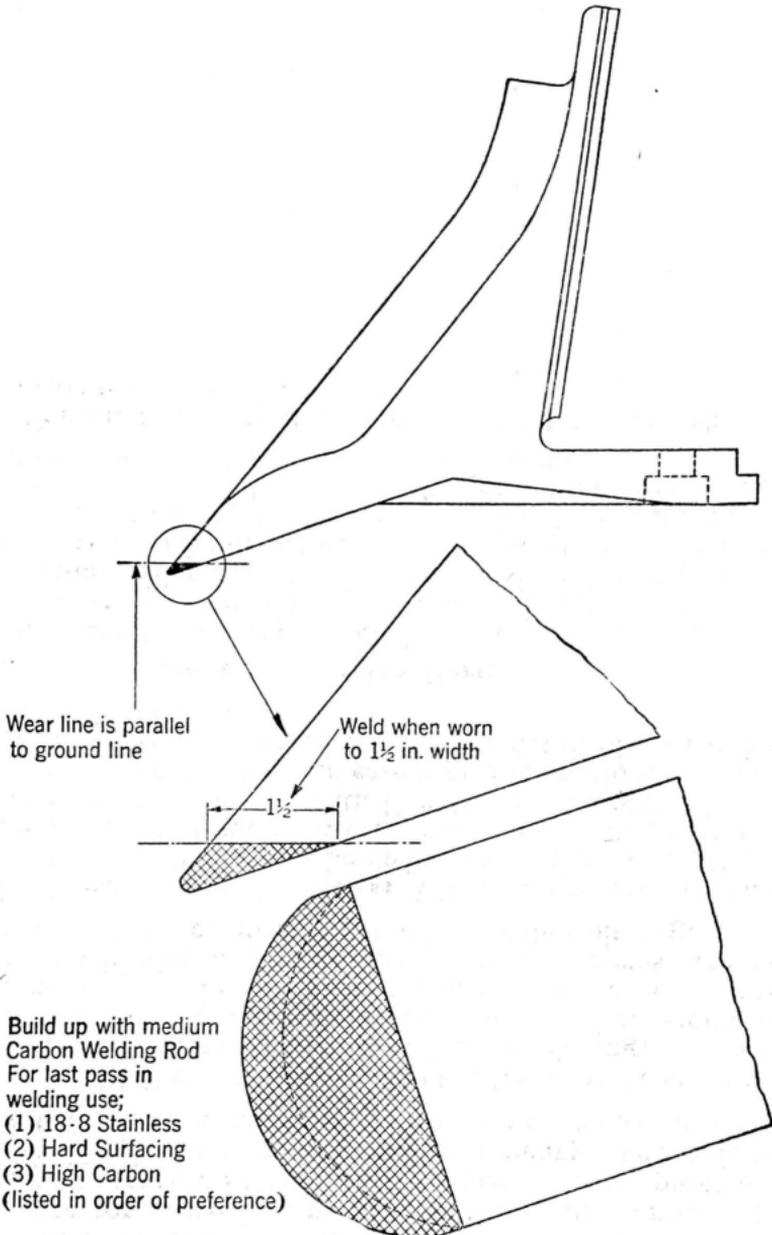
2.09 Avoid Hazards Due to Rooted Trench: If several days elapse between rooting and cable placing, rooting may be impracticable in open fields occupied by live stock which might be injured in the rooted trench. Under some circumstances it will also not be practicable to root across frequently traveled roads much in advance of the cable placing.

2.10 Procedure at Obstacles: Where obstacles are encountered which cannot be dislodged by the roter, the share can be raised and then lowered after the obstacle is passed. The place shall be marked with 1" x 4" stake on which is printed "boulder" or "root" or other essential information. Its approximate location shall be noted also on the detail plans for further attention. See Part 3.

2.11 Replacement of Wearing Parts.

(a) **Plow Points** should be kept reasonably sharp. If the worn section on the original design of plow point becomes wider than 1-1/2 inches, it should be replaced with a new or rebuilt point and the worn point should be returned to a welding shop for rebuilding. The cut below shows the original shape of the plow point and the shape when worn section is 1-1/2 inches wide.

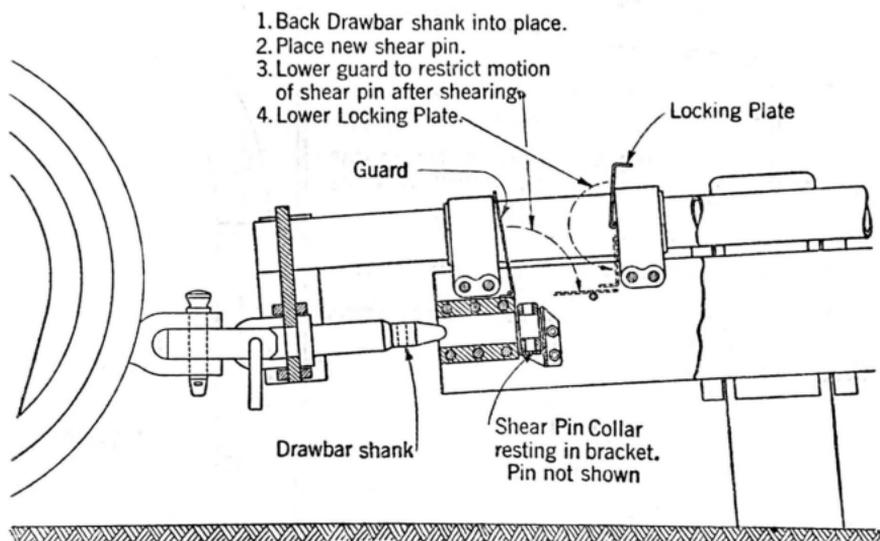
For the special roter share the point remains sharp until worn up to the wide flat section.



REBUILDING OF ORIGINAL DESIGN PLOW POINT

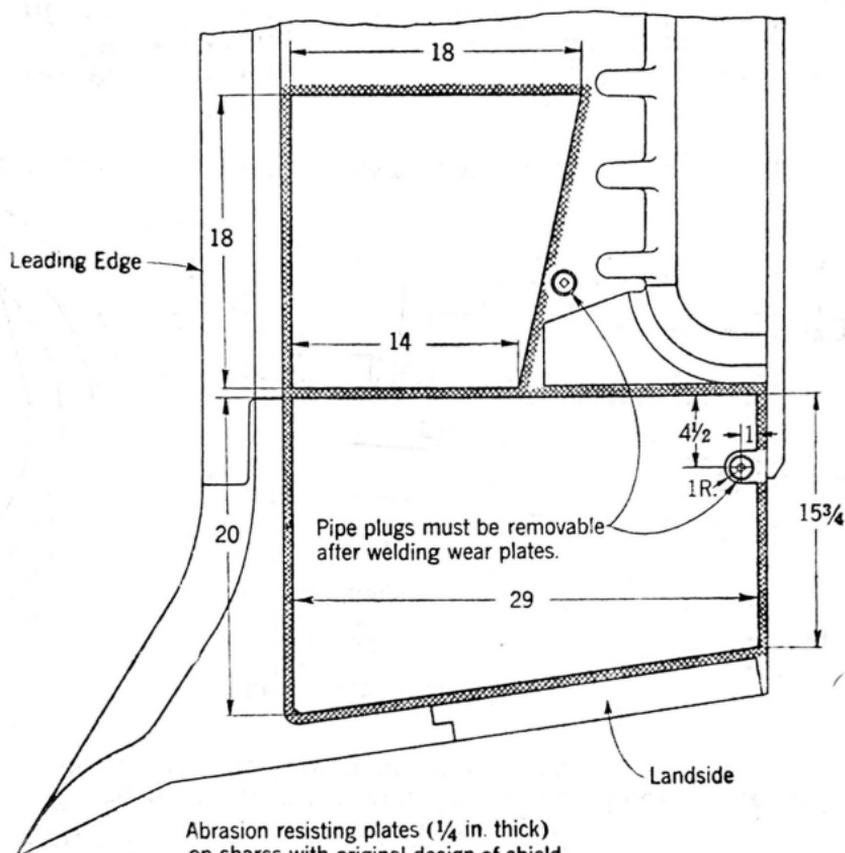
(b) **Shear pins** need to be replaced only when they break in service. An extensible plow tongue operates after the shear pin breaks, and is of such length that the tractor driver can stop the tractor before the two parts of the tongue separate. When a shear pin breaks, the holes in the collar and the drawbar shank should be examined and any remaining pieces of the shear pin removed. With the collar resting in its holder, the tractor can be backed and the drawbar shank will center itself in its bearing and collar. **DO NOT GUIDE COLLAR WITH HANDS AS SHANK ENTERS COLLAR.**

Place new shear pin and drop cover. Lock cover to keep ends from flying when pin shears again.

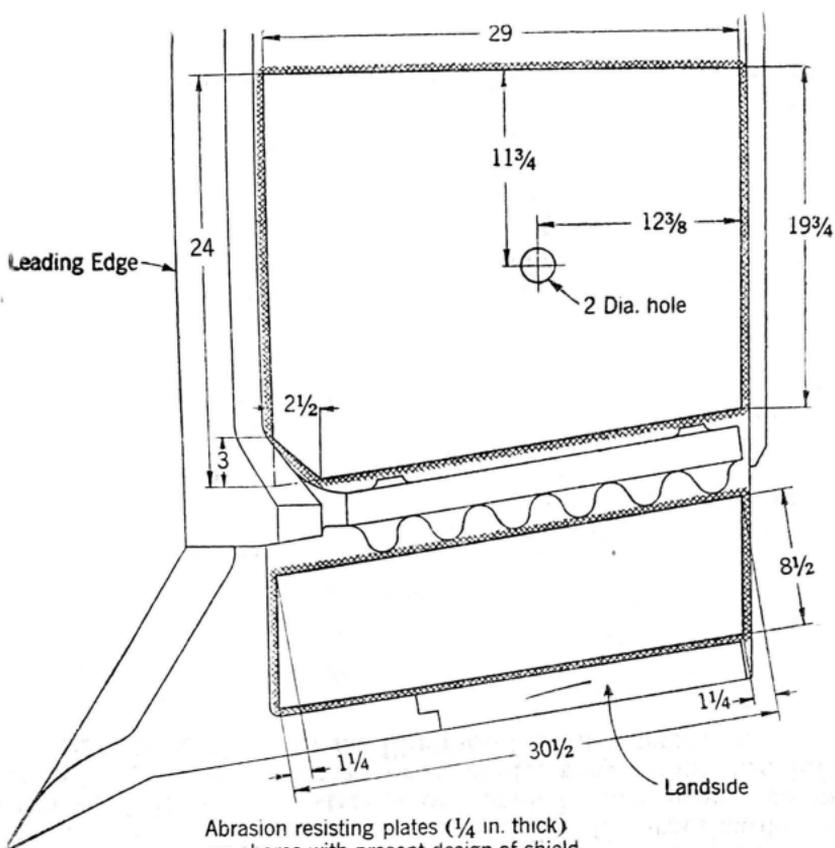


(c) **Weld worn sections** of plow as they develop in service. Wear plates are now standard equipment on the sides of the plowshare. At intervals of not more than 10 miles of plowing the extent of wear should be estimated by examination of the share. This can generally be done when the share is raised, drawn into a trench or otherwise exposed. The wear plates should be replaced when they start to puncture in spots or are worn thin enough to pull off in service. Abrasion resisting plates (such as those containing approximately 1.75% manganese) should be used in replacing worn wear plates. Drawings listed on 272-B-47 are for use of repair shop in replacing worn wear plates. If no spare

plow is available for use while repairs are being made, the work can be done in the field by turning the plow on its side and partially withdrawing the share exposing the section to be worked on. Other sections should be examined when exposed in this operation. The leading edge and landsides should be built up with hard surface welding rod if the sections are worn.



Abrasion resisting plates (1/4 in. thick)
on shares with original design of shield
wire ducts.
Use same welding as described in 2.11 (a)



Abrasion resisting plates ($\frac{1}{4}$ in. thick) on shares with present design of shield wire ducts.
Use same welding as described in 2.11 (a)

3. OBSTACLES IN RIGHT OF WAY

- 3.01 **Obstacles left in the rooting operation** should be uncovered by hand and removed.
- 3.02 **If it is impracticable to remove the obstacle**, and changes in route are not desirable, a trench around the obstacle should be considered, such a trench being toward the near edge of the right of way, to avoid interference if an additional cable is placed at a later date.
- 3.03 **A trench can be prepared** through a ledge or boulder by blasting if a detour is impracticable.

4. ADDITIONAL GRADING

4.01 Additional grading that may have been indicated by the rooting operations should be done in advance of the cable plowing.

5. SPOTTING REELS

5.01 Spot the reels on firm ground at a readily accessible point, preferably about 100 feet from the splice location in the direction from which cable plow will approach and sufficiently to one side so as not to interfere with the placing train. If two cables are being placed, the two reels should be spotted so that either may be loaded from either side, without moving the other.

5.02 Reels should be securely blocked to prevent rolling. Reels should not be left on grades if it can be avoided. When it is necessary to leave a reel on a grade, cant and block it so that it cannot roll downhill. They should be stored where they will not inconvenience the public. If practicable, they should be left on side streets or roads in preference to main thoroughfares. In so far as practicable, they should be left at locations where there is no likelihood of fire hazards.