THE BRAKING MECHANISMS USED TO WAGONS AND LOCOMOTIVES

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Abstract: This paper presents kinematic diagrams of the major mechanisms used as linkages for parking brakes on rail wagons and locomotives. For classical linkage brake blocks on wheel axle wagons or locomotives are used articulated mechanisms with bars, gears, chains and bolts articulated motion. In the case of planning linkage blocks (jaws) disk brake consists of deformable elements, such as cables. Two-axle wagons or 4 axles (bogies with two axles) with central linkage, when is only one brake mechanism. At diesel-electric locomotives with three-axle bogies there are two mechanisms for each bogie brake.

Key words: Keywords: mechanism, kinematic element, kinematic joint, parking brake, car, train, central wheelhouse, mobility, sabot, jaws (sabot plan).

1. General aspects

Each railway vehicle, like other types of vehicles is equipped with brake systems [2, 3, 4]. Brake mechanism of railway vehicle is realized in several variants, as articulated rods structure [1,4], gears, screw motion, articulated chain and special cables (in the form of flexible rod guided channel ball).

These mechanisms differ by type of vehicle brake linkage, which may be cylindrical blocks wagon wheel running (Fig. 1.1) and locomotives (Fig. 1.2) or jaw (jaw plan) discs mounted on axles wagons.

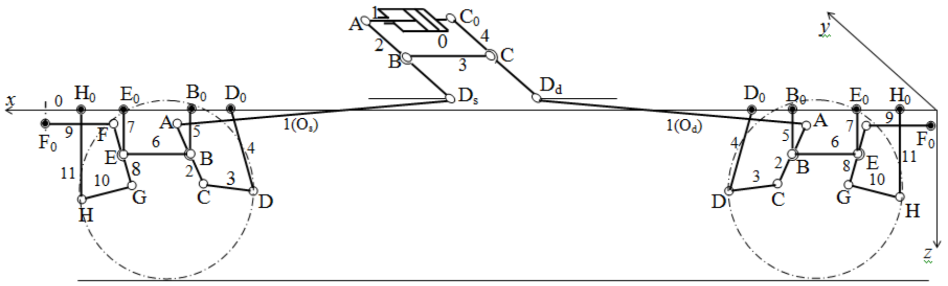

Fig. 1.1. Kinematic scheme of a braking mechanism on a two-axle rail car

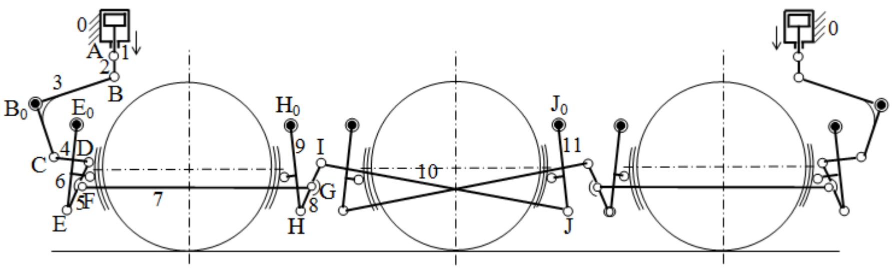

Fig. 1.2. Kinematic scheme of the mechanism of the bogie brake blocks on 3 axles (locomotive)

2. Wheelhouse cars with brake blocks on wheels

To wagons with wheel brake blocks the brake linkage, is placed at one end of the wagon and act only in a sense the central linkage (Fig. 1.1) located in the horizontal plane (Fig. 2).

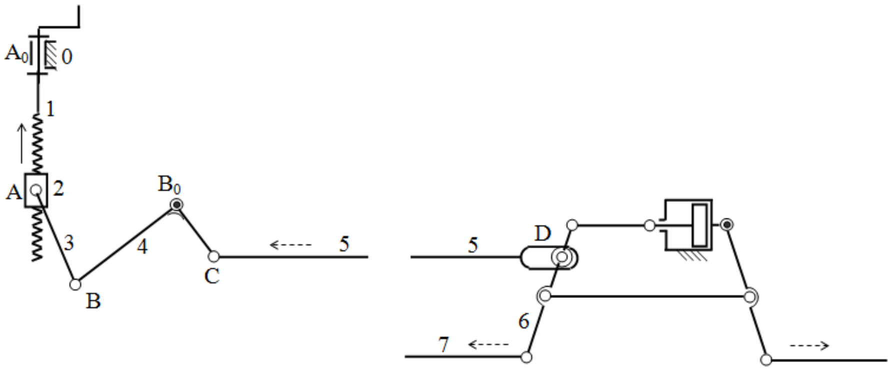

Fig. 2. Kinematic scheme of the hand linkage with screw, from wagon.

The mechanism driver is the vertical screw element 1 (Fig. 2), which is manually operated with crank that rotates horizontally.

By means of nut-skate 2 and the connecting rod 3, the movement is transmitted vertically to the arm 4.

Trough C joint the arm 4 is articulated at bar 5, with long length, at the end of the wagon to central wheelhouse.

Note that, by pressing the bar 6 from brake cylinder, the longitudinal rod 5 oscillates slightly around point C because point D of roller is guided rectilinear in channel.

In the first phase of functioning of brake linkage (Fig. 2.1) the D centre of roller remains fixed.

Because it identifies two independent closed contours families equal ($f_1 = f_2 = 2$), mobility of parking brake mechanism is calculated by the formula [1, 5, 6]

$$M = (6 - f)n - \sum_{k=f+1}^{5} (k - f)C_k \tag{2.1}$$

where $f = f_1 = f_2 = 2$ is the real family.

If in (2.1) are replaced the numerical parameters (fig. 2):

$$f = 2,\ n = 5, C_5 = 6,\ C_4 = 0,\ C_3 = 1,\ C_2 = C_1 = 0,$$

It results the mobility

$$M = (6-2)\times 5 - (5-2)\times 6 - (4-2)\times 0 - (3-2)\times 1 = 4\times 5 - 3\times 6 - 1\times 1 = 1 \tag{2.2}$$

3. Handbrake on diesel - electric locomotives (D - E)

In the case of D-E locomotives, kinematic scheme of handbrake linkage (Fig. 3a) is similar to that of wagons.

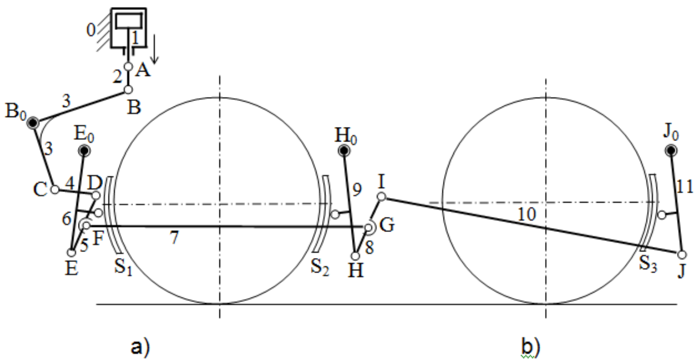

Fig. 3. Kinematic scheme of one of the linkage brake of D-E locomotives

Trough the crank rotation (screw joint motion 1) the skate movement is transmitted to nut-2 and hence through rod 3, movement reaches to arm 4 (Fig. 3a).

Further movement is transmitted through dyadic chain LD (5, 6) to the longitudinal bar 7.

The mechanism mobility is calculated with the relation P. Antonescu [1]:

$$M = (6 - f_a) \cdot n - \sum_{k=1}^{5} (k - f_a) \cdot C_k \qquad (3.1)$$

In the mechanism structure they are two closed independent contours: the kinematic chain (0,1,2,3,4,0) with family $f_1 = 2$ and the chain (0,4,5,6,0) with family $f_2 = 3$. We obtain the apparent family f_a as a real number and are established as arithmetic average of those two contours families:

$$f_a = \tfrac{1}{2}(f_1 + f_2) = \tfrac{1}{2}(2+3) = \frac{5}{2} \qquad (3.2)$$

Observing the kinematic scheme (fig. 3.1a) we identify $n = 6$ mobile kinematics elements, $C_5 = 8$ kinematics joints by 5 - category.

Introducing the numerical date in the formula (3.1) it results:

$$M = (6 - \tfrac{5}{2}) \times 6 - (5 - \tfrac{5}{2}) \times 8 = 1 \qquad (3.3)$$

The obtained result $(M = 1)$ shows that the handbrake mechanism for those three blocks S_1, S_2 and S_3 (fig. 3b) can be actuated from a single kinematic element (the driver element 1).

4. Handbrake linkage with articulated chain (Gall)

The other three blocks on the right side of the bogie (Fig. 1.2) are manually operated by another brake linkage mechanism, placed in the right of kinematic scheme (Fig. 1.2).

There is a variant of handbrake linkage mechanism from passenger coaches which uses the articulated chain 2 type Gall and screw motion 3' fixed with gear 3 (fig. 4).

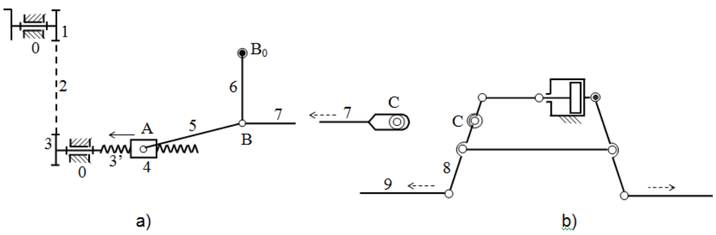

Fig. 4. Kinematic scheme of brake mechanism with Gall chain and screw motion

The crank is fixed with the gear 1 upon passes the Gall chain 2, by means of the rotation movement is transmitted to tooth gear 3 (fixed to the motion screw 3'). The rotation motion of the screw is transformed in translation movement of the nut-skate 4 (fig.4a) which is articulated in joint A to the rod 5.

By means of the rod 5 the translation movement of the skate 4 is transformed in rotation movement of the arm 6. The B joint is double, because in this joint are coupled three kinematic elements 5, 6 and 7.

The element 7 connects the central linkage (fig. 4b) in point C, from which the movement is transmitted trough bars 8 and 9 farther to the brake linkage blocks. The mechanism mobility (with bars, cylindrical gears, articulated chain and screw) of the hand brake (fig. 4a) can be calculated with the formula P. Antonescu [1]

$$M = \sum_{m=1}^{5} (mC_m) - \sum_{r=2}^{6} (rN_r) \qquad (4.1)$$

Following the kinematic scheme (fig. 4a) are identified the following structural parameters (the kinematics joints mobility m , the number of kinematics joints C_m by class m , rank of space associated r of a closed contour, number of contours N_r by rank r) :

$m=1;\ C_5=8;\ r=3;\ N_3=1;\ r=4;\ N_4=1$.

Replacing those numbers in relation (4.1) we obtain the value of mobility: $M=1\times 8-(3\times 1+4\times 1)=1$, which justify the possibility of actuating of the hand brake from a single motor element 1 (fig. 4.1a).

5. Mechanism of handbrake with cable

Cable handbrake mechanism is used both to complex linkage blocks on wheels from wagons and the simple linkage braking jaws (blocks plane) on a disk (Fig. 5.1a) or two disks (fig. 5.1b) fixed on wagon axle [7, 8].

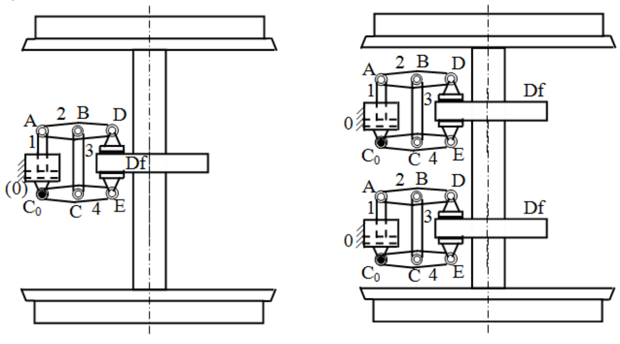

Fig. 5.1. The constructive schemes of the simple disk-brake mechanisms

In this case the hand brake (fig. 5.2) has a complex structure (with rigid and flexible kinematics elements), and as final element is the piston 6 of the automatic handbrake [8, 9].

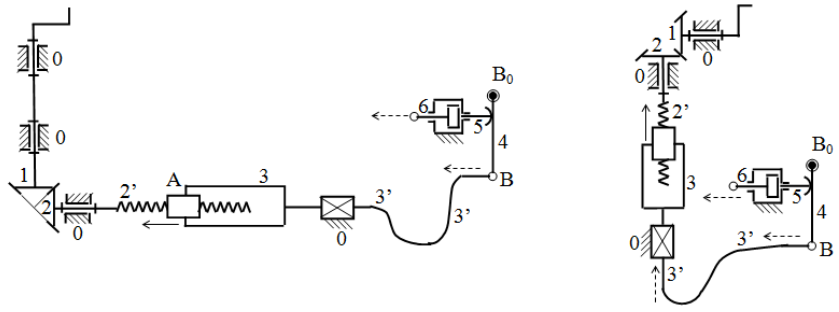

Fig. 5.2. Kinematic scheme of handbrake linkage with cable - elastic rod

The crank is fixed with the conical tooth wheel 1 which engages with the tooth gear 2 fixed with the motion screw 2'. The rotation movement of the screw 2' is transformed in translation movement of the nut-skate 3. The cable 3' (which is fixed with the skate 3) is guides by means of a deformable tube and actuate upon the arm 4. The element 4 pushes on the rod 5 which in turn push the plunger 6 producing braking of disk mounted on the wagon axle.

6. Handbrake for complex linkage of brake with jaws on disc

The mechanism of hand brake for the jaws on disc brake linkage from a two axle's bogie is presented in (fig. 6).Consider the case of a two-axle bogie with automatic brake disk using sabots (Fig. 6) in which each braking linkage of an axle with two disks is driven by a single actuator cylinder oscillating around the joint axis A_0.

Those two disc brake mounted on an axle is obtained by successive action of four jaws including B1, B2 on disk D_{f1} or B3 and B4 on disk D_{f2}. The crank rotation is transmitted and converted into translational movement of the cable 13 with two branches (Fig. 6) and passing over a roller mounted in the centre J of the bar 9.

By moving to the left of the bar 9, translational motion is transmitted through the bars 10 and 10' to the balancing arms 11 and 11', which rotate in opposite directions.

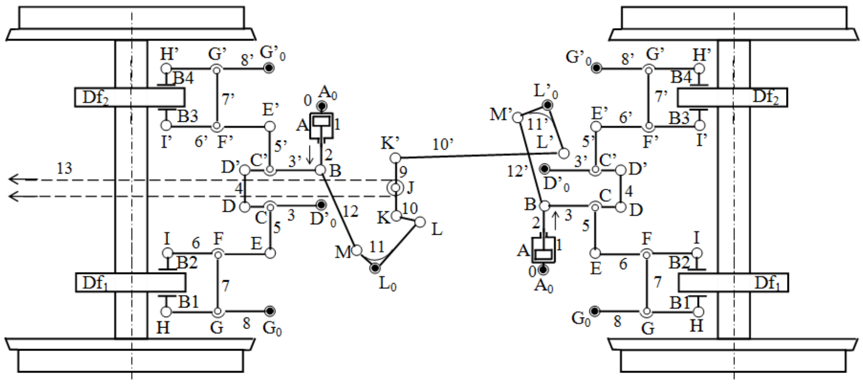

Fig. 6. Kinematic scheme of handbrake linkage with cable.

From those two balancing arms 11 (which rotate trigonometrically) and 11' (which rotate reverse direction), the movement is transmitted by means of rods 12 and 12' to piston 2 (left and right), actuating those two branches of the cable 13 in the direction indicated in the scheme (fig. 6.1) from right to left.

7. Conclusions

Mechanisms studied in this work are used as parking brake linkage fitted to railway wagons and locomotives.

To operate the parking brake wagons and locomotives are used motion screw mechanisms and other cinematic elements of different types, such as plane articulated bars, the gears (cylindrical or conical) articulated chain and cable guide. Handbrake mechanism is a kinematic chain with serial connections, which can act if lost engine piston motor agent represented by the compressed air from the brake cylinder.

By using screw motion in all kinematic schemes handbrake mechanism, is ensured satisfactory mechanical efficiency, which allows reduction of railway vehicle braking time.

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